What is Network Analyst?
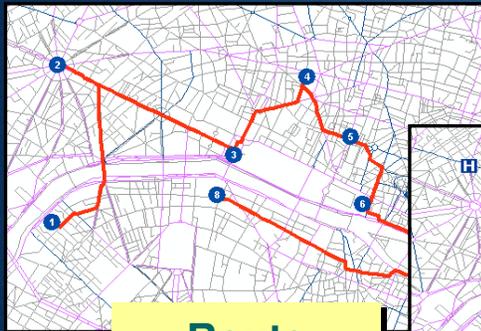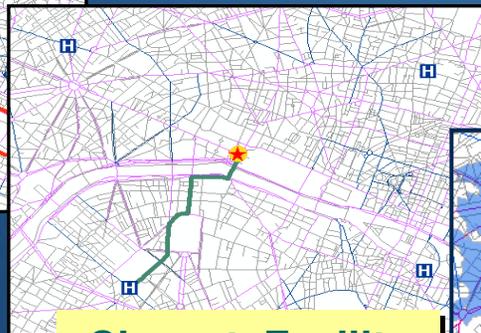
- Extension for analyzing transportation networks
  - Four network solvers

Route

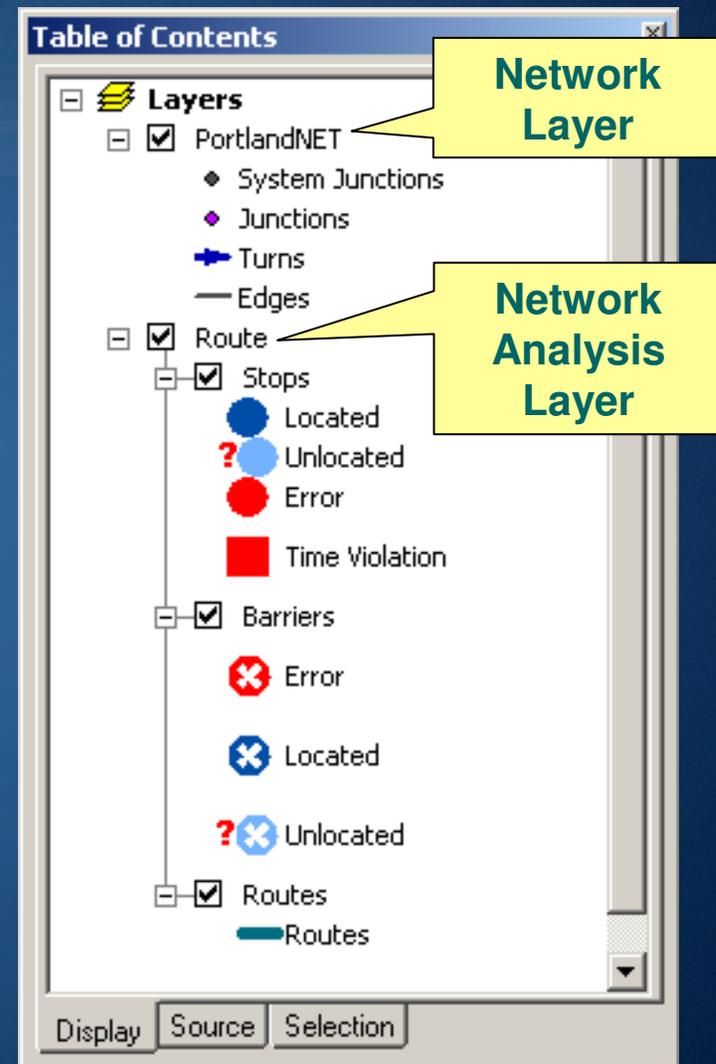**Closest Facility**

Service Area

Origin-Destination (OD) Cost Matrix
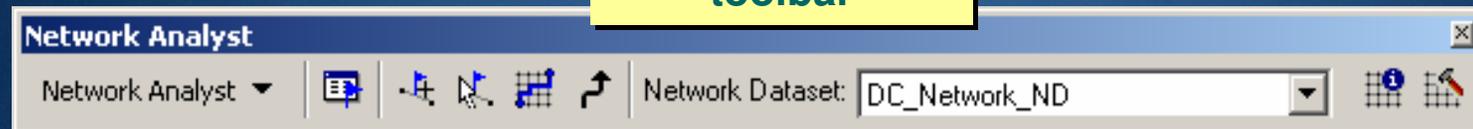
- Uses Network Datasets

Specialized layers

- ## Network layer
  - References a network dataset
  - Appears in table of contents and Network Analyst toolbar

- ## Network analysis layer
  - Composite layer for network solver
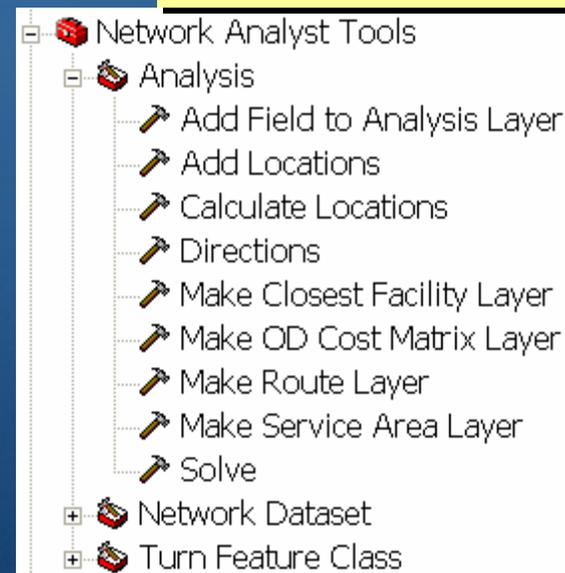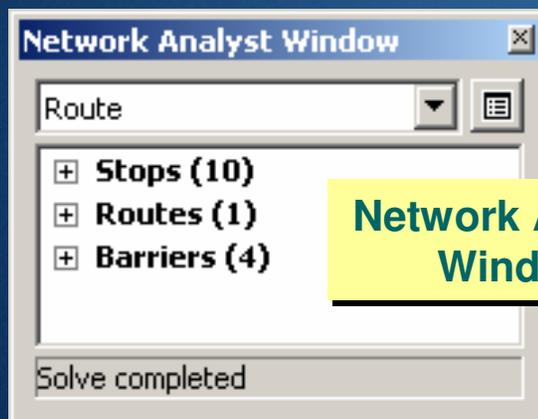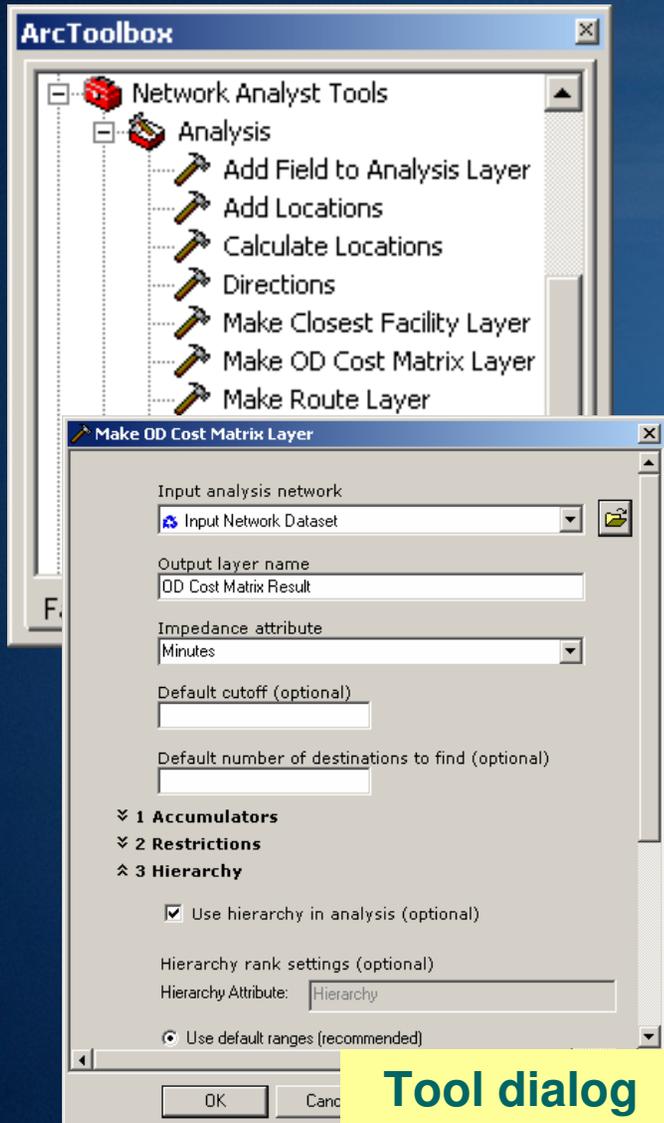 - Appears in table of contents and Network Analyst Window

Network Analyst in ArcMap

Network Analyst toolbar

Network Analyst
Network Analyst ▾ | Network Dataset: DC_Network_ND

Network Analyst toolbox

Geoprocessing Tools

Network Analyst Window

Route

☐ **Stops (10)**
☐ **Routes (1)**
☐ **Barriers (4)**

Solve completed

Network Analyst Window

- 🔴 Network Analyst Tools
  - 📁 Analysis
    - 🔧 Add Field to Analysis Layer
    - 🔧 Add Locations
    - 🔧 Calculate Locations
    - 🔧 Directions
    - 🔧 Make Closest Facility Layer
    - 🔧 Make OD Cost Matrix Layer
    - 🔧 Make Route Layer
    - 🔧 Make Service Area Layer
    - 🔧 Solve
  - 📁 Network Dataset
  - 📁 Turn Feature Class

Network Analyst in Geoprocessing

Command line

Model

Script

Tool dialog

Demo

- Route Solving in ArcMap

Time windows

- Defines interval of time (start/end) a stop should be visited by a route
  - Network location properties
  - Time or date values supported
  - May affect the total cost

Route solver result
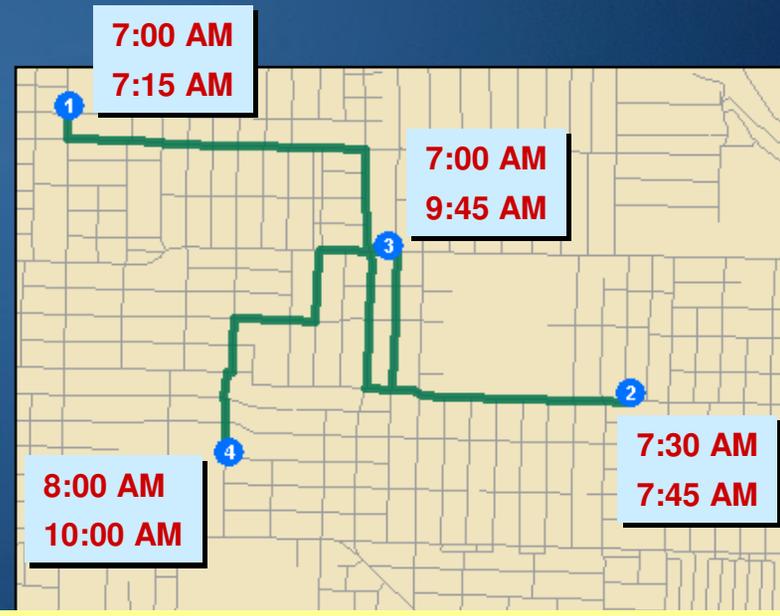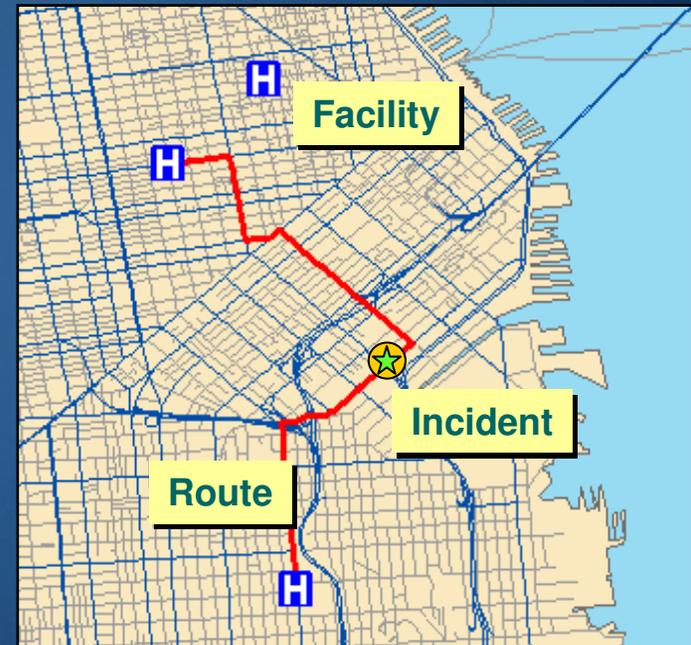
7:00 AM
7:15 AM

7:00 AM
9:45 AM

7:30 AM
7:45 AM

8:00 AM
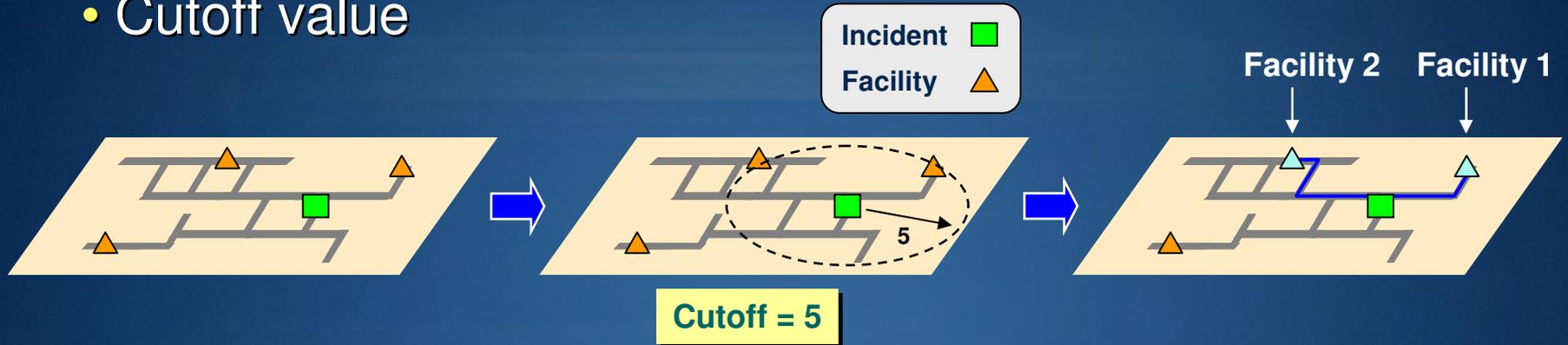10:00 AM
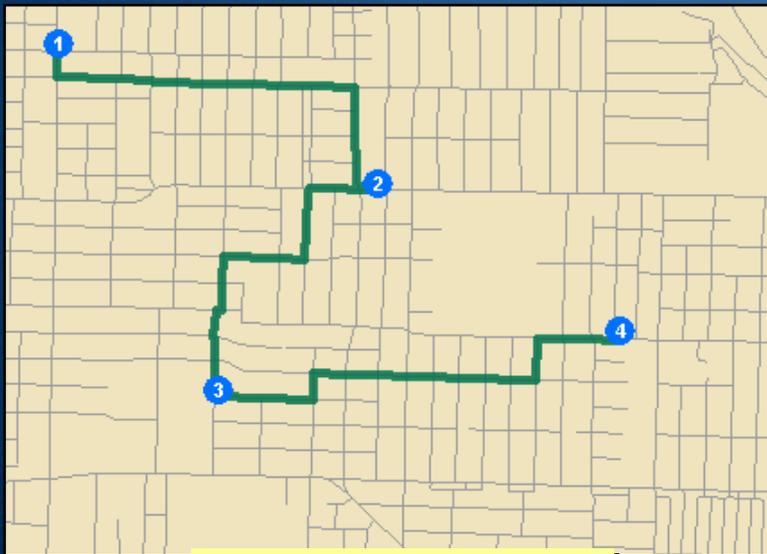
Route solver result with time windows

Closest Facility solver

- Finds the route(s) that minimize travel cost between incidents and facilities
- Options
  - Impedance
  - Cutoff value
  - Number of facilities to find
  - Direction of travel
  - Directions
- Applications
  - Emergency vehicle dispatch
  - Customer to stores

Closest Facility options

- Cutoff value

Incident ▪

Facility ▲

Facility 2   Facility 1

Cutoff = 5

- Direction of travel

Accident

Incident to facility

Fire

Facility to incident

Directions

- Generated from Route and Closest Facility solver results
- Options
  - Expandable inset maps
    - Feature labels supported
  - Reported units
    - Distance
    - Travel time
  - Running time/distance
  - Time windows
  - Print options

Service Area solver

- Finds the area or edges that can be traversed within a specified cost
- Options
  - Impedance
  - Multiple break values
  - Direction of travel
    - Away from or towards facility
  - Polygon and line options
- Applications
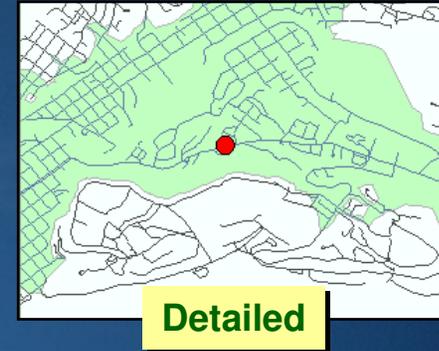 - Fire response zones
  - Customer service areas

Polygons

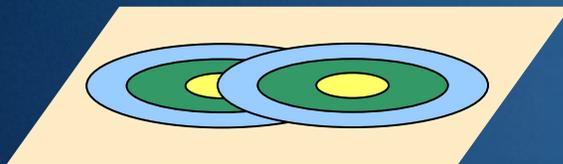**Lines**
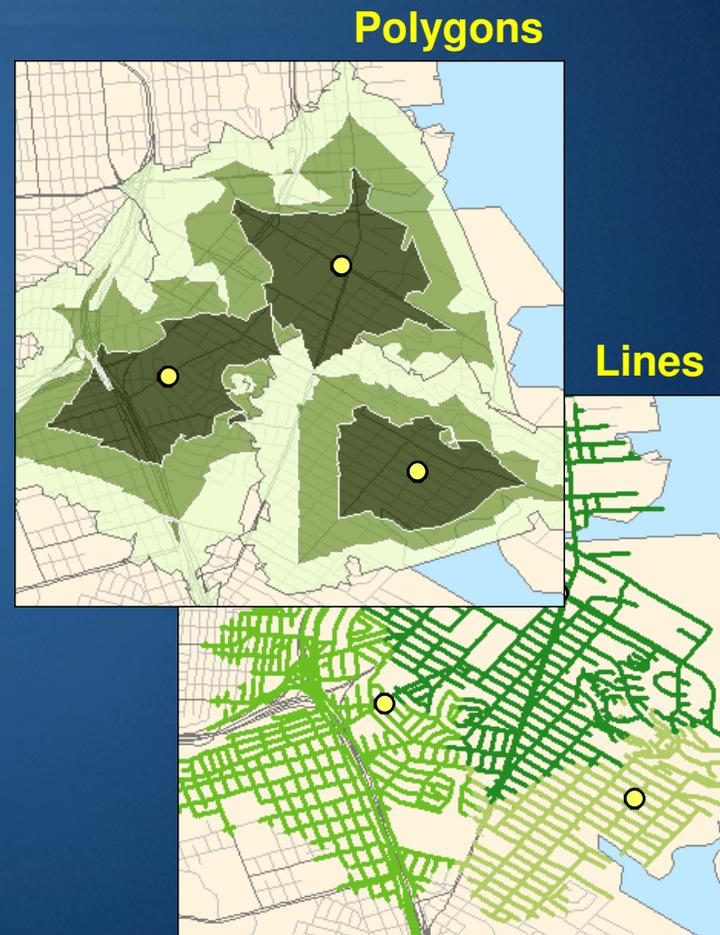
Service Area polygon options

- Polygon type
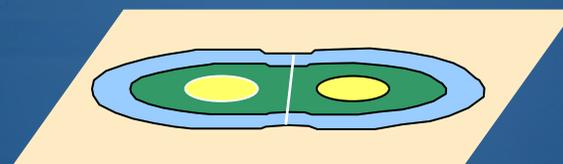

Generalized

or

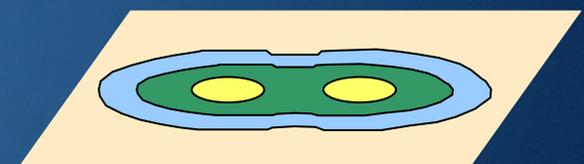**Detailed**

- Multiple facilities options
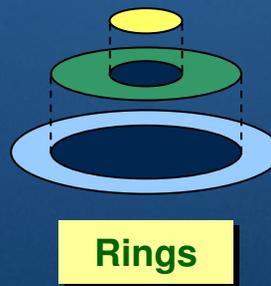

Separate polygons per facility

or

Not overlapping polygons

or

Merge polygons by break

- Overlap type

Rings

or

Disks
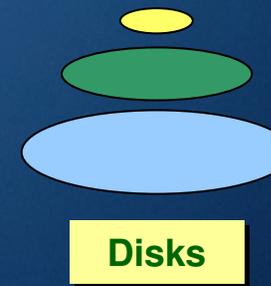
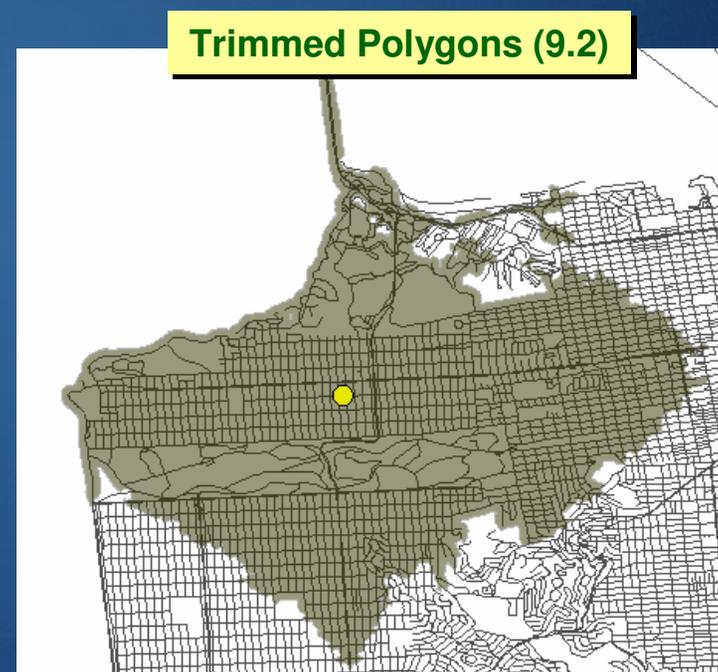# Service Area polygon trimming options

- Trim Polygons
  - Minimizes polygons in sparse areas
  - Specify trim distance

Untrimmed Polygons

Trimmed Polygons (9.2)
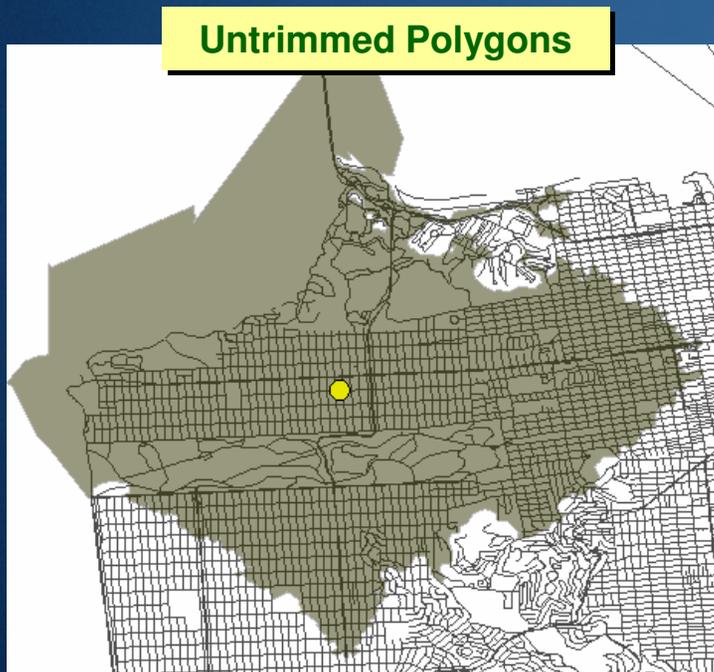
Service Area line options

- Generate measures (used for linear referencing)

4 lines

- Split lines at breaks

Breaks: 2 6 8

6 lines

- Overlap options

2 Facilities

or

Overlapping

Not overlapping
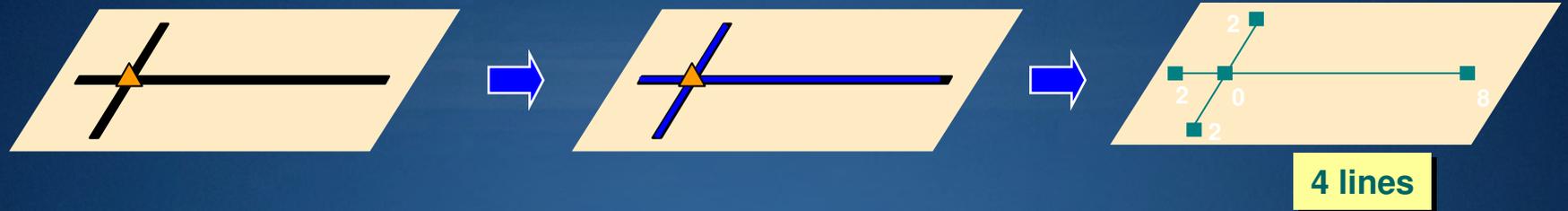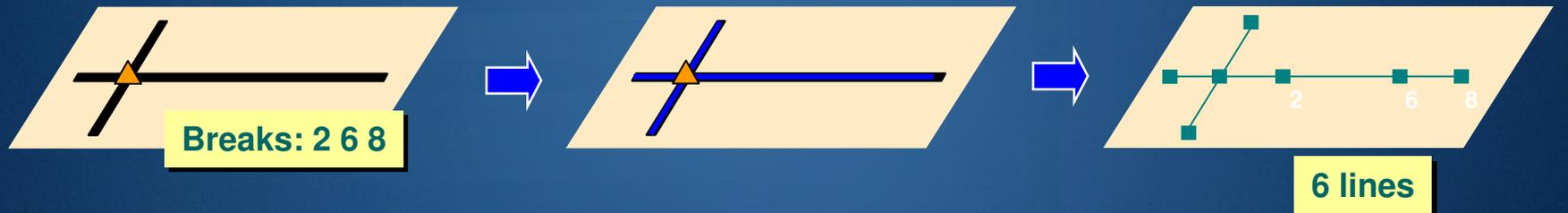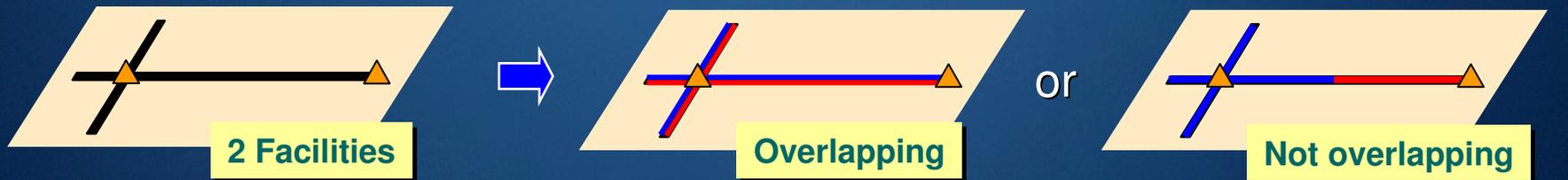
Origin-Destination Cost Matrix solver

- Generates an "OD" matrix of the cost from each origin to each destination
- Options
  - Impedance
  - Cutoff value
  - Number of destinations
- Application
  - Travel time matrix

Warehouses

Stores	A	B	C
1	29.4	21.5	17.3
2	24.2	11.5	5.67
3	31.3	18.7	19.1

Curb approach

- Specifies side of vehicle a route will approach a location
  - Network location property
- Critical for applications where you want the vehicle to park "curbside" and not cross the street
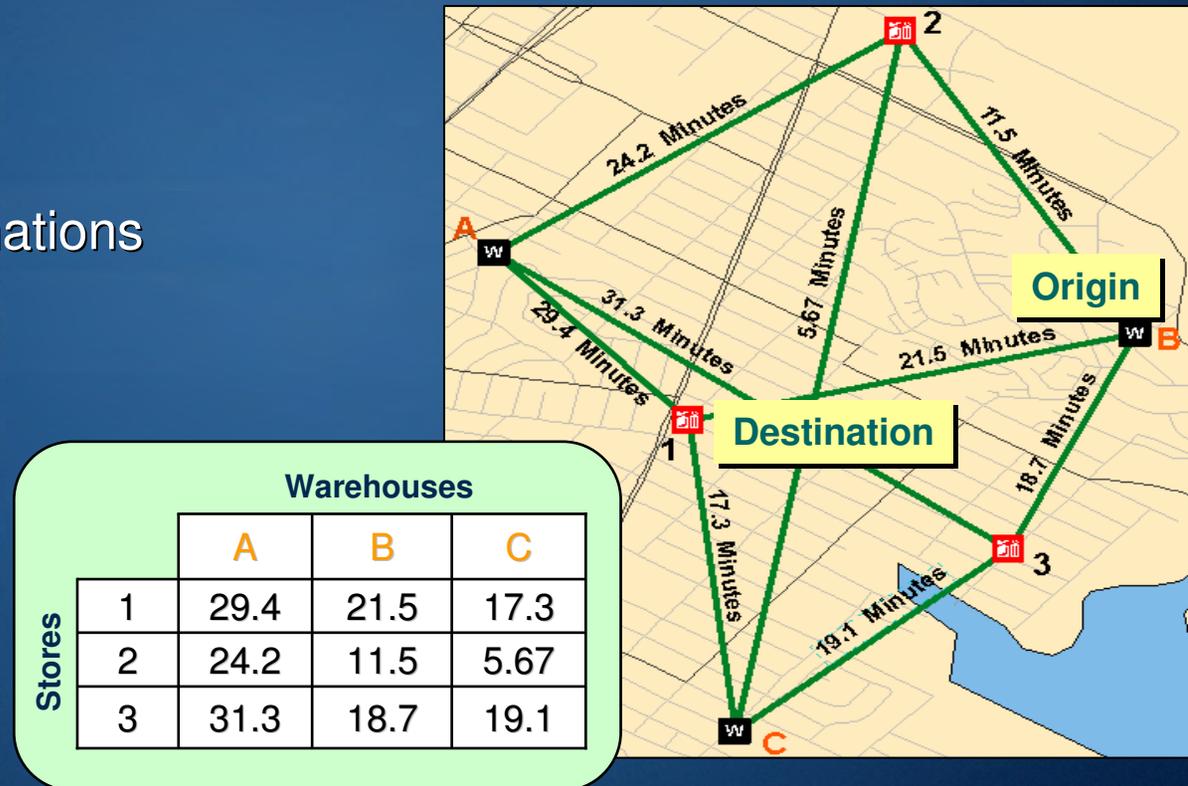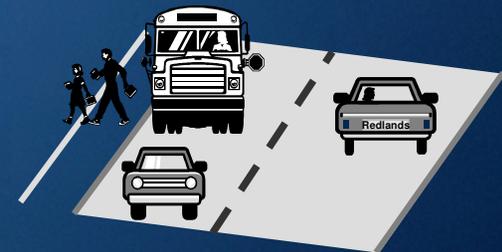 - Examples: Downtown deliveries and school bus stops

Name	CurbApproach
Victoria Elementary	Right side of vehicle

Route will approach location on the vehicle's "right side"

Hierarchy

- Minimizes impedance while favoring higher order roads
- Basic assumption:
  - Higher order roads are "faster" (time),
    not necessarily "shorter" (distance)
- Hierarchy classifies network edges into three ranks when the network dataset is built
  - Ranks: lower number = higher order road

Primary
Secondary
Local
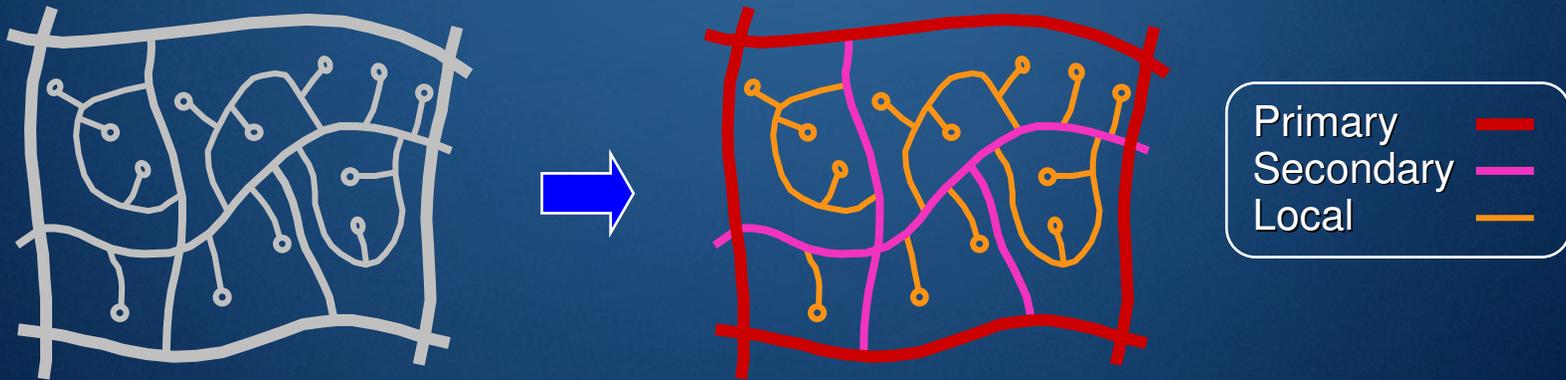
Reasons to use hierarchy

- Faster calculation of results
- Ideal for performing network analysis on long distances
  - E.g., Driving from Los Angeles to New York primarily using interstate highways

- Does not apply to service area analysis

Exact route vs. hierarchical route

Exact route =
Non-hierarchical

Hierarchical

- Hierarchical route may not be the shortest route, but is typically more realistic

Network datasets

- Network designed for ArcGIS Network Analyst
- Built from simple features
- Supports transportation modeling
- Source data
  - Geodatabase feature classes
  - Shapefiles
  - StreetMap data
   - Pre-built network dataset
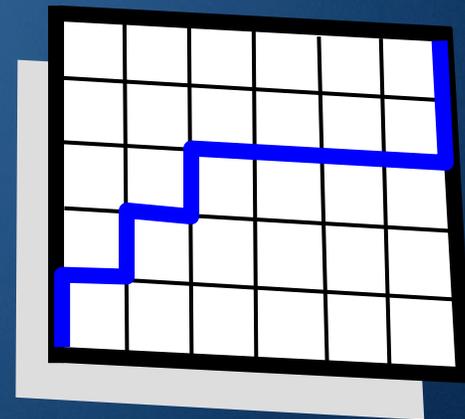
Network element types

- Three types of network elements
  - Edge
    - Derived from line features
    - Bi-directional
  - Junction
    - Derived from point features
  - Turn (optional)
    - Derived from line features or turn tables
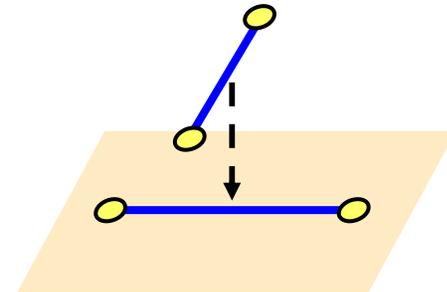   - Describes transitions between edges

Coincident Geometries

- Points of coincidence should exist where line features cross or intersect
  - Enables network connectivity to be modeled
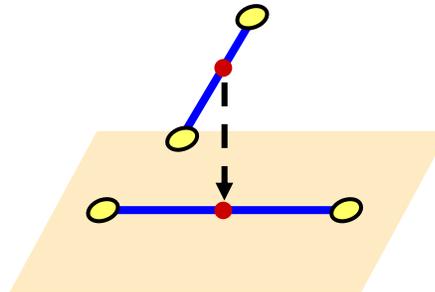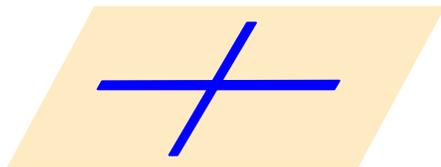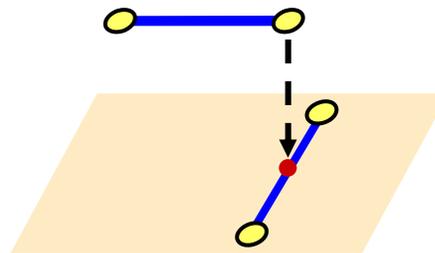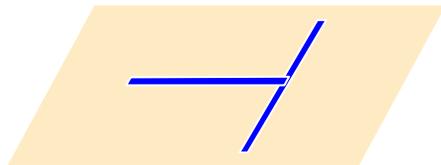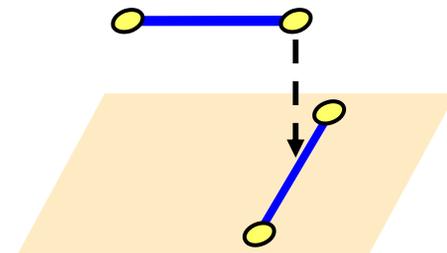
Creating coincident geometry

- Include sources in a Topology
- Use the Geoprocessing Integrate Tool
- Both methods compare features and makes vertices within the cluster tolerance coincident
  - Inserts vertices where features intersect

  - Snaps features that are not coincident

Common fields for street data

- Fields hold network attribute data
- Need attributes for good network analysis

| Field name	Data type	Application
Oneway	Text	Helps determine one way streets
Length	Double	Calculate shortest route
Travel time	Double	Calculate fastest route
Speed	Integer	May be used to calculate travel time
Street name or Address data	Text	Helps generate network locations and directions

Connectivity policies

- Edge connectivity policies
  - End point
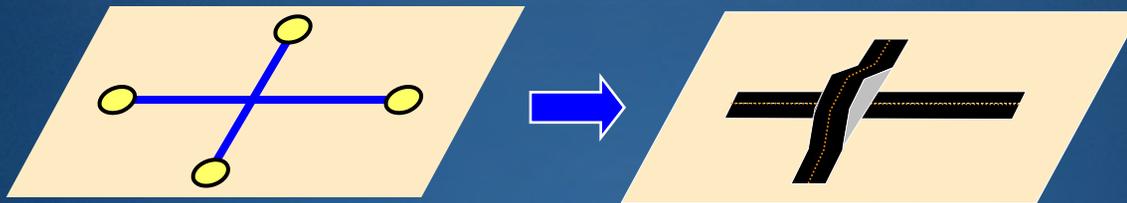
  - Any vertex
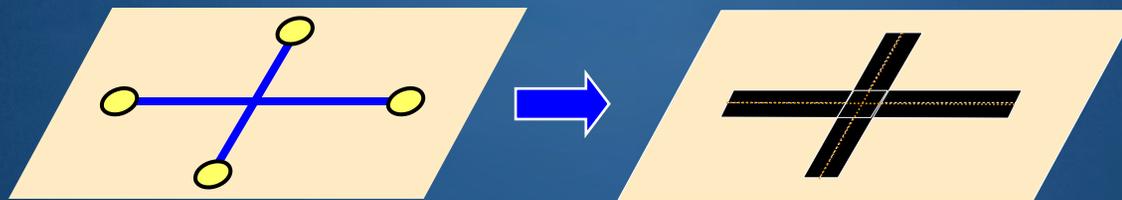
- Junction connectivity policies
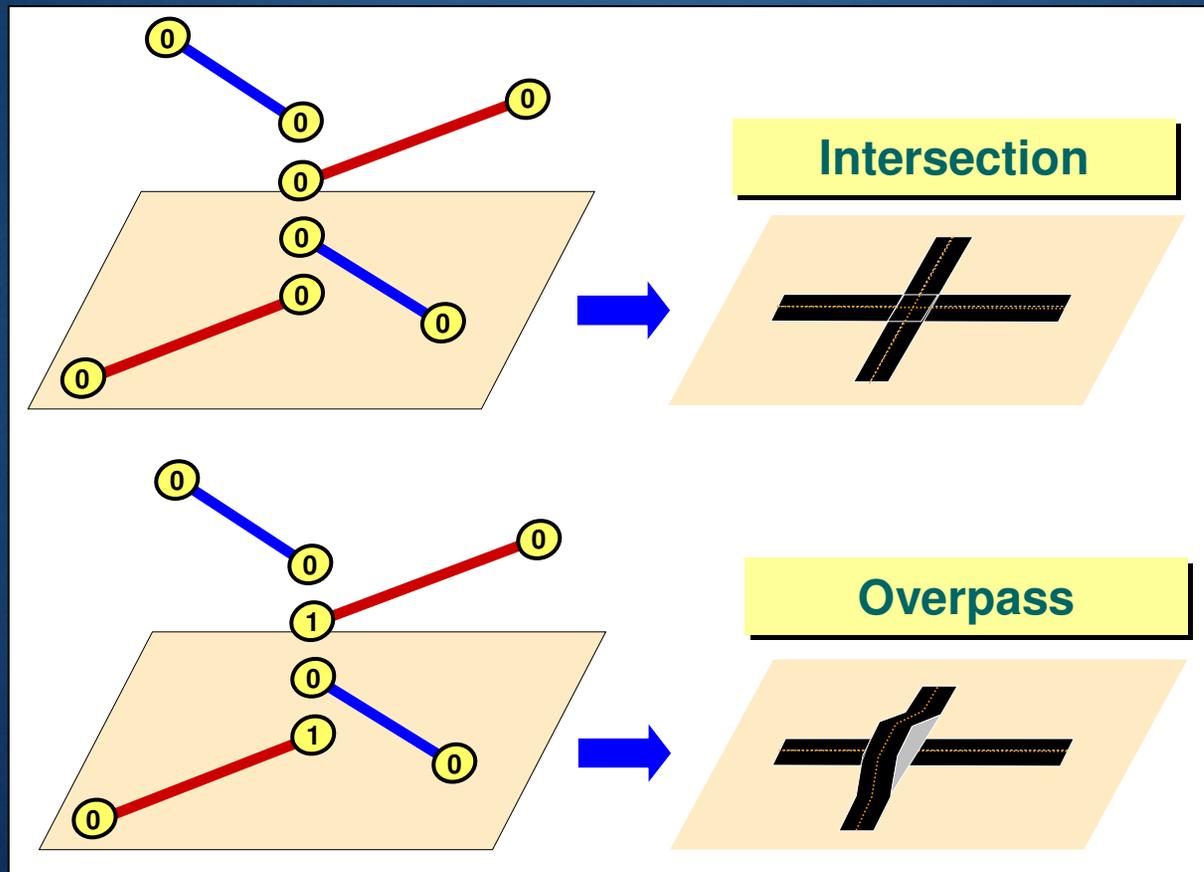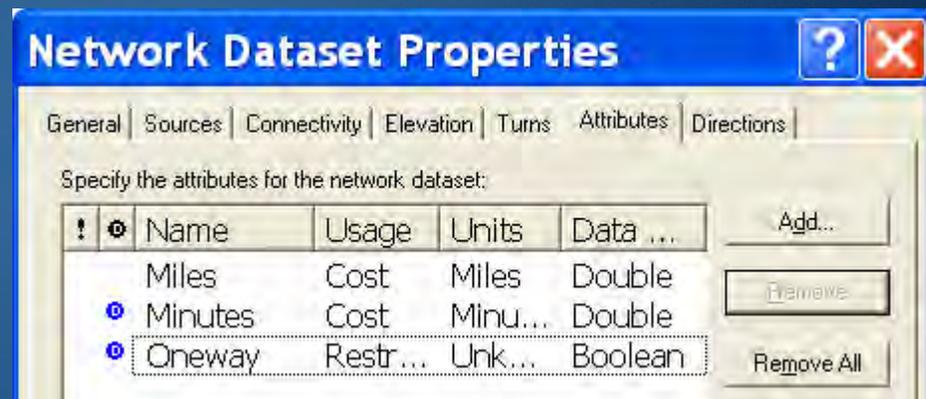 - Honor
  - Override

Elevation fields (Z-levs)

- Attributes that specify the "level" at endpoints
- Applied to line features with coincident endpoints

Network attributes

- Used to control navigation through the network
- Every attribute has 5 properties:
  - Name
  - Use by default
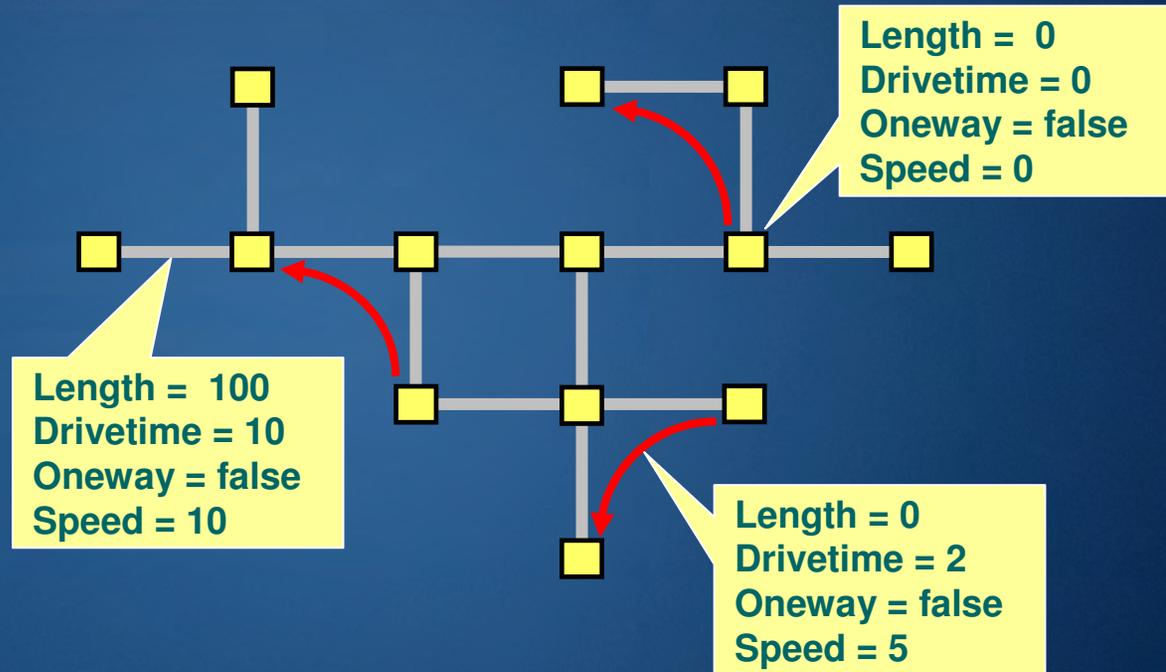 - Usage type
  - Units
  - Data type

- Can add, remove, or modify attributes once created

Network dataset attributes

- Attributes associated with network elements
  - Edges, junctions, and turns

Network dataset attributes
Length
Drivetime
Oneway
Speed

Length = 0
Drivetime = 0
Oneway = false
Speed = 0

Length = 100
Drivetime = 10
Oneway = false
Speed = 10

Length = 0
Drivetime = 2
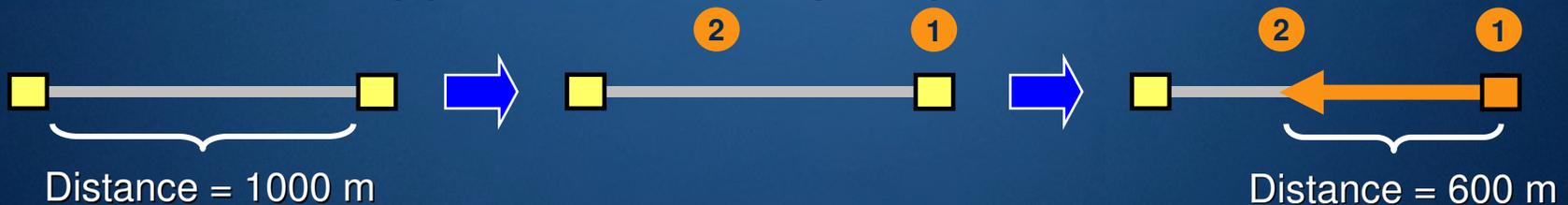**Oneway = false**
Speed = 5

- All elements in the network have the same set of attributes with potentially different values

Cost attributes

- Value that is accumulated as you traverse a network element
 - Examples: Distance, driving time, walking time

Distance = 1000 m
Drivetime = 5 min
Walktime = 20 min
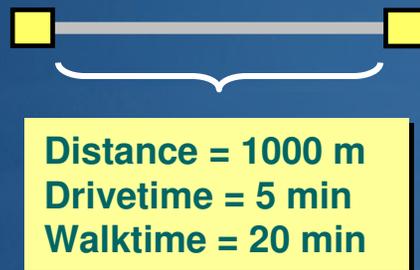
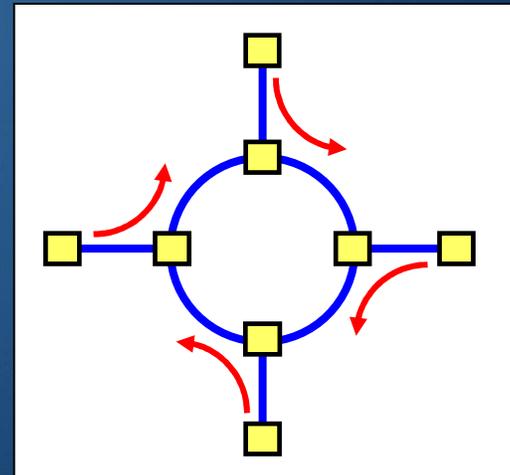- Values are apportioned along edges

Distance = 1000 m

Distance = 600 m

Restriction attributes

- A boolean condition that has one of two values:
  - Restricted (true) or Traversable (false)

One-way directionality

F_endpoint   T_endpoint

FT directionality
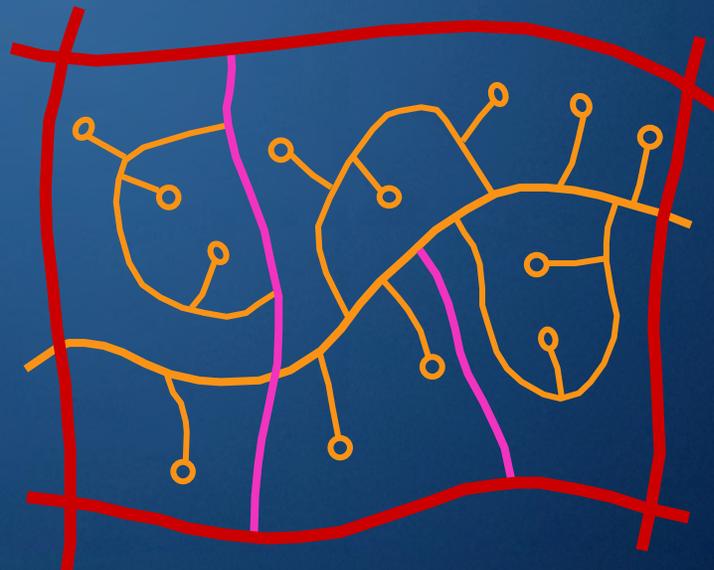
F_endpoint   T_endpoint

TF directionality
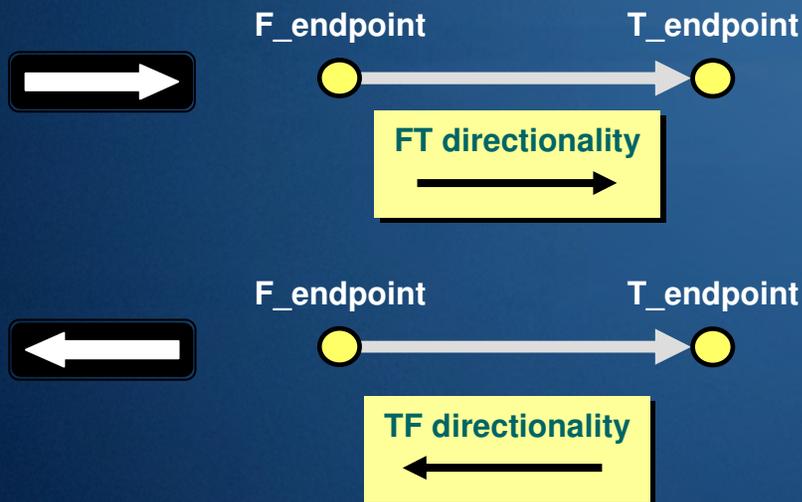
Restricted turns

Hierarchy attributes

- Integer values representing ranks
- Enables multi-level classification of edge elements
- Used when finding paths in a network dataset
- Network solvers currently support three levels
  - Example: Road type

1 = highway
2 = major road
3 = local street

Descriptor attributes

- Description that is true for the entire length of the network element
- Used for detailed driving directions or to help derive other attributes

Number of lanes

2 lanes

4 lanes

Road material

Dirt Road

Pavement
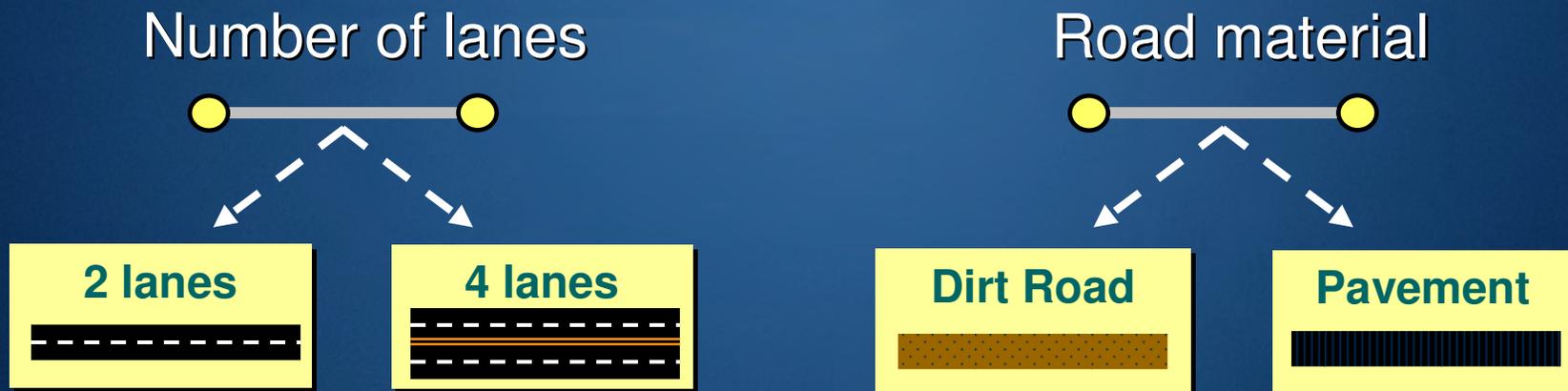
Evaluators

- A function that determines attribute values for network elements in a network dataset
  - Three different types:
    - Field – Assign an existing attribute field from a network source
    - Constant – Assign a constant value
    - VBScript – Assign expression to generate custom values

| Attribute	Evaluator
Length	*Field* – assign the [meters] field
SpeedLimit	*Field* – assign the [speed] field
TurnRestriction	*Constant* – "true" (implies all turns restricted)
DriveTime	*VBScript* – use attributes Length/SpeedLimit

- Custom evaluators can be developed

Attribute Parameters

- Some attribute evaluators need additional info at runtime
  - Vehicle characteristics
  - Current speeds per road class
- Parameter values set within Network Analyst by users
- Used by VBScript evaluators returning attribute values
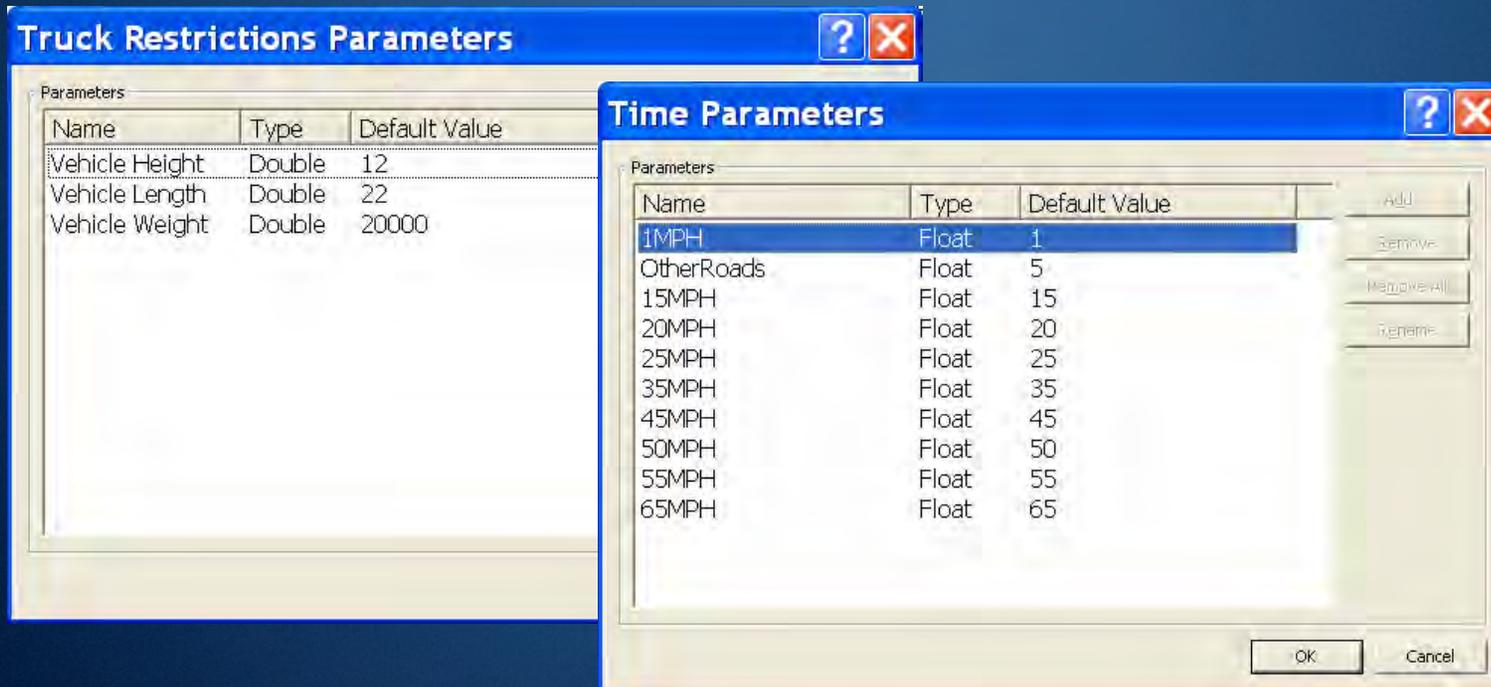
Turn features

- Line features in a specialized feature class
- Two methods to generate
  - Create new turn features in an ArcMap edit session
  - Convert turn table → line feature class
- Complex turn movements supported
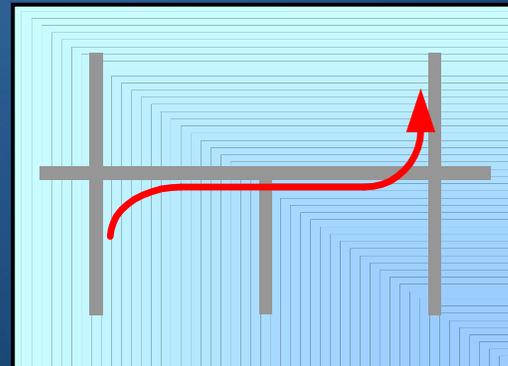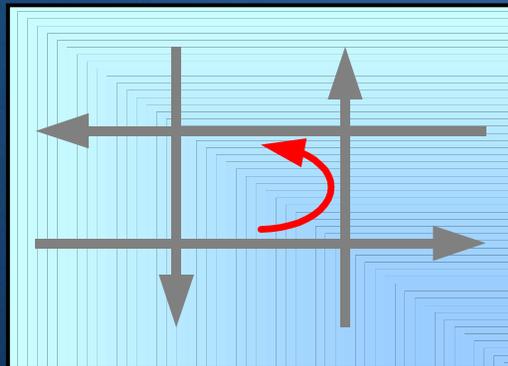
Demonstration

- Network Dataset
- Web Editing

Multimodal example