09. Trace Network in ArcGIS

GE3238 GIS Design and Practices
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It is a network

It is different from Network Dataset

Predecessor of trace network

	Network dataset	Geometric network
Application	For transportation modeling	For utilities and natural resources modeling
Analysis	Pathfinding and allocation operations	Network tracing functionality
Sources	A network dataset is built from junction, edge, and turn sources, which are simple feature classes in a geodatabase feature dataset or shapefiles.	A geometric network is initially built from simple line features, from which simple edge, complex edge, and junction feature classes are made.
Features	Network sources are simple point and line feature classes. Some feature classes build the junction-edge connectivity model and other feature classes define turns, used to restrict the traversability of the network.	Features in a geometric network are in one of these network classes: junction, simple edge, and complex edge.
Connectivity	Connectivity in a network dataset is non-reactive and refreshed with a network build.	Geometric networks dynamically update and validate connectivity with every edit.
Turns	Turns are line features that follow two or more connected street lines and model traffic scenarios such as restricted left or U-turns.	Geometric networks do not model turns.
Topology	Network source feature classes in a geodatabase can participate in topologies.	Geometric network feature classes cannot participate in topologies.
Attributes	Network datasets have an attribute model with costs, descriptors, restrictions, and hierarchy.	Geometric networks have a simpler attribute model using weights.
Workflow	Network connectivity is built on demand, similar to validating topology. Once any source feature class is edited, the network is invalid and must be rebuilt.	Network connectivity is continually maintained with every edit.
Multimodal modeling	A network dataset can model multimodal systems using connectivity groups.	A geometric network uses complex edges for a simple hierarchy and is not suited for multimodal systems.

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GIS and "Facility"

- GIS can be used through the life cycle of a facility
  - Site selection
  - Design and construction to use
  - Maintenance and adaptation
  - Closing, repurposing, and reclamation

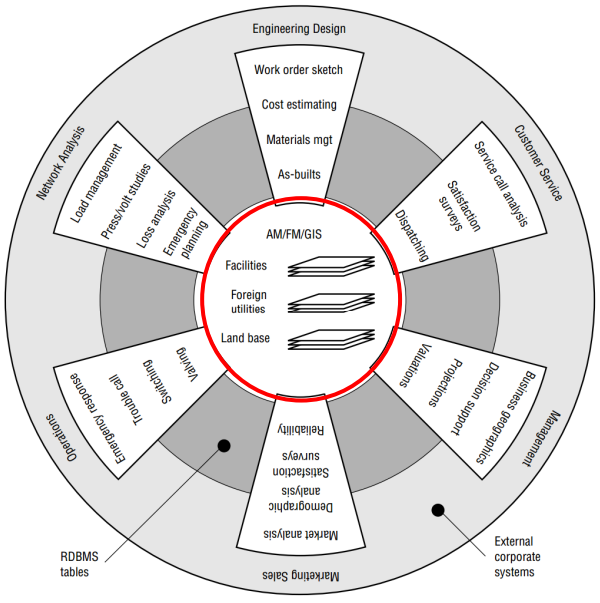

Fig 2. AM/FM/GIS data and integrated functions (Press = pressure; Mgt = management).

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Reality ~Conceptual model~ ~Logical model~ Physical model & visualization

Outline

- Trace network
  - What is it and what does it do?
  - Simplicity – easy to migrate
  - Similarities (and differences) to other network models supported in Geodatabase

Usefulness of trace network?

- To trace (along the network), of course

- A general network type for use across various nonutility disciplines
  - It has no predefined schema (or information model), thus flexibility

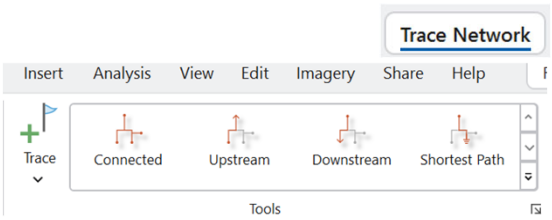
https://www.esri.com/arcgis-blog/products/arcgis-pro/data-management/introducing-the-trace-network-with-arcgis-pro-2-6/

	Utility Network	Trace Network
Predefined schema	✓	
Flexible schema		✓
Direct migration from geometric network		✓
Subnetwork trace	✓	
Subnetwork Controllers trace	✓	
Isolation trace	✓	
Loops trace	✓	
Flow direction based on sources or sinks	✓	
Trace by Flow Direction	✓	✓
Multiple Domain Networks	✓	
Structure Network	✓	
Rules	✓	
Connectivity Associations	✓	
Containment Associations	✓	
Structural Attachment Associations	✓	
Terminals	✓	
Nonspatial Objects	✓	
Subnetworks	✓	
Tiers and Tier Groups	✓	

Usefulness of trace network?

- To **trace** (along the network), of course
  - It is related to *search* – a network search
- A general network type for use across various nonutility disciplines
  - It has no predefined information model, thus flexibility

- Connected
- Upstream
- Downstream
- Shortest Path



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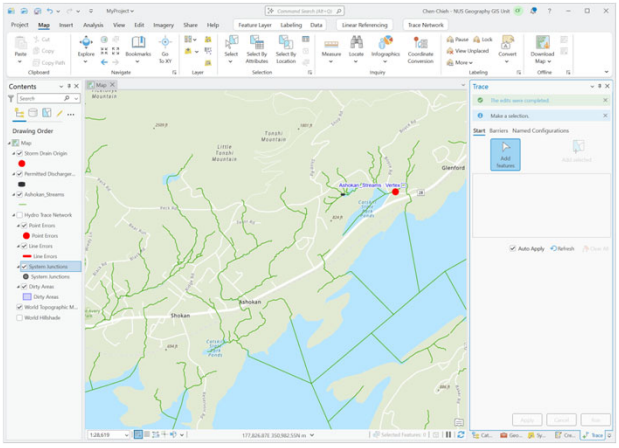
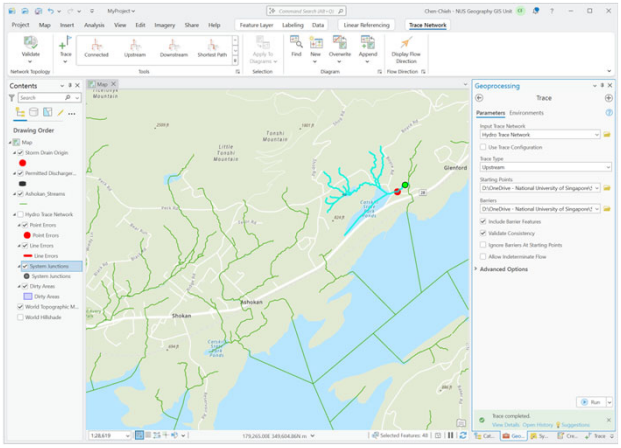
Add a point (as a user-defined "sink")



Upstream (trace)



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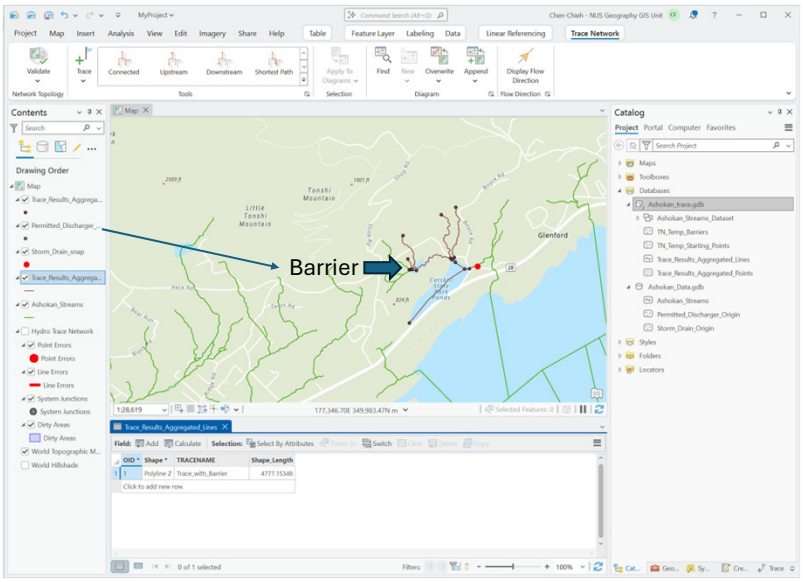
Trace with Barrier



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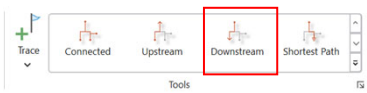
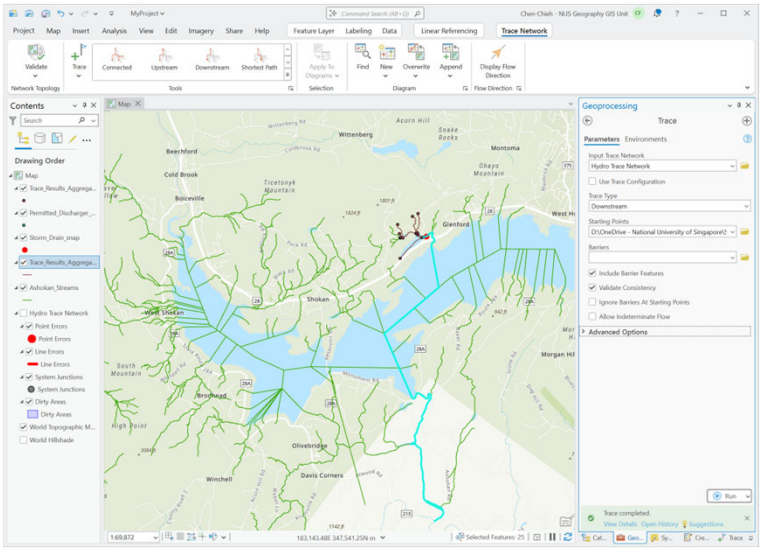
Trace Downstream





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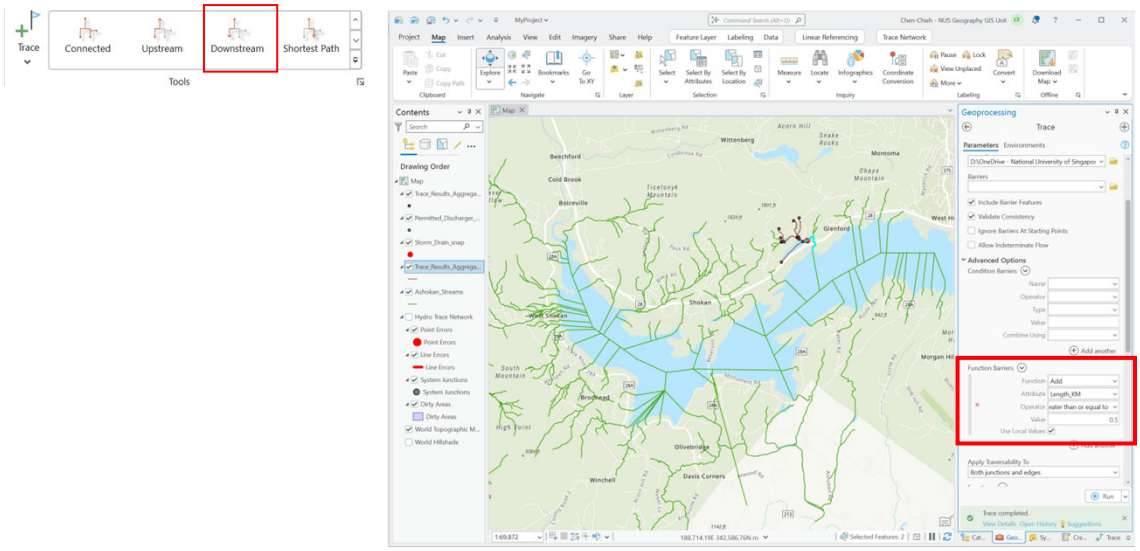
Trace Downstream with Functional Barrier



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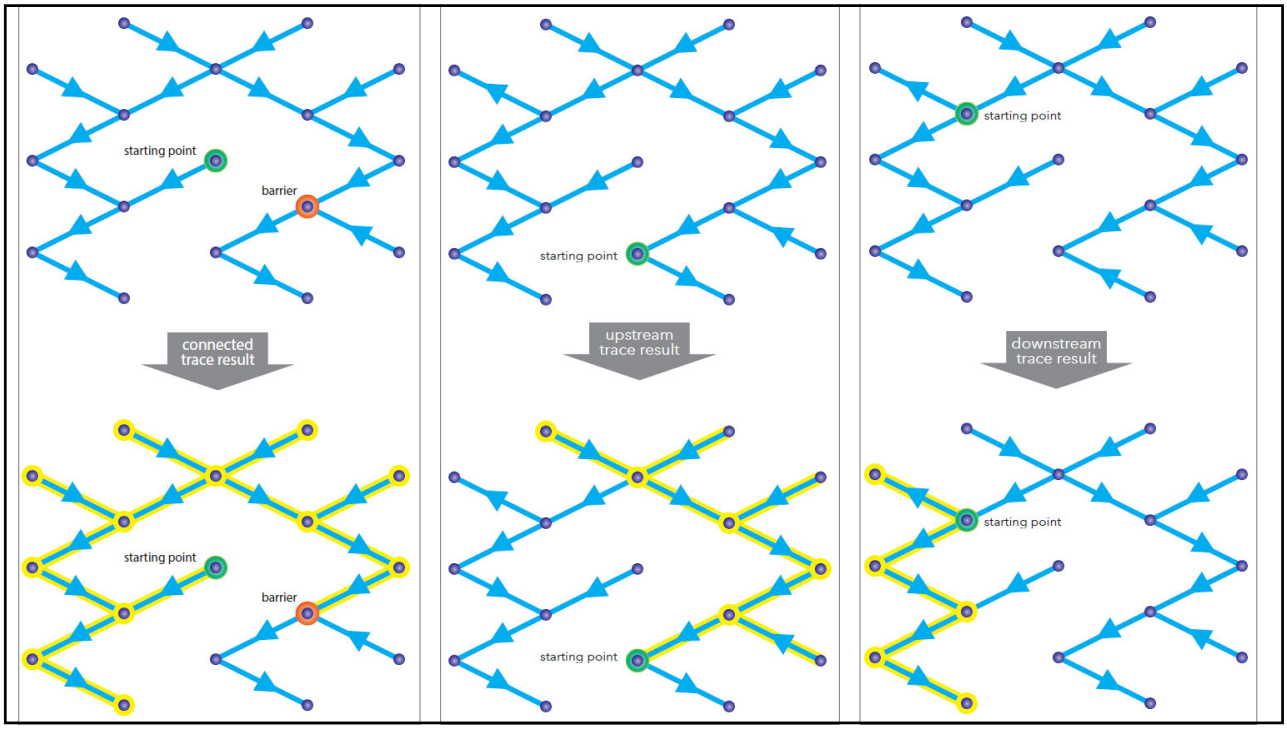

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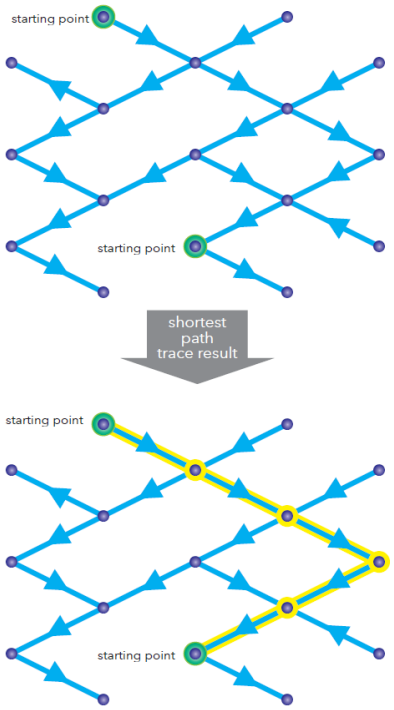

- Does the result in the lower diagram show a possible output?
- Do you feel the shortest path is somewhat different from that in network dataset?

https://pro.arcgis.com/en/pro-app/latest/help/data/trace-network/trace-network-trace-types.htm

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Creating a trace network

- To demonstrate
  - Data model and database schema
  - Connectivity still matters; Connectivity somewhat similar to that in Network Dataset
    - As such, dirty area from topological editing pops up again
  - Direction matters as well – generally more restricted to one-directional flow
- (Refreshing your memory of Network Dataset)
  - Create a network dataset (schema)
  - Connect edges with polylines
  - Assign 1..M costs
  - Include other network attributes
  - **Build**

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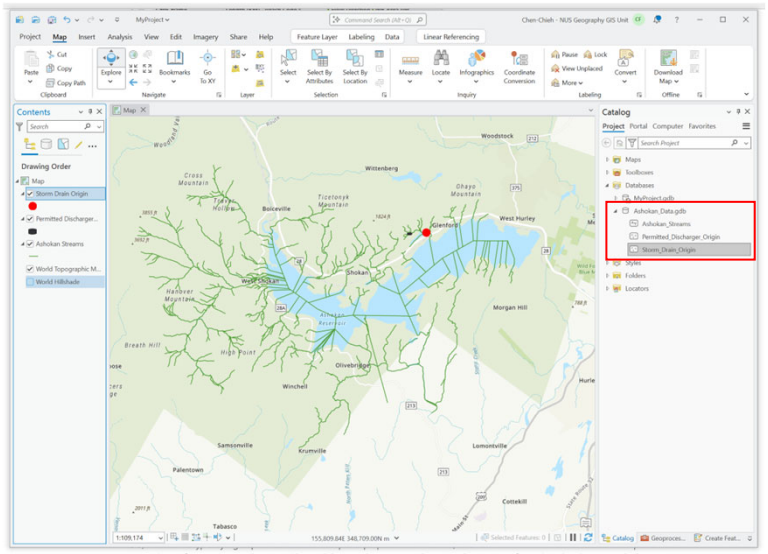
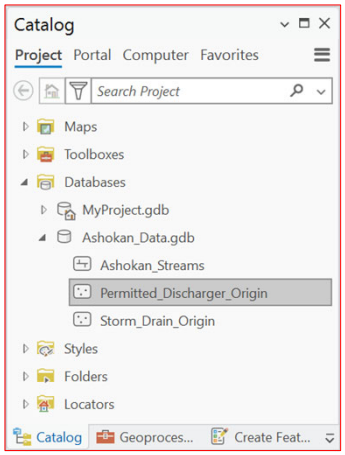
Creating a trace network (cont.)





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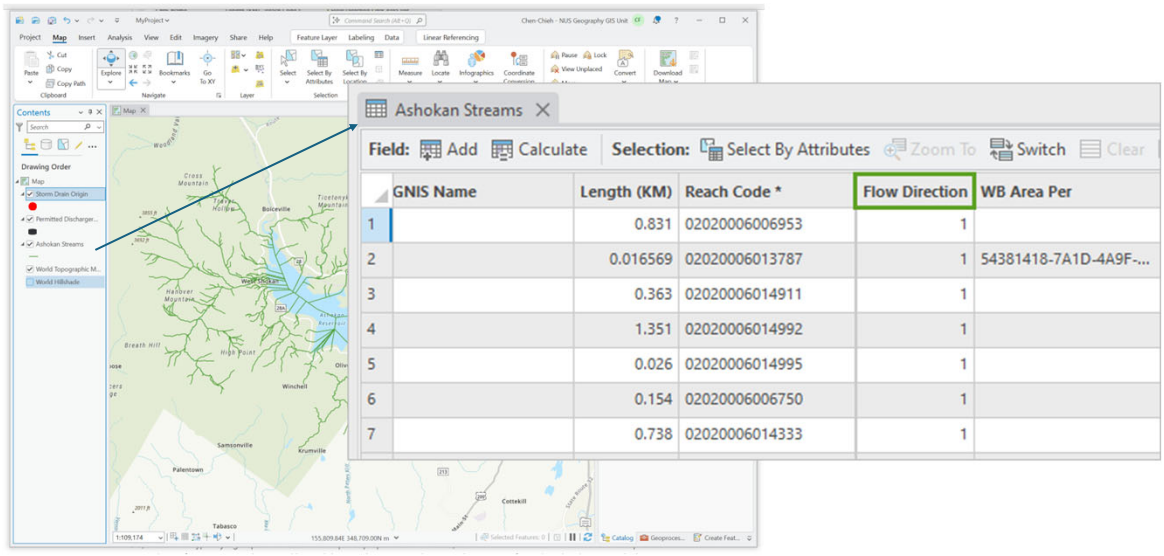
Creating a trace network (cont.)



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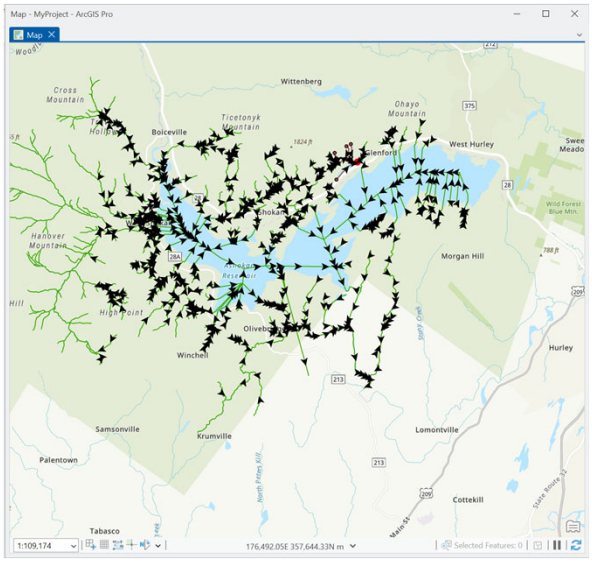
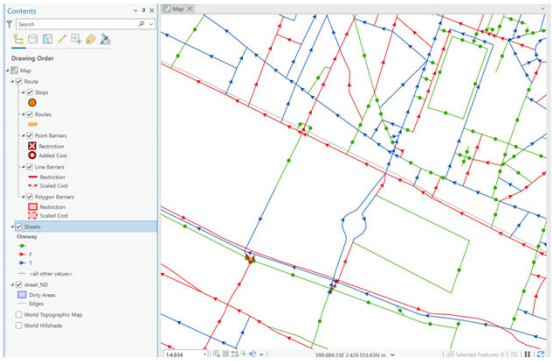
Creating a trace network (cont.)





Screen capture from week 4 lecture

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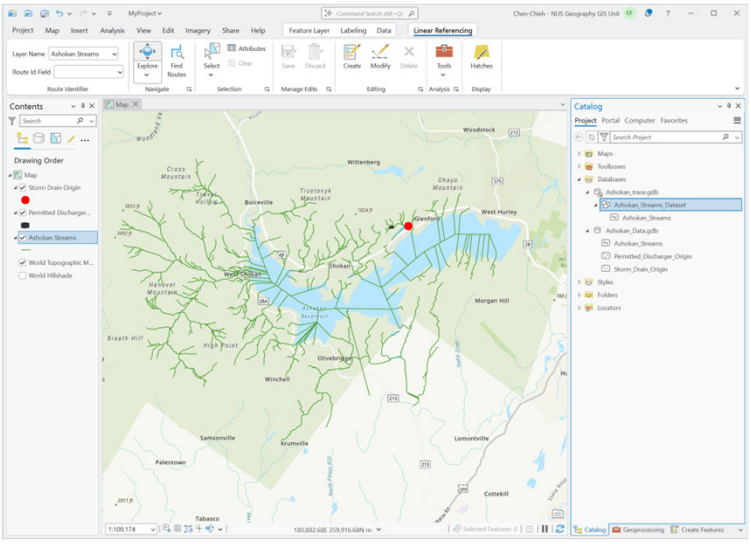
Creating a trace network (cont.)



- You need a feature dataset to organize feature classes participating in a network
  - The same constraints hold, e.g. projection and spatial extent

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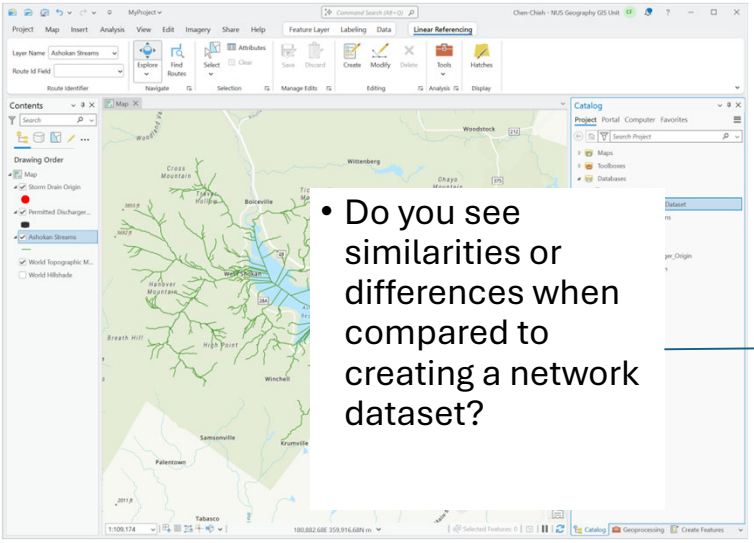
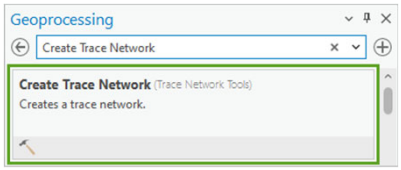
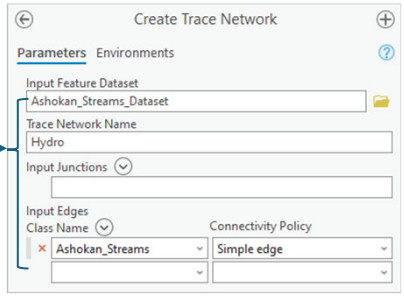
Creating a trace network (cont.)

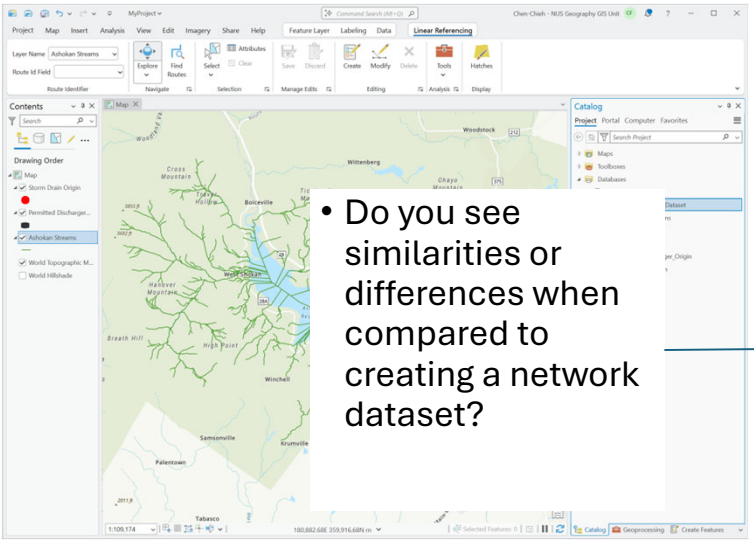


- Do you see similarities or differences when compared to creating a network dataset?





Creating a trace network (cont.)



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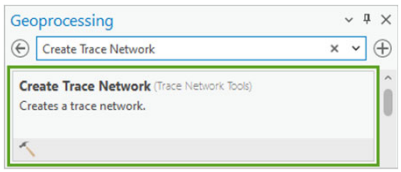
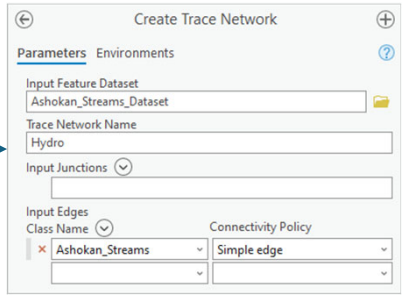
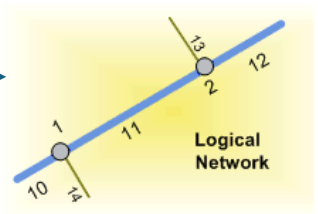




Simple edge (and counterpart)

- The edge concept remains – hinting *connectivity*
- Counterpart of simple edge – complex edge
  - Simple: resources (water in this lecture) flows from one end of the stream to the other
  - Complex: resource are siphoned off along the length of the stream (complex edge)



Simple edge (and counterpart)

- Do you have something similar to the distinction of single edge and complex edge in Network Dataset?

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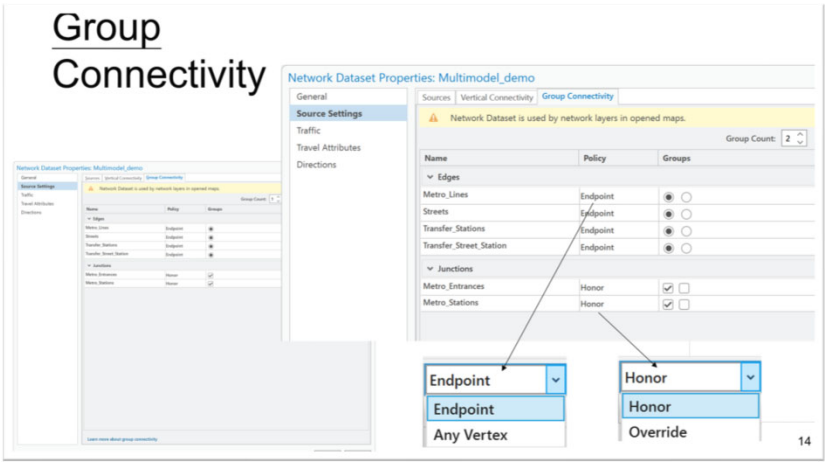
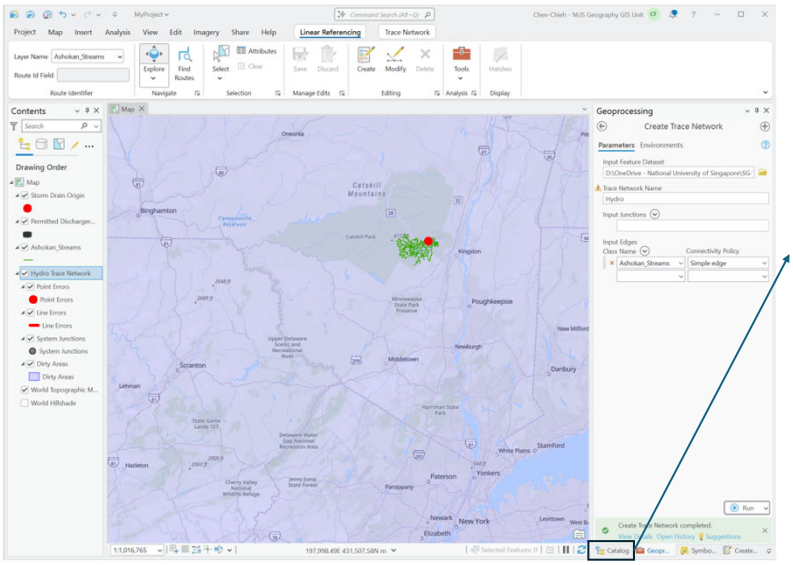
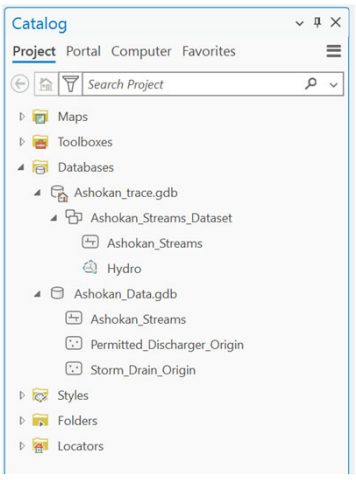


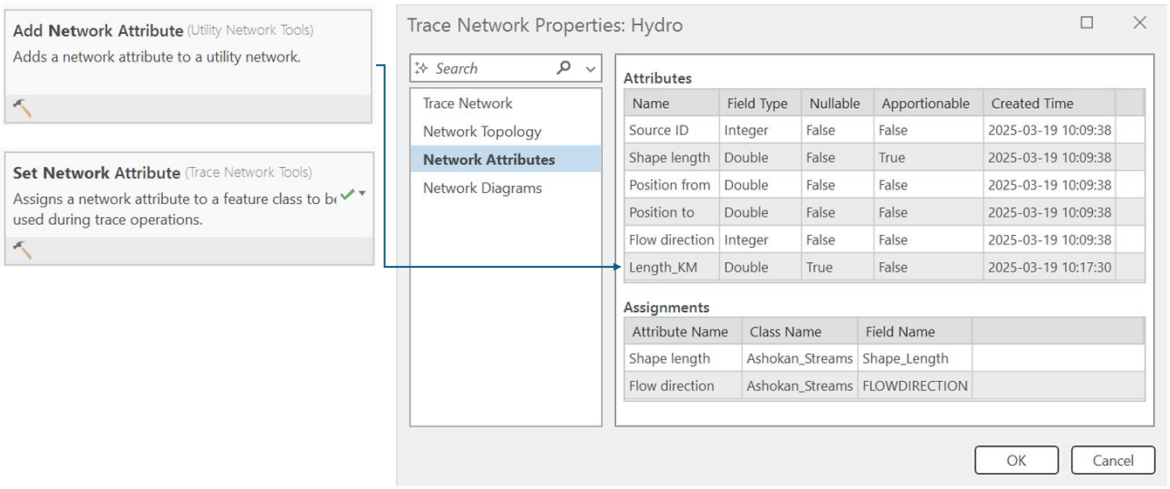
Slide 14 from week 4 lecture

Creating a trace network (cont.)

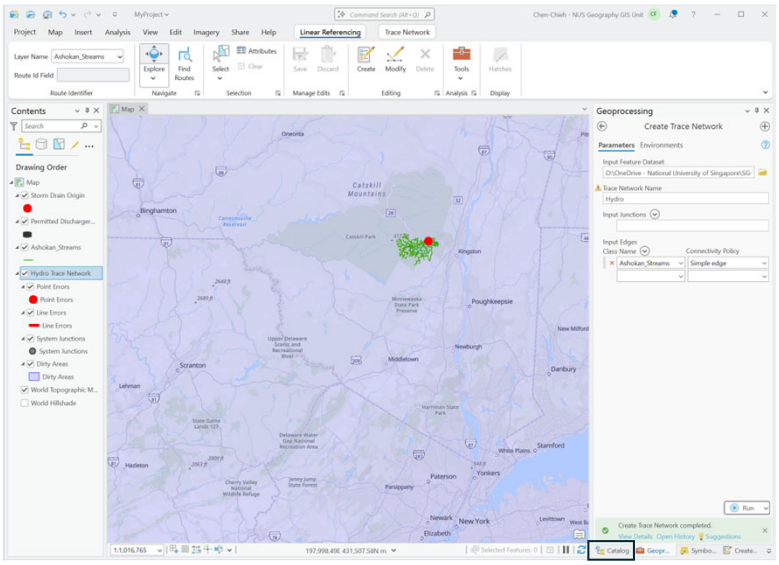




Adding and Setting A Network Attribute

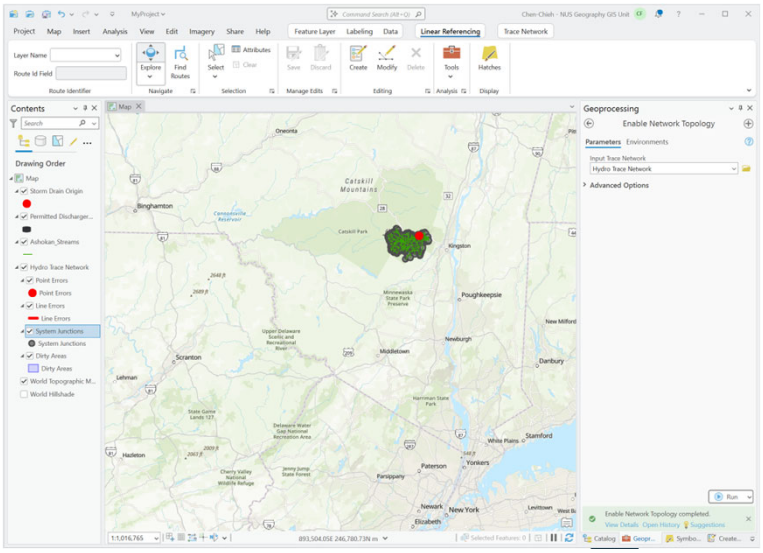


Creating a trace network (cont.)



- Before running Enable Network Topology

Creating a trace network (cont.)



- After running Enable Network Topology

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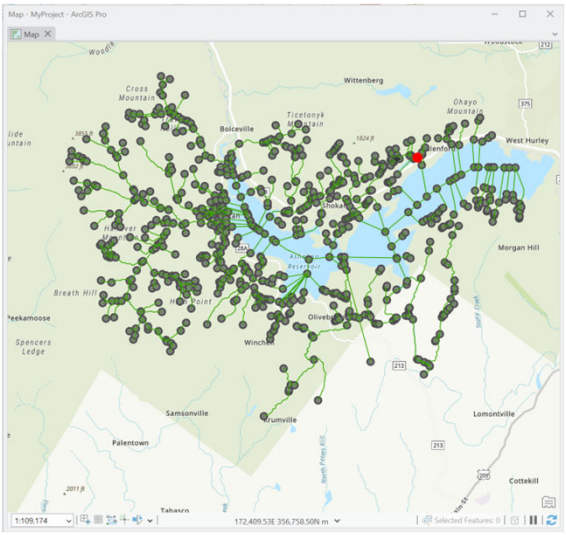
Creating a trace network (cont.)



- After running Enable Network Topology
- Connectivity by geometric coincidence, basically co-location

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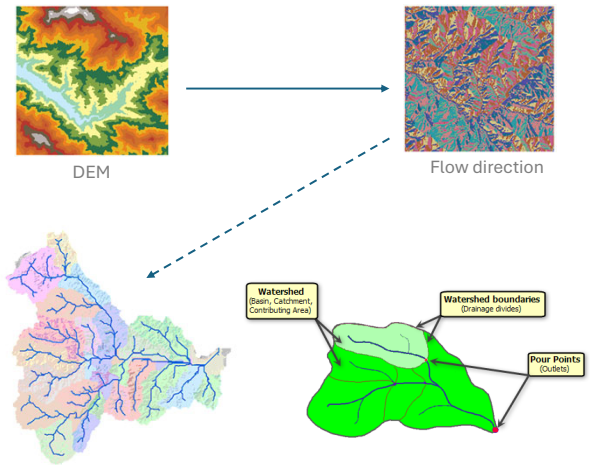
What are the usefulness of trace network?

- To **trace** (along the network), of course
  - It is related to *search* – a network search
- A general network type for use across various nonutility disciplines
  - It has no predefined information model, thus flexibility
  - But it offers the most fundamental construct -- connectivity

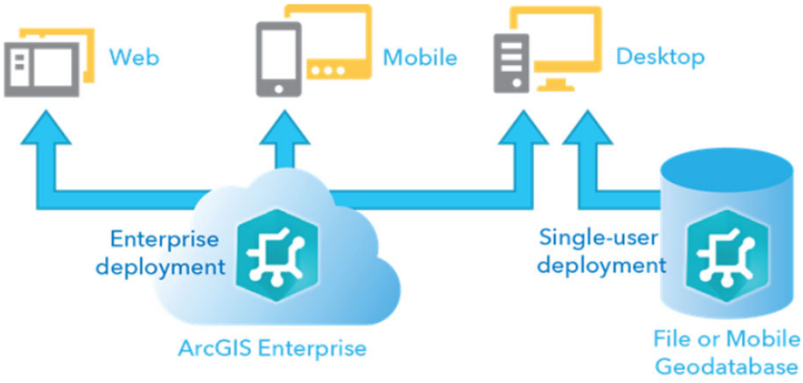


https://pro.arcgis.com/en/pro-app/latest/tool-reference/spatial-analyst/hydrologic-analysis-sample-applications.htm

Other networks

- Geometric network (superseded by trace network)
- Utility network
  - Structural network
  - Domain network
    - Electric, gas and pipeline, water, sewer, stormwater, and telecommunications.

- An enterprise deployment provides the richest capabilities of the utility network through a services-based architecture using ArcGIS Enterprise. This model enables large-scale, multiuser deployments and full network display, editing, and analysis capabilities through web maps and apps, mobile apps, and ArcGIS Pro on the desktop.
- A single-user deployment provides the full analytic capability of the utility network while hosted on a file or mobile geodatabase. In this model, you interact with the utility network through ArcGIS Pro on the desktop.



https://pro.arcgis.com/en/pro-app/latest/help/data/utility-network/what-is-a-utility-network-.htm

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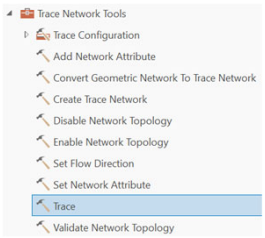
Summary

- Trace network
  - Share some characteristics with Network Dataset but also has its unique set of characteristics
    - Connectivity via co-location
  - Very simple, can be extended to different domains (e.g. surface hydrology and utility)
    - No specific rules for connectivity
    - See ArcGIS Pro toolbox Trace Network Tools
  - One interesting comment
    - "we have found that it is an acceptable solution for simple gravity networks to complete simple traces"
      (For full story see https://tinyurl.com/4e4na98b)



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Supplement information

- Terminologies in trace network
  - https://pro.arcgis.com/en/pro-app/latest/help/data/trace-network/trace-network-vocabulary.htm
- A blog on trace network since ArcGIS Pro 2.6 – interesting videos to demonstrate the capabilities of a trace network
  - https://www.esri.com/arcgis-blog/products/arcgis-pro/data-management/introducing-the-trace-network-with-arcgis-pro-2-6/
- The lecture is based on the following Esri Learn material
  - https://learn.arcgis.com/en/projects/trace-a-stream-network/