

Network

- Topology-based features – connectivity
 - Intersections (junctions)
 - Junctions
 - Sources and sinks
 - Turns, Turn impedance
 - Overpasses and underpasses
 - Links (edges)
 - Directions
 - Impedance (length, travel time, flow volume)
 - Directional impedance

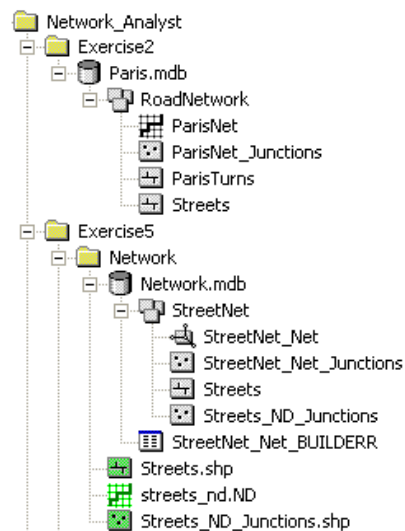
ArcGIS Network

Network types

- Geodatabase geometric network
- Shapefile-based network dataset
- Geodatabase network dataset

Network tools

- Utility Network Analyst
- Network Analyst



Network Analysis & Applications

- Utility (geometric) network
- Transportation network dataset

- ArcInfo (Arcplot network commands)
- ArcGIS: Persistent network dataset

- Network
 - Line (coverage)
 - Edge + junctions (geodatabase)

Utility Network Analysis

- Trace upstream elements
- Trace downstream elements
- Upstream accumulation cost
- Find a path upstream
- Find common ancestors of a set of locations on the network
- Find connected elements
- Find disconnected elements
- Find multiple-path loops
- Find all paths between locations

Compiling a Street Network

1. Coverage, shapefile, or Geodatabase
2. Line features
2. Building a network
 - Composite feature (ArcInfo)
 - Geometric network
 - Network dataset (multimodal network)
3. Assign link impedance
4. Assign link direction
5. Create a turn table

Network Analysis in ArcInfo

```
Arcplot: netcover netcov routel
Arcplot: stops path1.stp order route impedance ~
        demand out_order cumul_imped cumul_demand
Arcplot: path stops `find minimum path b/w stops
Arcplot: mapex netcov `set display extend
Arcplot: arcs netcov `display arcs
Arcplot: routelines netcov routel 2 `display
        selected route using line symbol 2 (red solid
        line)
```

Attributes of Geometric Network

- Edges
 - Cost: distance
 - Descriptors: weight (diameter)
 - Restrictions: enabled/disabled
 - Flow direction
- Junctions
 - User-defined/orphan
 - Source/sink
- Connectivity-rules
 - Edge-edge
 - Edge-junction

Attributes of Network Edges (Links)

- Edges
 - Cost: meters, minutes, FT_minutes, TF_minutes
 - Descriptors: speed limit, # lanes
 - Restrictions: one-way (FT, TF, N, etc)
 - Hierarchy: hierarchy, roadclass (1, 2, 3, etc)

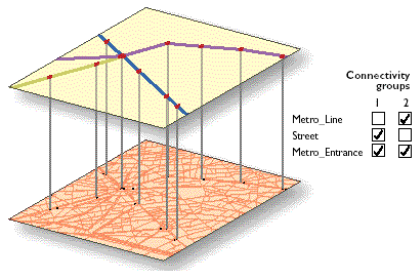
Source	Direction	Element	Type	Value
Metro_Lines	From-To	Edge	Constant	-1
Metro_Lines	To-From	Edge	Constant	-1
Streets	From-To	Edge	Field	FT_Minutes
Streets	To-From	Edge	Field	TF_Minutes
Transfer_Stations	From-To	Edge	Constant	-1
Transfer_Stations	To-From	Edge	Constant	-1
Transfer_Street_Station	From-To	Edge	Constant	-1
Transfer_Street_Station	To-From	Edge	Constant	-1
Metro_Entrances		Junction		
Metro_Stations		Junction		
ParisNet_Junctions		Junction		

Attributes of Network Junctions (Nodes)

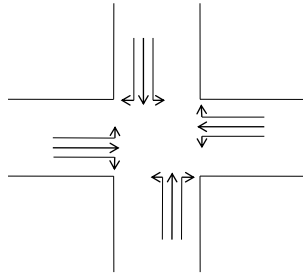
- Turn impedance: minutes
- Turn angle: angle
- Turn restriction
- Linked edges (a max of 20)

Connectivity Groups

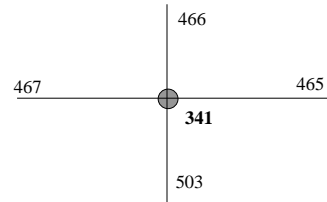
- Each edge source is assigned to exactly one connectivity group
- Each junction source can be assigned to one or more connectivity groups.
- Junctions that are assigned to two or more connectivity groups are the only way that edges in different connectivity groups can connect.
- Connectivity rules
 - coincident endpoints
 - coincident vertices
 - Override
 - elevation



Turns

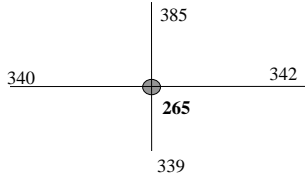


Possible turns at an intersection with four street segments. No U turns are allowed in this example.



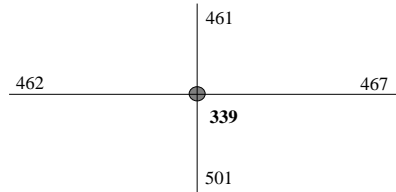
node#	arc1#	arc2#	angle	minutes
341	503	467	90	0.500
341	503	466	0	0.250
341	503	465	-90	0.250
341	467	503	-90	0.250
341	467	466	90	0.500
341	467	465	0	0.250
341	466	503	0	0.250
341	466	467	-90	0.250
341	466	465	90	0.500
341	465	503	90	0.500
341	465	467	0	0.250
341	465	466	-90	0.250

Possible turns at node 341



node#	arc1#	arc2#	angle	minutes
265	339	342	-87.412	0.000
265	339	340	92.065	0.000
265	339	385	7.899	0.000
265	342	339	87.412	0.500
265	342	340	-0.523	0.250
265	342	385	-84.689	0.250
265	340	339	-92.065	0.250
265	340	342	0.523	0.250
265	340	385	95.834	0.500
265	385	339	-7.899	0.000
265	385	342	84.689	0.000
265	385	340	-95.834	0.000

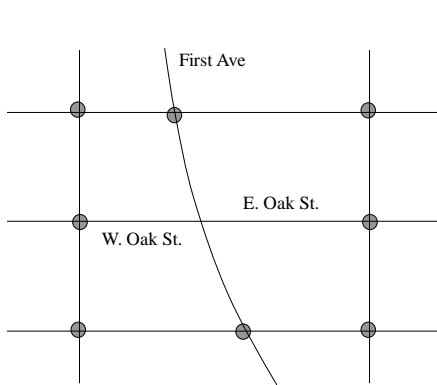
Node 265 has stop signs for the east-west traffic.



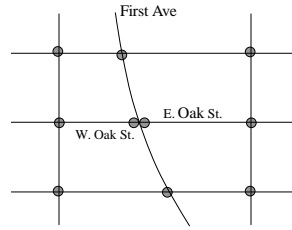
node#	arc1#	arc2#	angle	minutes
339	467	501	90.190	0.500
339	467	462	1.152	0.250
339	467	461	-92.197	-1.000
339	462	501	-90.962	0.250
339	462	467	-1.152	0.250
339	462	461	86.651	-1.000
339	461	501	2.386	0.250
339	461	467	92.197	0.500
339	461	462	-86.651	0.250

Node 339 is an intersection between a southbound one-way street and an east-west two-way street.

Overpasses & Underpasses



First Ave. crosses Oak St. with an overpass. A non-planar representation with no nodes is used at the intersection of Oak St. and First Ave.



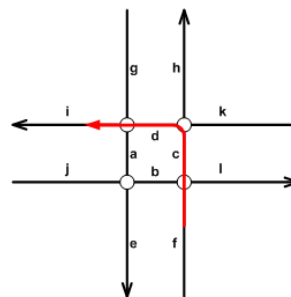
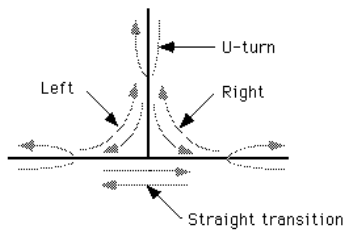
Street Name	F-elev	T-elev
First Ave	0	1
First Ave	1	0
W. Oak St.	0	0
E. Oak St.	0	0

First Ave crosses Oak St with an overpass. A planar representation with two nodes is used at the intersection: one for First Ave, and the other for Oak St. The elevation value of 1 shows that the overpass is along First Ave.

Multiedge Turns

- Divided roads
- Interior edges (a, b, c, d)
- Exterior edges (e, f, g, h, etc)

Two-edge turns



Network Applications

- Routing: shortest-path analysis b/t 2 points
- Closest facility: shortest-path analysis b/t 1 source and multiple target points
- Service Area: Allocation (proximity)
- Location-allocation (proximity + supply + demand)
- Urban transportation planning
- Watershed analysis (ArcHydro)
- Traveling salesman problem (TSP)