

Geographic information—Location Based Service—A Brief Introduction to Partition Network Model

28 May, 2008

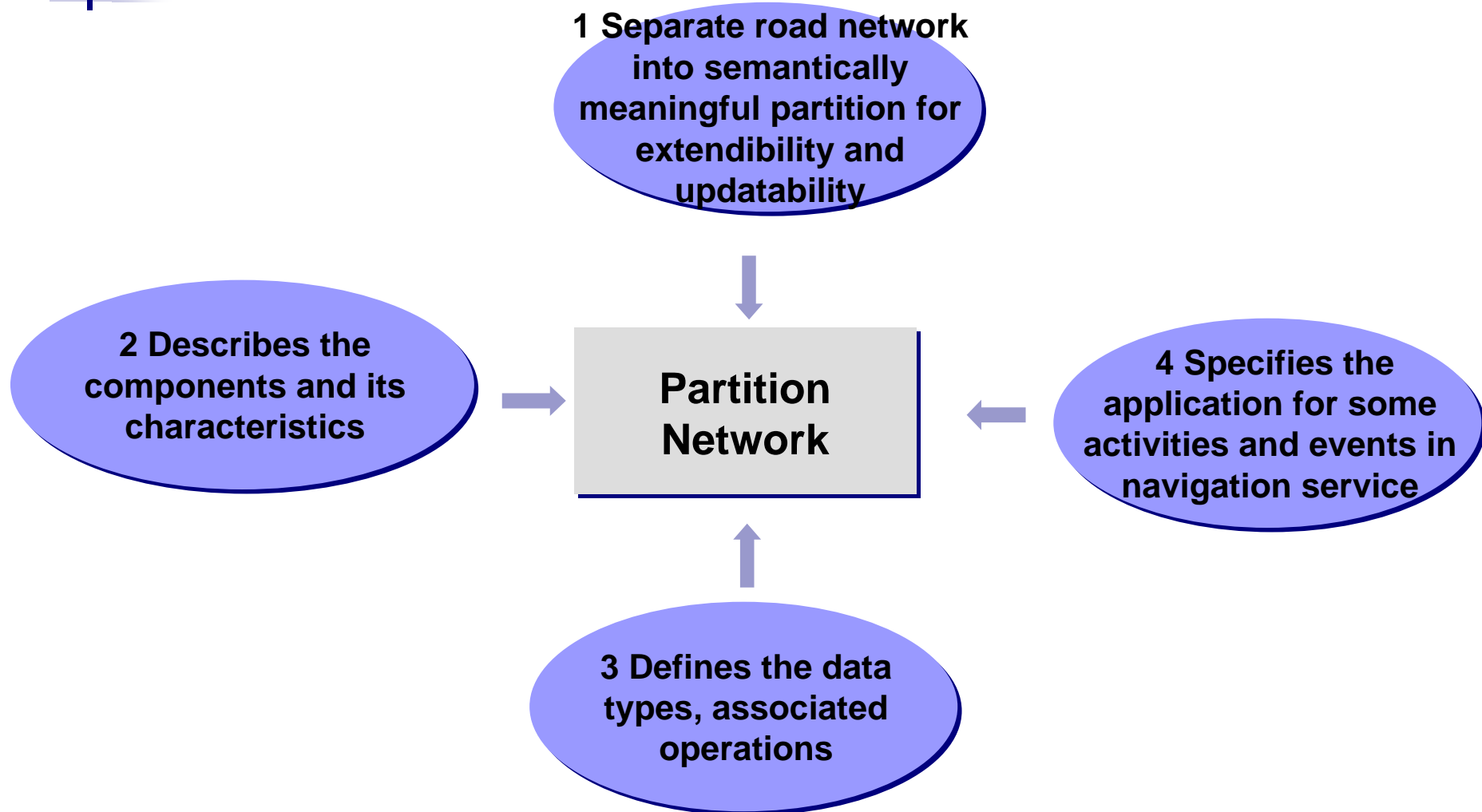
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ISO/TC 211 Workshop standards in action

Contents

- 1 Main objectives**
- 2 Related Standards**
- 3 Overview**
- 4 Creating**
- 5 Operations and Roles**
- 6 Conclusions**

1 Main objectives



2 Related Standards

- Expands the ISO 19133 network model, in order to enhance the efficiency of routing and updating
- Other referenced document
 - ISO 19107: Spatial Schema
 - ISO 19108:Temporal schema
 - ISO 19109:Rules for application schema
 - ISO 19110:Methodology for feature cataloguing
 - ISO 19111:Spatial referencing by coordinates
 - ISO 19112:Spatial referencing by geographic identifiers
 - ISO 19128:Web Map Server interface
 - ISO 19132:Location based services – Reference Model
 - ISO 19134:Location based services - Multimodal routing and navigation

3 Overview: Focusing on partitioning

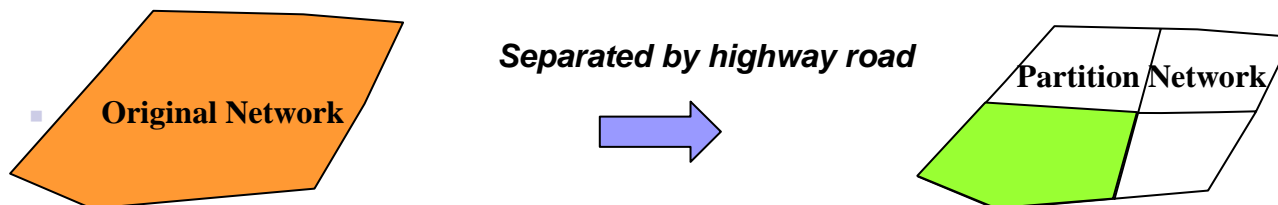
- **The road network as a whole is too large to load into memory and find a minimum-cost route fast, it is necessary to use some kind of pre-processing, such as partitioning**
- **Some applications are used or concerned only with part of the network. We may create a relatively small region which includes these links, according to the procedure of creation defined in this clause**

3 Overview: Focusing on partitioning

- **Constructs the partition network to support the service mode “Data On Demand”. This service mode provides the necessary data just to fulfill the users’ demands. When roads are changed, the partition network model can be used to implement partial update models which define the methodology to update the network data only on changed partitions or data blocks.**

3 Overview: Separate road network

- Uses the natural hierarchy present in road networks to decompose the network into semantically meaningful areas
- All roads with class lower than the ones used for decomposition are called the lower-level roads; Other roads used as decomposition separator are called the highway roads
- Highway roads should be selected under the principle of achieving size balanced partitions

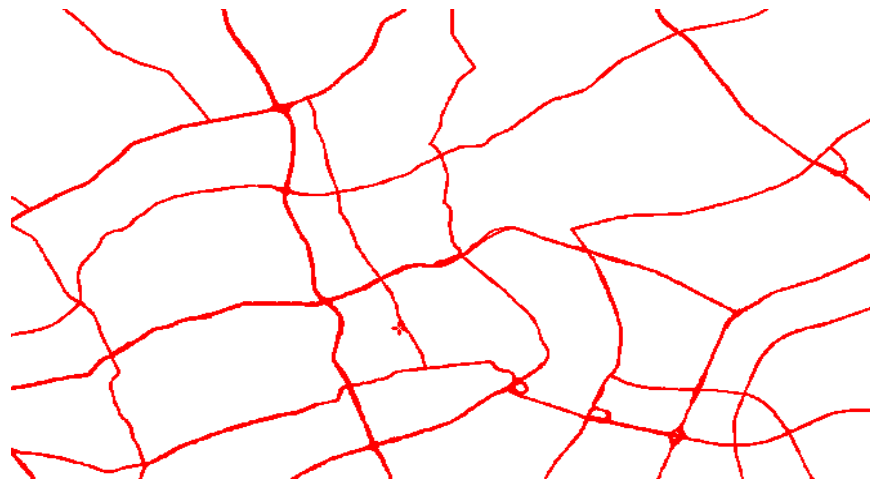


3 Overview: 2-level partitions

- For a 2-level road class approach, the resulting partitions including a single highway partition and a set of lower-level partitions.
 - Every link in *original network* is contained in exactly one partition (either highway or lower-level network).
 - For a multi-level road class approach, by iteratively repeating the decomposition procedure, we can expand to multi-level partitions.

3 Overview: Example of Highway Partition

- To provide efficient calculation of shortest paths between nodes not contained in the same partition, we define a highway partition, which is actually a partition with highway roads of the origin network, whose nodes intersect all (lower-class) partitions



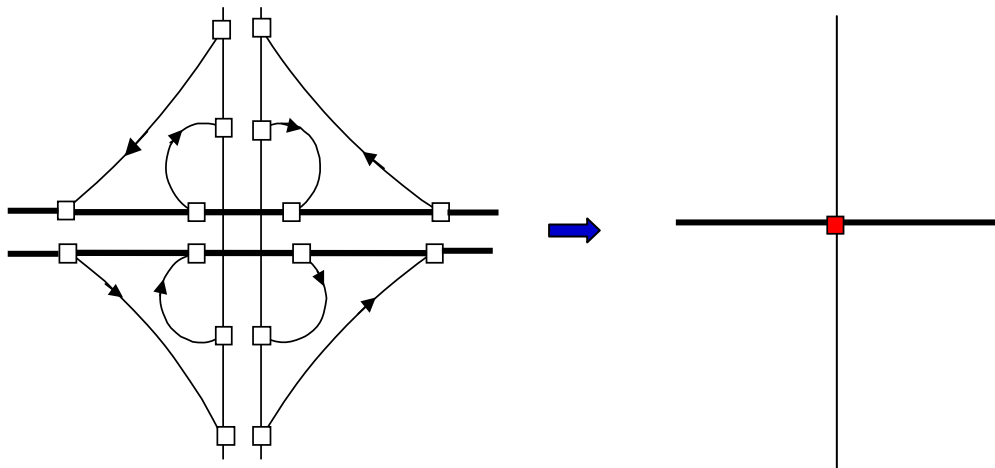
3 Overview: Example of Lower-level Partitions

- **Each lower-level partition is enclosed by roads with highway classes, and contains only lower-level roads**
 - Being quite natural when compared to arbitrary partitioning methods such as the grid-based one
 - There will be many but smaller partitions in dense regions of the network, and less but larger partitions at more sparse regions of the network
 - Every partition inherits the attributes of the original network.



4 Creating: Generalize Highway Network

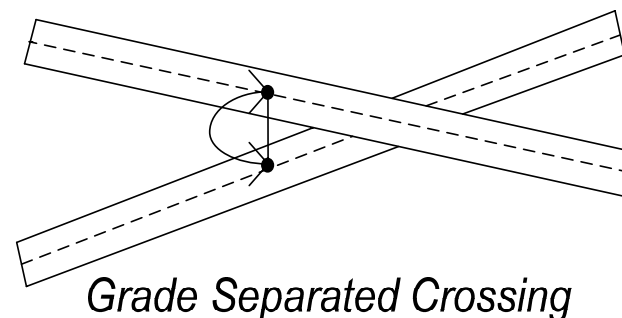
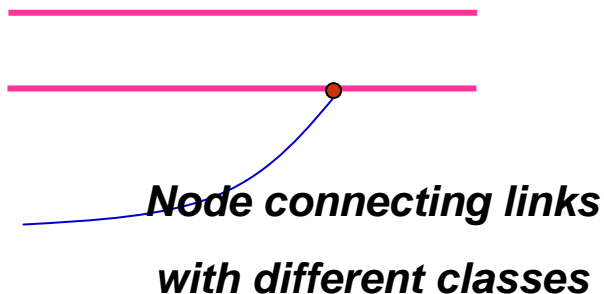
- The decomposition process can use the higher highway roads to divide the network into regions enclosed by such roads
- It is advantageous if the decomposition handles complex highway network element as a whole and not as a set of nodes and links in order to provide semantically meaningful decomposition.



4 Creating : Select Separator

■ Select partition separator

- A node connecting links from lower-level roads to highway roads;
- In situation with a lower-level road that has the relationship of *Grade Separated Crossing* with a highway road, We need a partition separator on the same position of crossing



4 Creating: Get Internal Element

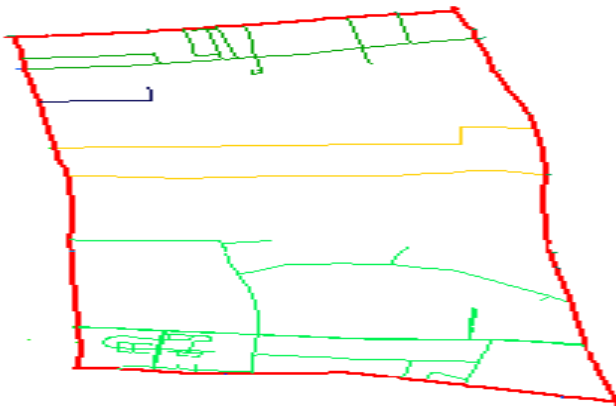
- **Chooses a node with all connected links having lower-level classes**
- **Move to all neighbors of the node that are reachable through the nodes excluding partition separator**
- **The reachable road shall form a area that is called a partition**

■ Creating: Get Geometric Boundary

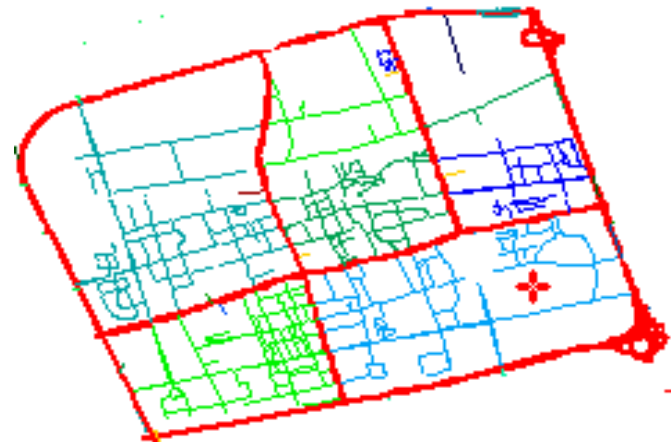
- A partition network, a part of the original network, is separated from the remainder of the original network. In this case, we call it a complementary partition network.
- The partition's geometric boundary divides the network into 2 regions: the region of the partition network; and the region of complementary partition network
- Owing to taking *grade separated crossing* as the partition separator, the geometric boundary is not necessarily topological connected

4 Creating: Combine Small Partitions

- Builds a single partition from component partitions that have the same Geometric boundary
- Builds a single partition from small component partitions that are adjacent. Downwards the related highway roads which are used to separate the component partitions



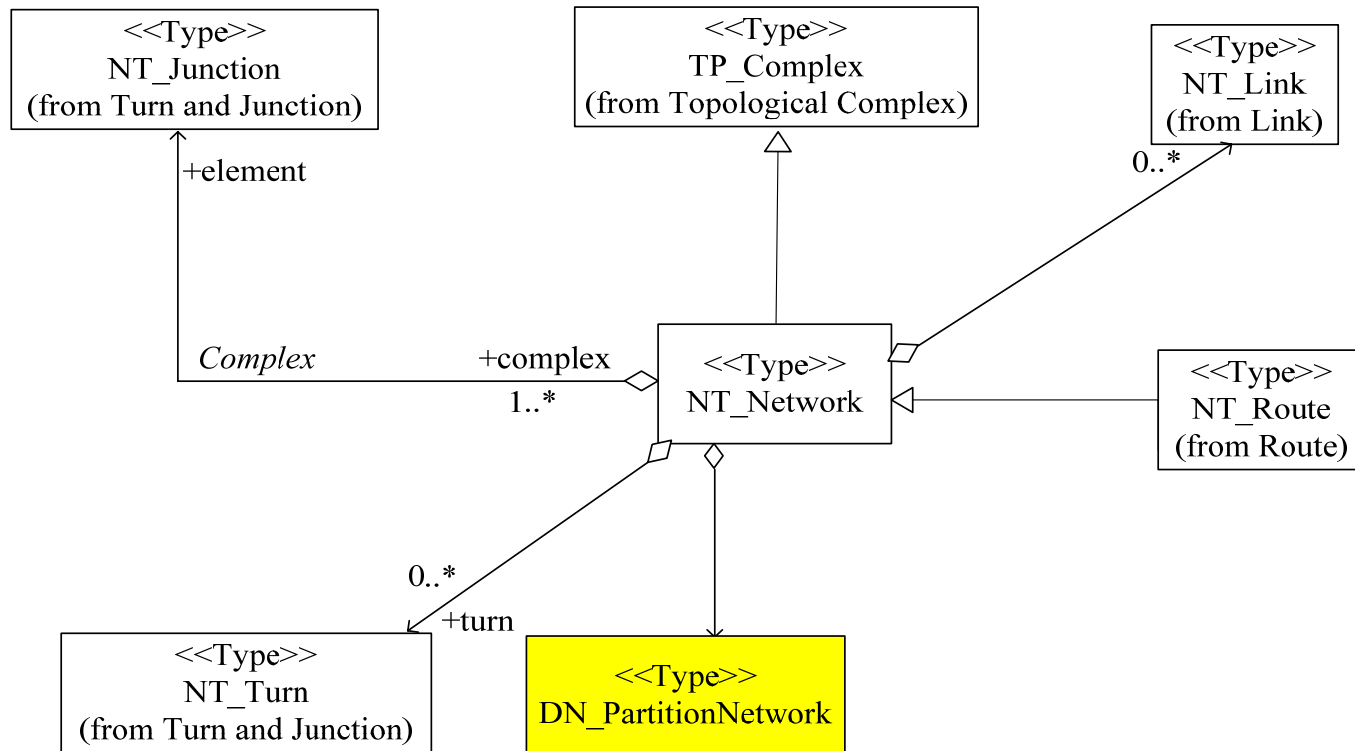
*partitions with the same
minimum closed boundary*



Small adjacent partitions

5 Operations and Roles

- Expand Network Definition in ISO19133.
 - Package PN_PartitionNetwork are added

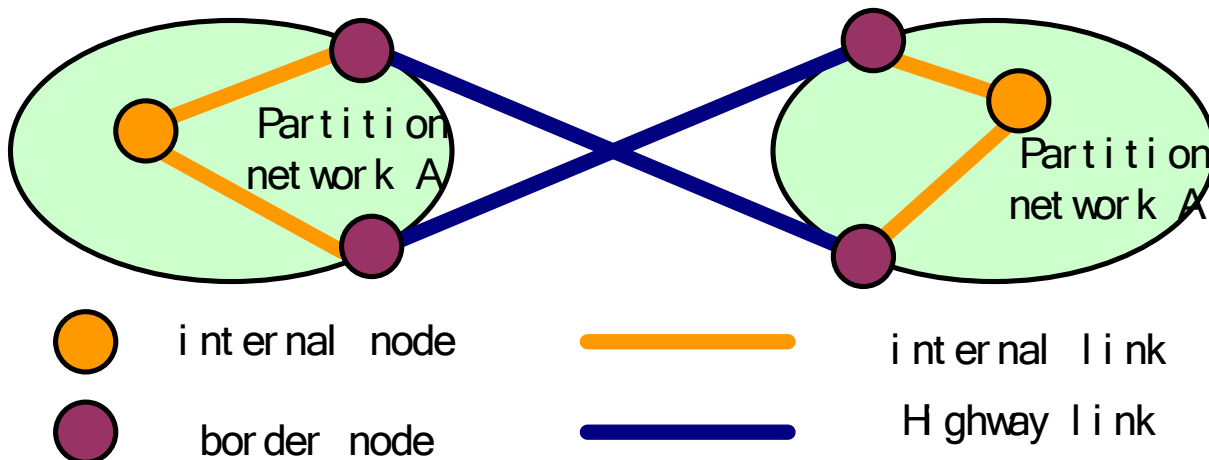


5 Operations and Roles

- **Attributes:**
 - **LifeCycle:TM_PeriodDuration**
 - **StartTime:TM_Position**
 - **ProduceType:PN_ProduceType**
- **Operations:**
 - **getRoute**
- **Roles:**
 - **internalLink : PN_InternalLink**
 - **internalNode : PN_InternalNode**
 - **borderNode : PN_BorderNode**
 - **topological boundary : PN_TPBoundary**
 - **highway route : DN_HWRRoute**

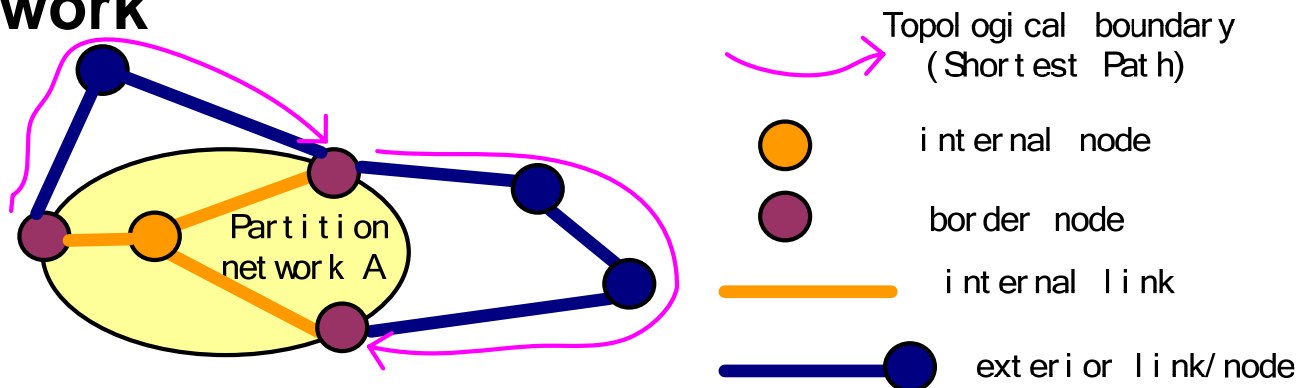
5 Role : Basic Elements

- **Internal nodes:** All nodes excluding partition separator
- **Internal links:** All links that connect nodes of a single partition are also part of that partition
- **Border nodes:** Refers to the partition separator. Highway network does not have border nodes.



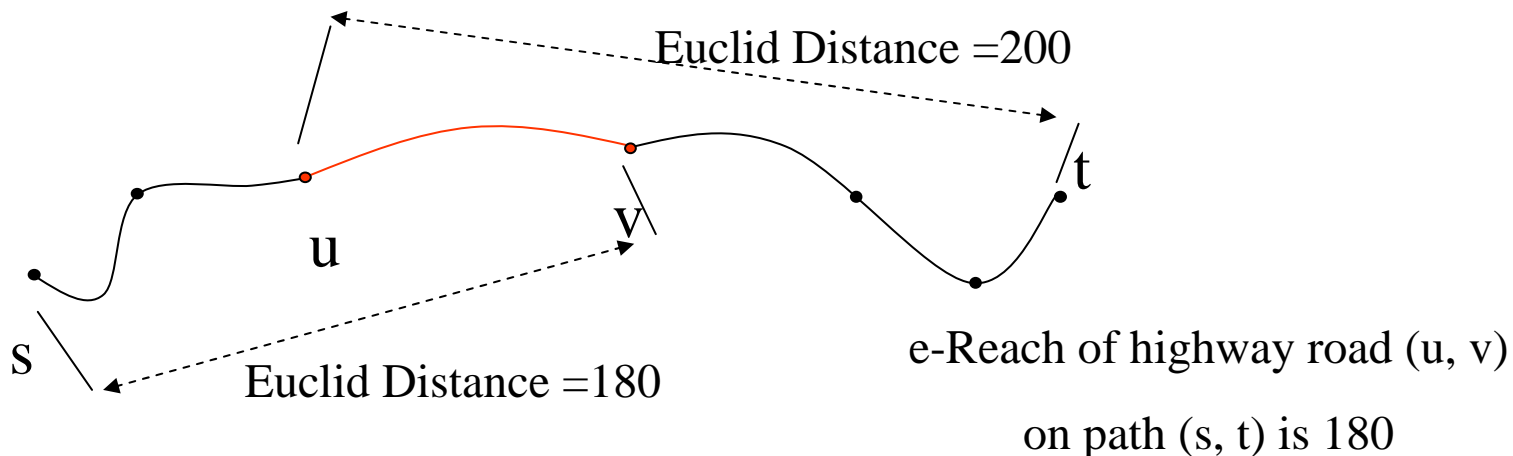
5 Role: Topological Boundary

- When a network is divided into partitions, the elements within one partition may not be capable of being connected and navigable
- Some topological boundary need to be used for each partition in order to fulfill the requirement of connectivity and optimism
- Topological boundary doesn't exist in highway network



5 Role: Highway routes

- Under some conditions a path using lower-level roads are shorter than the highway roads. These paths should be treated as highway routes. Highway routes does exists in lower-level network
- “e-Reach” can be calculated on each shortest path that passes through the highway route. The maximum “e-Reach” from all possible paths are important for routing



5 Operation: GetRoute (in same partition)

- **When a shortest path needs to be found between two nodes in the same partition, the path having the property that all links and nodes on the path are contained in the partition and its boundary routes**
- **The resulting path could leave the partition at some border node, passing the boundary routes , and re-enter the partition before arriving at the destination**

5 Operation: GetRoute (Between different partitions)

- **Given the decomposition, a shortest path between two arbitrary nodes in different partitions by constraining the path to pass out the partition containing the origin, through the highway network, and into the partition containing the destination**
- **When searching near the origin or the destination, highway routes with appropriate “e-Reach” should be considered; there incur the extra cost of looking the highway routes**

6 Conclusion

- The *partition network* data model is developed in order to provide the necessary and efficient network data for some specific application, for instance, disaster, dynamic navigation and partial data update, etc.