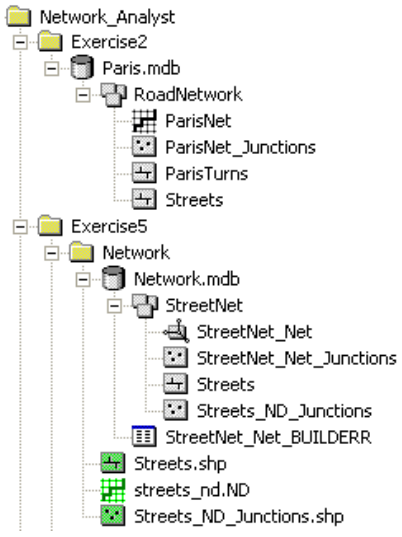
Network

- 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 commends)
- ArcGIS: Persistent network dataset

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

Compiling a Street Network

1. Coverage, shapefile, or Geodatabase
2. Line features
2. Building a network
   - Composite feature
   - 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 route1
Arcplot: stops path1.stp order route impedance ~
  demand 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 route1 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		

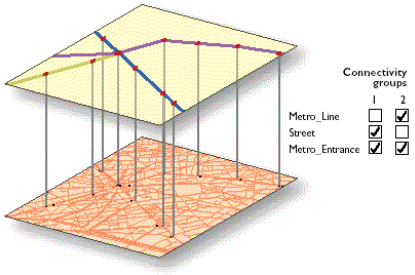
Attributes of Network Junctions (Nodes)

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

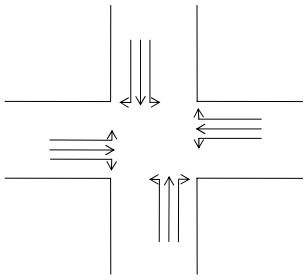
Connectivity Groups

- 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.

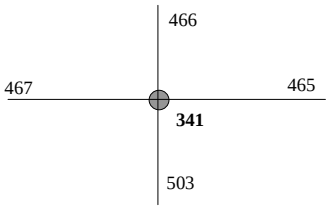
- Connectivity rules
  - coincident endpoints
  - coincident vertices
  - Override
  - elevation



Turns

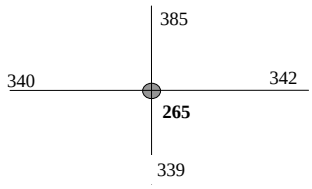


Possible turns at an intersection with four street segments. No U turns are allowed in this example.



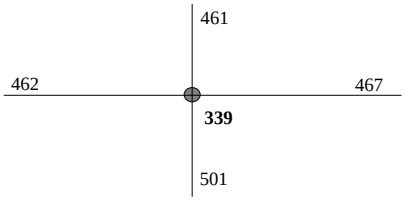
node#	arc1#	arc2#	angle	minutes
341	503	467	90	0.500
341	503	466	0	0.250
341	503	465	-90	0.250
341	467	503	-90	0.250
341	467	466	90	0.500
341	467	465	0	0.250
341	466	503	0	0.250
341	466	467	-90	0.250
341	466	465	90	0.500
341	465	503	90	0.500
341	465	467	0	0.250
341	465	466	-90	0.250

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

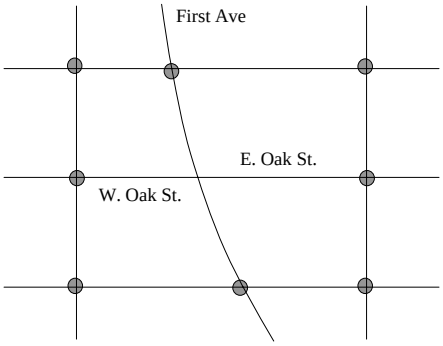
Node 265 has stop signs for the east-west traffic.



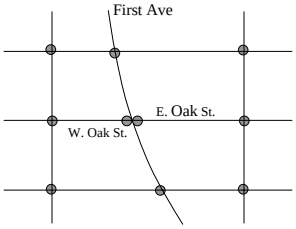
node#	arc1#	arc2#	angle	minutes
339	467	501	90.190	0.500
339	467	462	1.152	0.250
339	467	461	-92.197	-1.000
339	462	501	-90.962	0.250
339	462	467	-1.152	0.250
339	462	461	86.651	-1.000
339	461	501	2.386	0.250
339	461	467	92.197	0.500
339	461	462	-86.651	0.250

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.



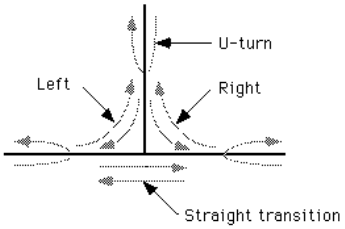
Street Name	F-elev	T-elev
First Ave	0	1
First Ave	1	0
W. Oak St.	0	0
E. Oak St.	0	0

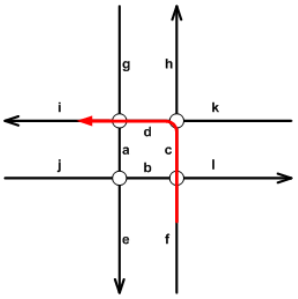
First Ave crosses Oak St with an overpass. A planar representation with two nodes is used at the intersection: one for First Ave, and the other for Oak St. The elevation value of 1 shows that the overpass is along First Ave.

Multiedge Turns

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

Two-edge turns





Network Analyst Evaluator/Solver

- Hierarchy
- Restriction (barriers, enabled?)
- Cost (impedance)

Network Applications

- Shortest-path analysis, closest facility
- Traveling salesman problem (TSP) (+ Time windows)
- Allocation (proximity)
- Location-allocation (proximity + supply + demand)
- Urban transportation planning
- Watershed analysis(ArcHydro)