



# Customizing Road Networks for Transportation Planning

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# Agenda

- Objectives
- Travel Demand Model
  - Scales
  - Issues
- Scope of the Project
- Base Network
- Improving Connectivity
- Lessons Learned
- References
- Q & A

# Objectives

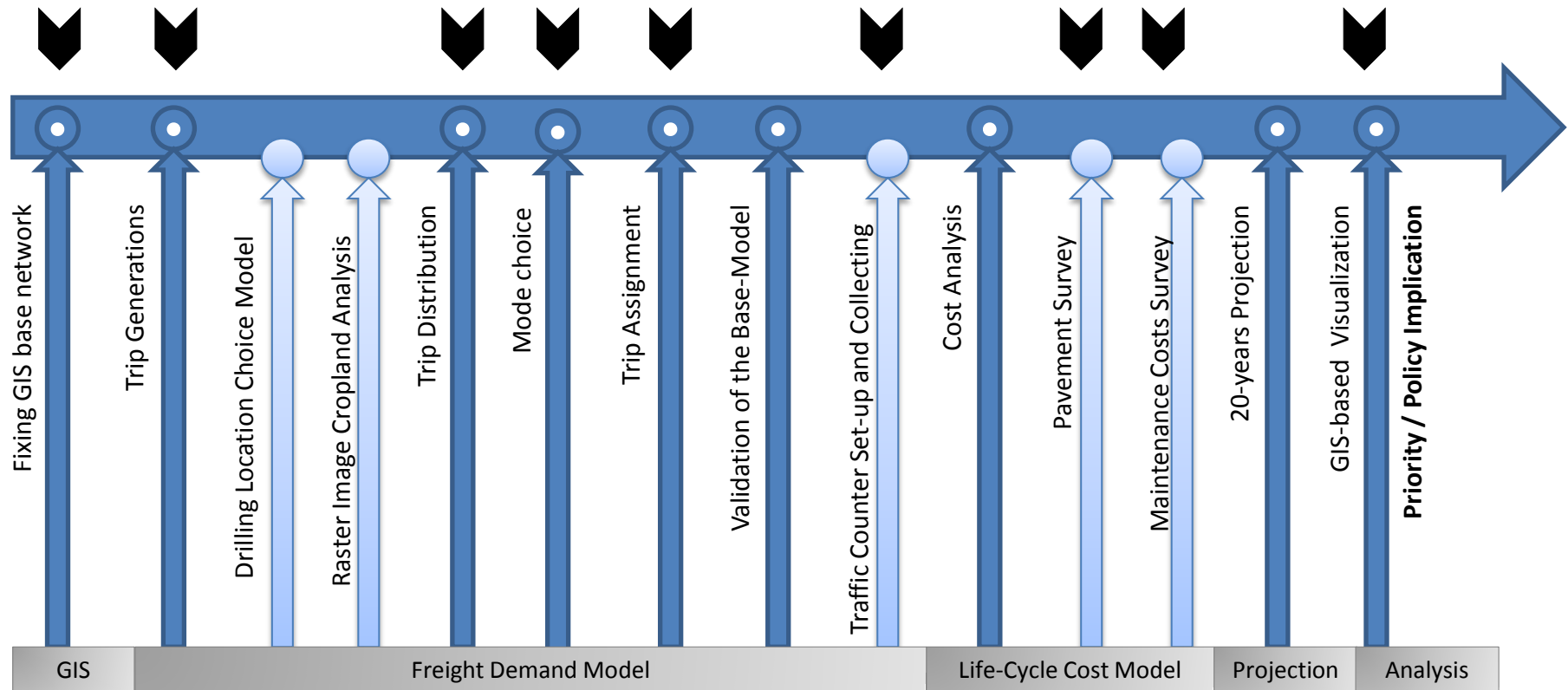
- Road Networks for Transportation Planning
  - Provide timely information for decision makers: transportation planners and policy makers
  - Build a reliable and cost effective modeling for short-range & long-range transportation planning



FHWA, US DOT

# Travel Demand Model

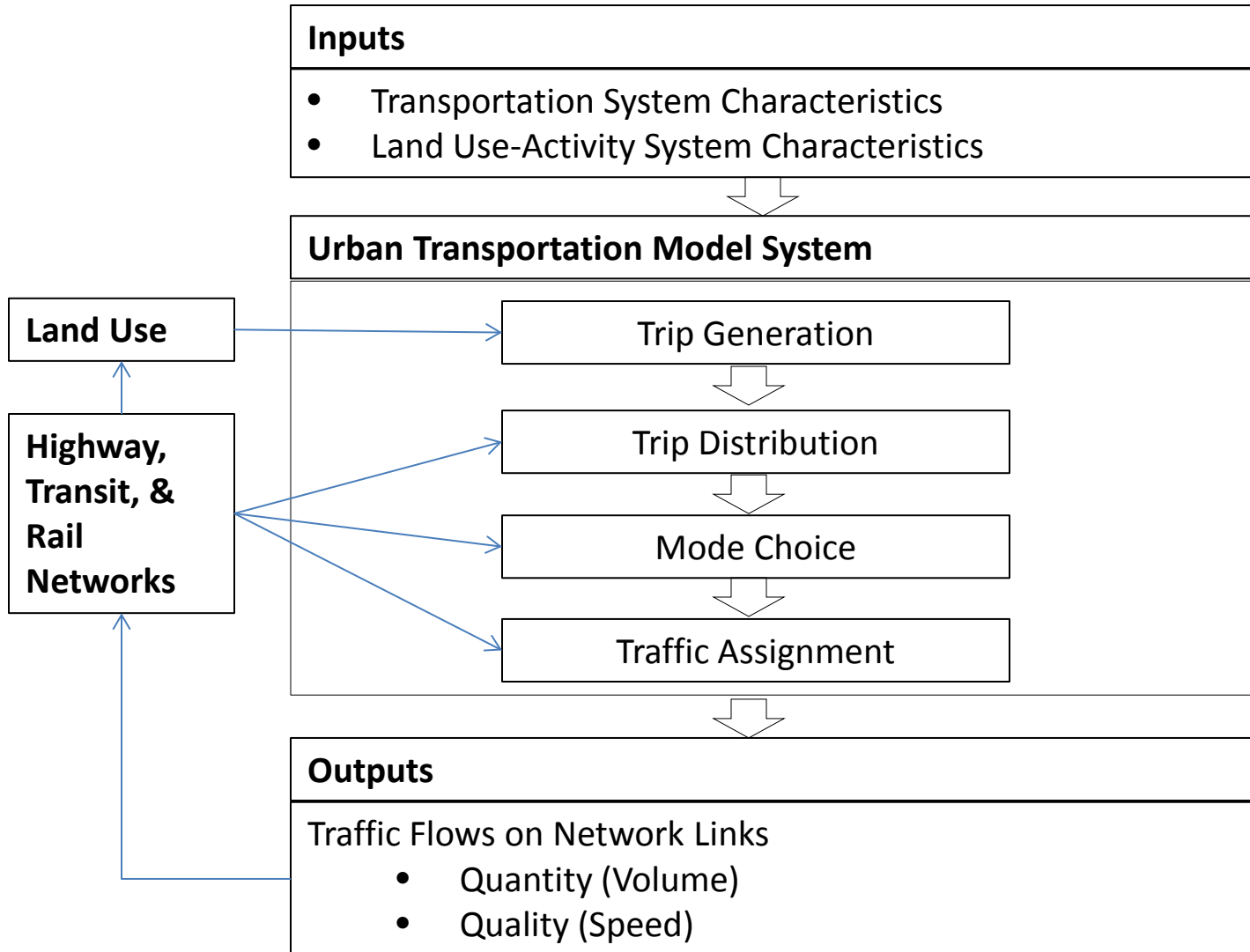
- Statewide Travel Demand Modeling (North Dakota)



 GIS Involved

See also EunSu Lee (2013)

# Travel Demand Model



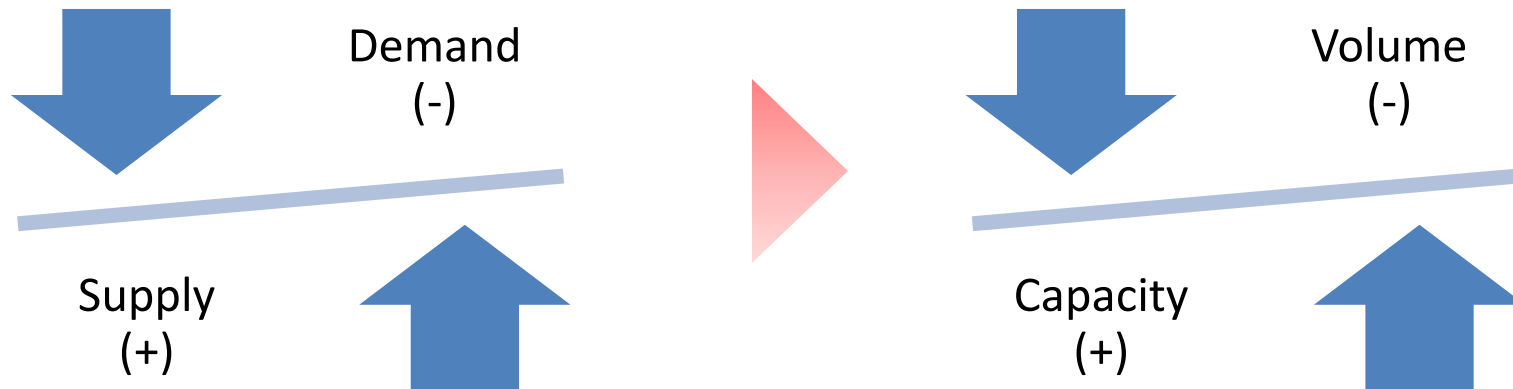
See also Hanson and Giuliano (2004) and Allison Butler (2008)

# Travel Demand Model

- Relative Eum (-) – Yang(+) Theory (상대성 음양이론)
- The Bureau of Public Roads – Link Congestion (Volume-Delay) Function

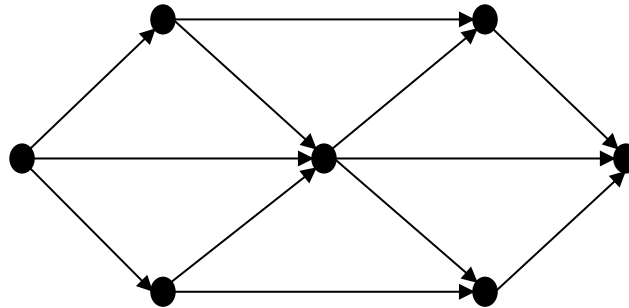
$$- AVGT_a(VOL_a) = FFT_a \left( 1 + \alpha \left( \frac{VOL_a}{CAP_a} \right)^\beta \right)$$

- Volume/Capacity Ratio



# Travel Demand Model

Capacity  
Pavement  
Maintenance Pattern  
Maintenance Cost  
Traffic



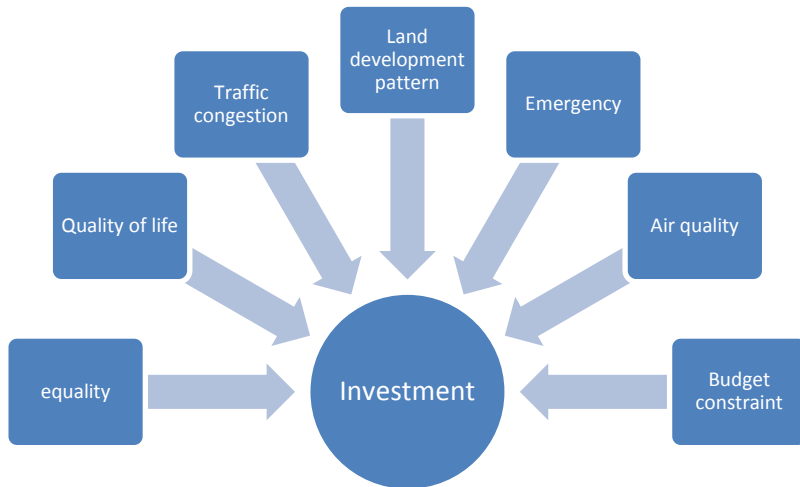
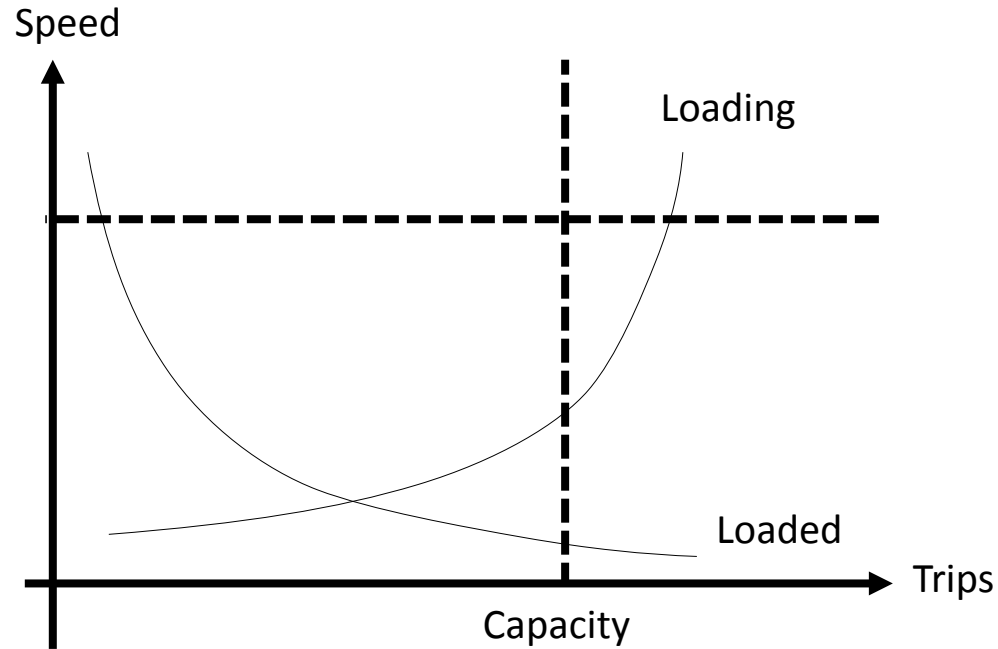
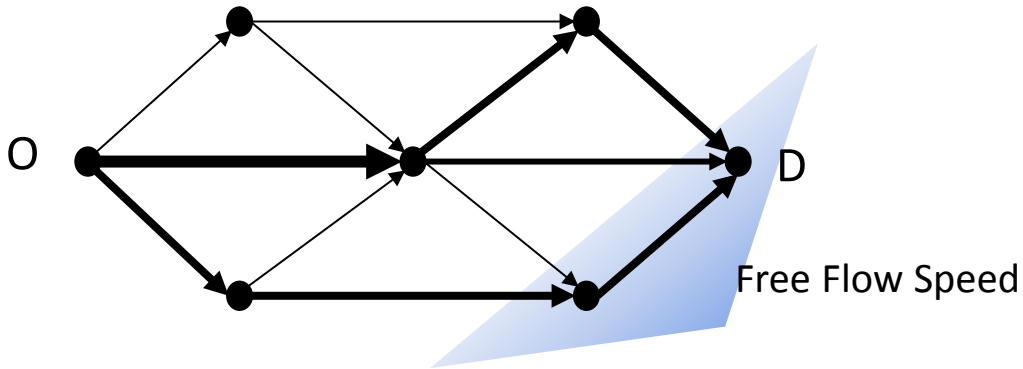
Volume estimate  
V/C Ratio  
VMT  
Projection AADT  
Cost(\$)  
Activity

- Vehicle Miles Travelled:  $Miles \times Number\ of\ Trips\ on\ a\ segment$
- Volume-Capacity Ratio:  $\frac{Traffic\ Volume\ on\ a\ segment}{Capacity\ of\ a\ segment}$
- Transportation Adequacy Measure (TAM) for each Small Area Zone:  

$$\frac{\sum VMT \times \frac{V}{C}}{\sum VMT}$$
- Level of Service: A (free flow) ~ E (unstable flow), F (breakdown flow)

# Travel Demand Model

- Capacity-Speed Relationship





# Scales

- Jurisdiction
  - City
  - County
  - State
  - Regional: MPO or RTPO
- Traffic Analysis Zones
  - County
  - Townships
  - Census Block Groups
  - Census Block
  - Subdivisions
- Functional Class
  - Interstate Highway
  - U.S. Highway
  - State Highway
  - Rural highway
  - Urban
  - Trail

Work independently, plan together for growth management  
(Hansen and Giuliano, 2004)

# Issues

- Investment Scheme
  - Pavement Type
  - Maintenance Frequency
  - Maintenance cost per Mile
  - 3<sup>rd</sup> Party Contractors
- Issues
  - Ongoing Data Collection/Cleaning
    - Household travel survey (random and panel)
    - Traffic counter
    - Census
    - Firm locations (trip generators and attractors)
  - Feed Travel Estimates into Land-Use Model/HERS-ST/MOVE
  - Relying on Exogenous Dynamic Growth Factor

# Scope of the Project

- Customizing Road Networks using Publicly Available Datasets
- Improving Connectivity
  - Sub-models:
    - Oil development
    - Agricultural transportation
    - Major manufacturing
    - Passenger travel
    - Through traffic
  - Networks
    - Federal and State highway
    - Local and Urban Roads
    - Railroad
    - Bridge Inventory

# Scope of the Project

- To update existing networks of
  - Interstate, U.S., and state highways from ND GIS Hub
  - County roads from ND GIS Hub
- To develop a navigable road networks of the state
  - Connecting segments
  - Splitting long segments based on intersections and entry points
  - Physical travel directions and truck routes
- To develop a scheme for planning software
  - Should be navigable
  - One way and direction
  - Should have start and end nodes for links (A and B nodes)
  - Should provide travel speed (speed limit or measured average travel speed)
  - Should provide capacity based on road inventory information


# Improving Connectivity

- Three Steps

Identifying



Fixing



Validating

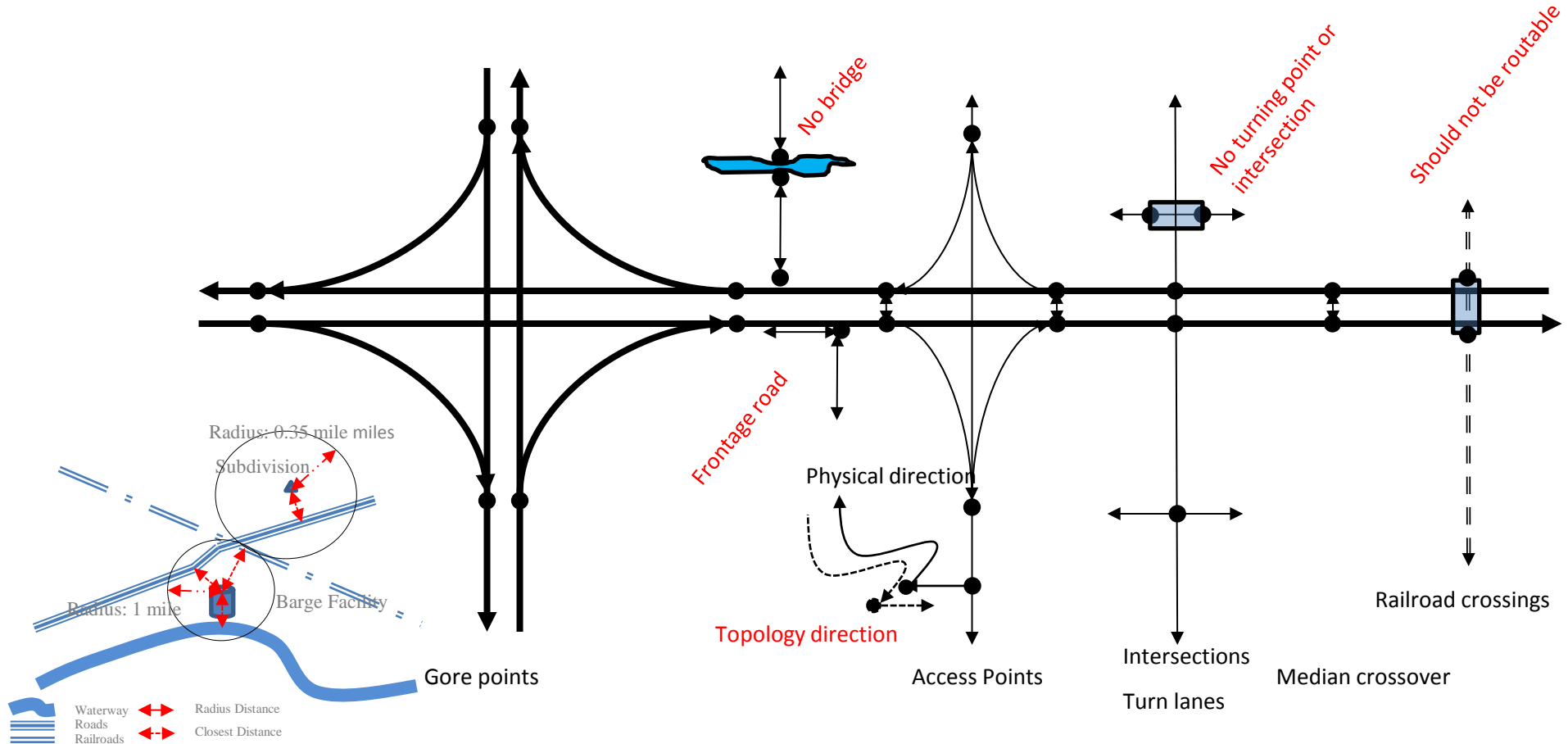
Dangle  
Undershooting  
Overshooting  
Missing  
Redundant  
attributes

Connecting  
Disconnecting  
Splitting  
Adding  
Removing

Visual Inspection  
Using Network Analyst®  
Generating Dangling points  
others

# Improving Connectivity

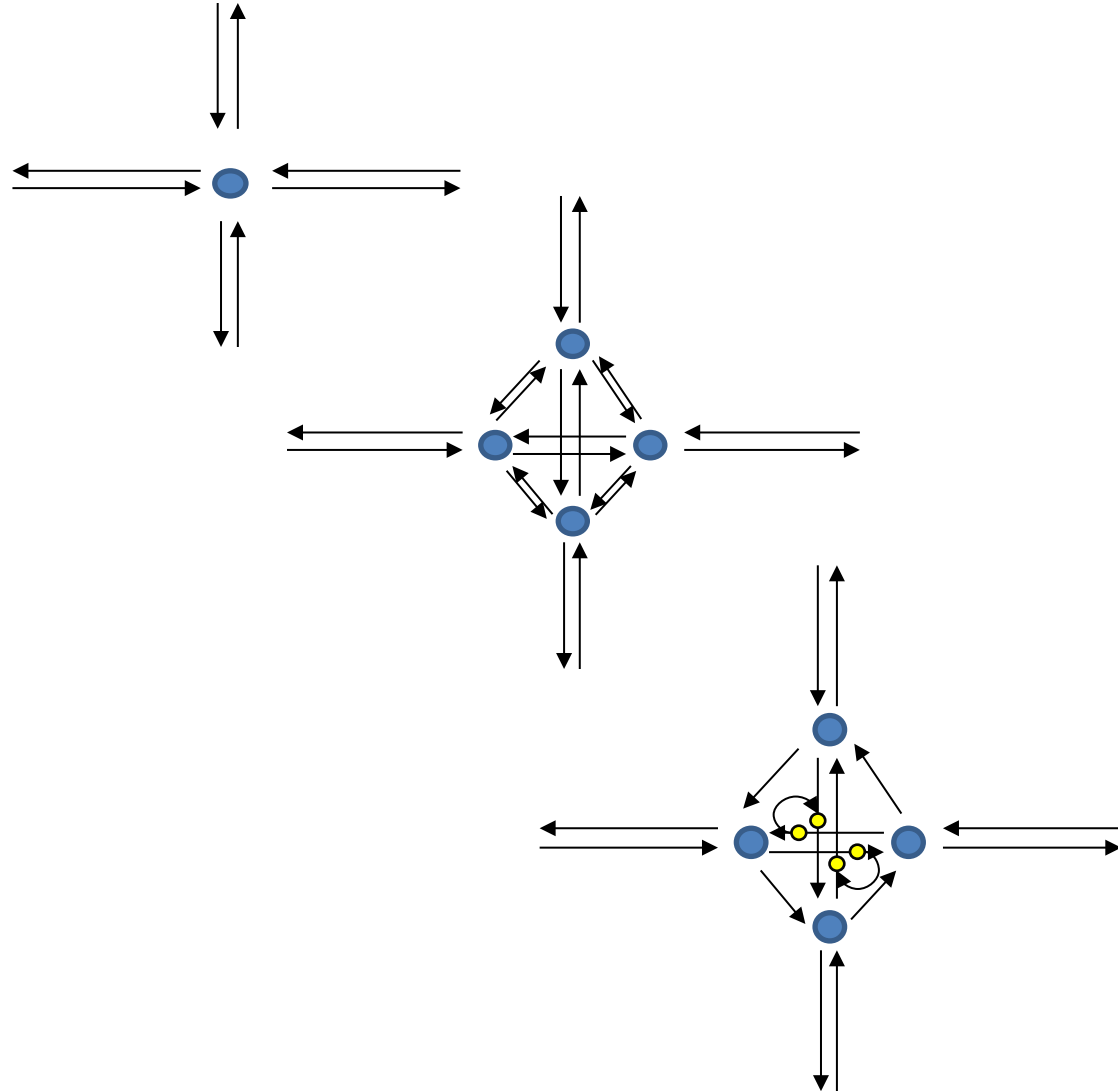
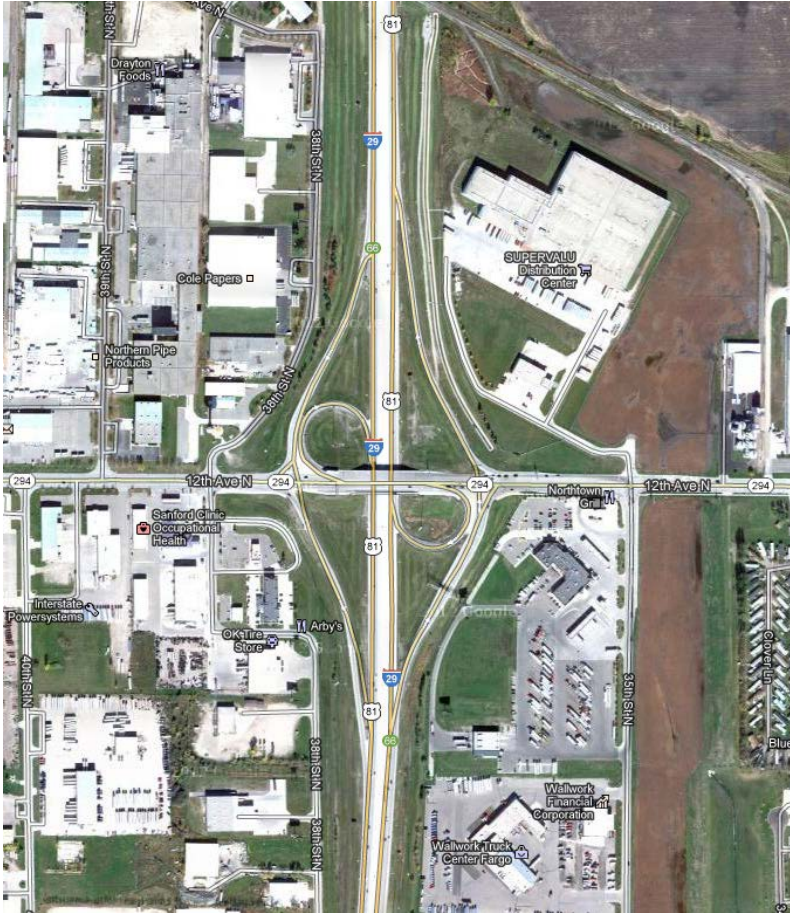
- Routable Road Networks – Connectivity



See also EunSu Lee (2013) at GIS-T Symposium

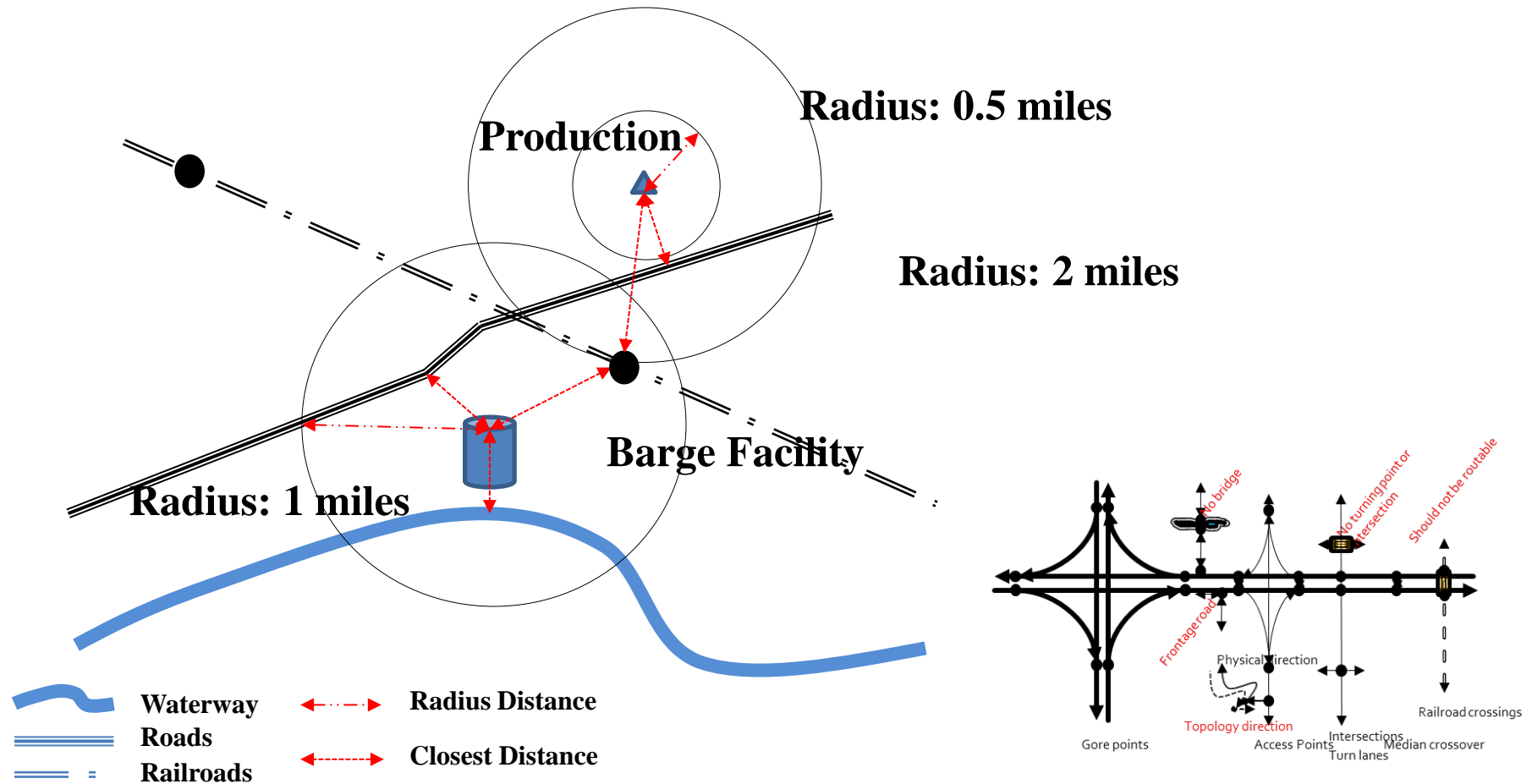
# Improving Connectivity

- Connectivity



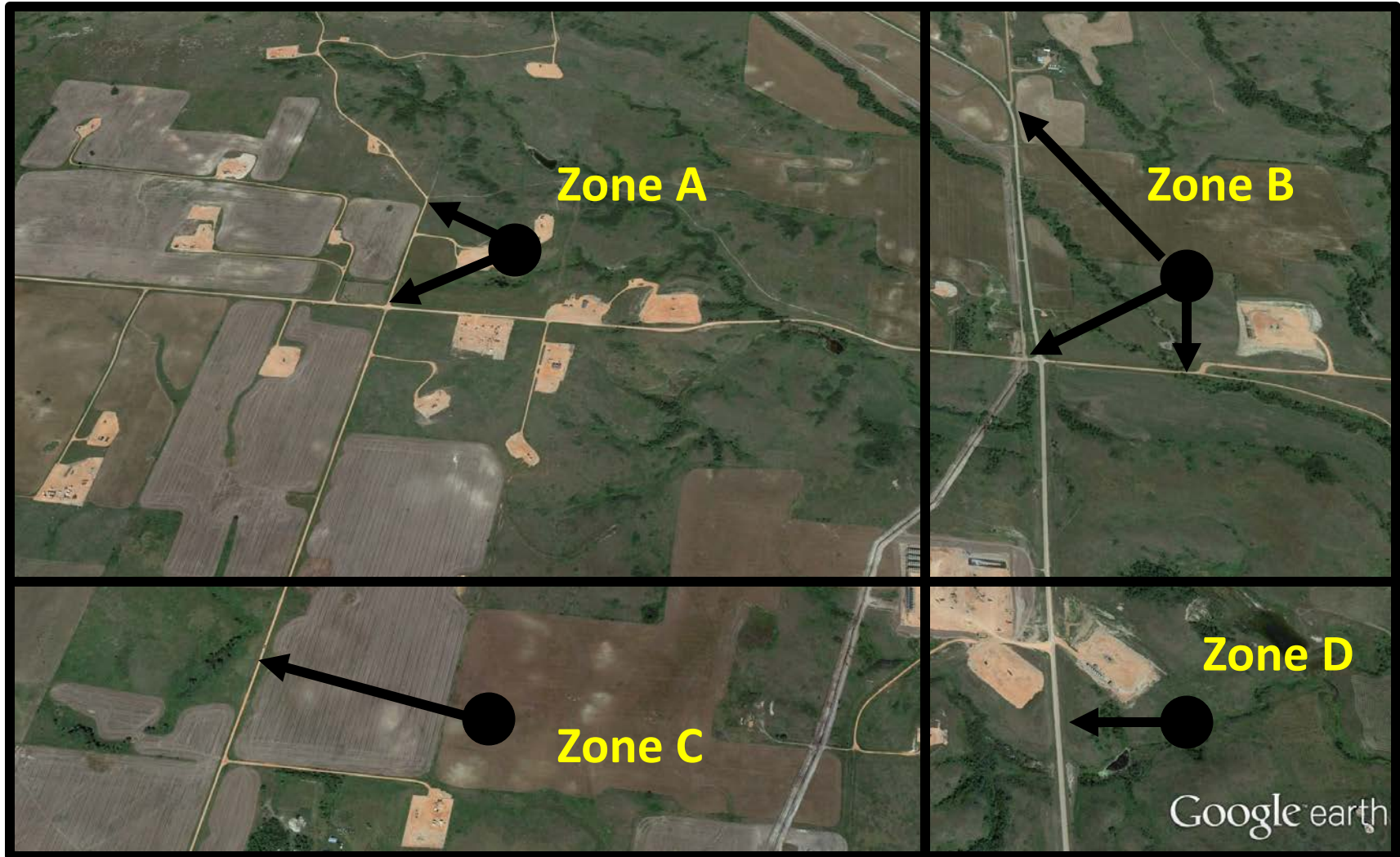
# Improving Connectivity

- Routable Intermodal Networks – Connectivity



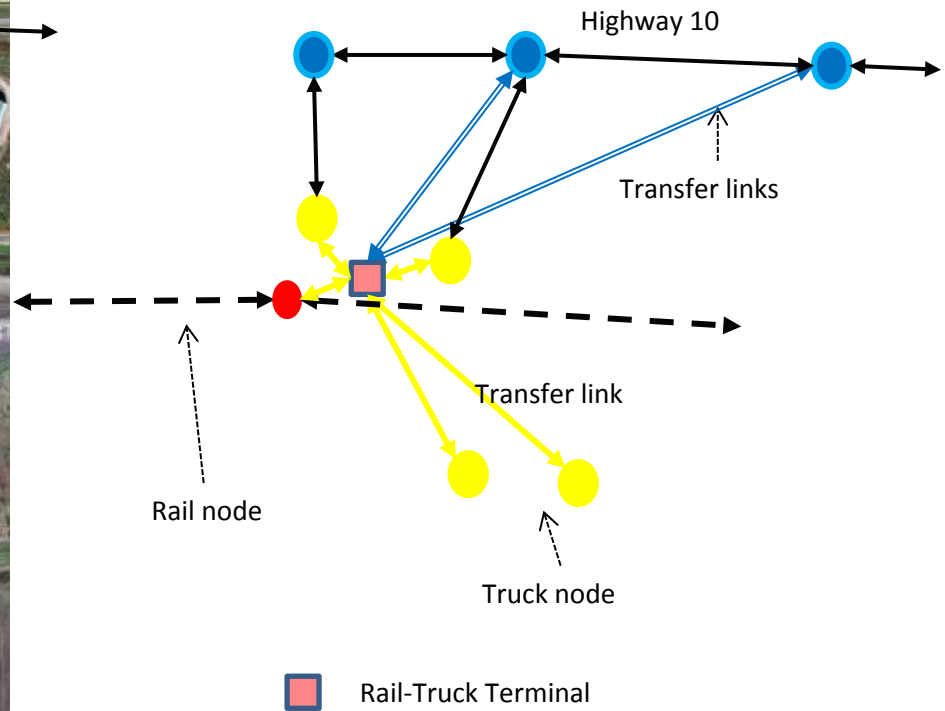
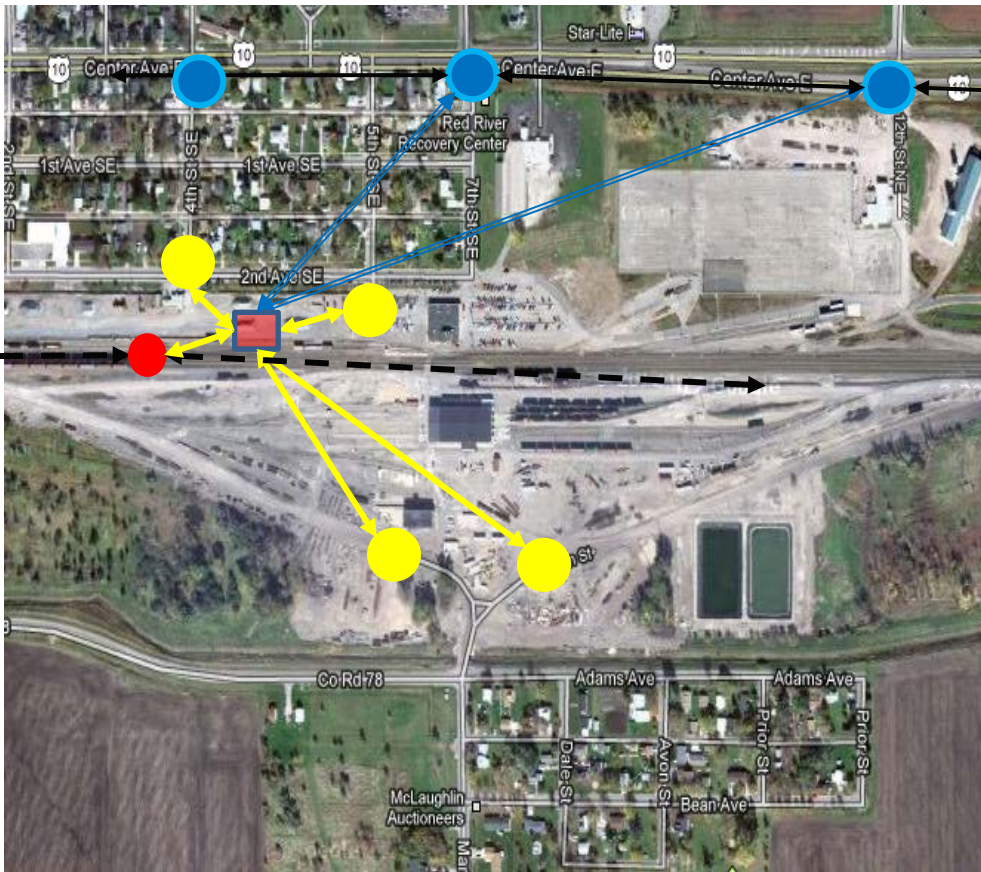


# Improving Connectivity



# Improving Connectivity

- Intermodal Terminal – Dilworth, MN





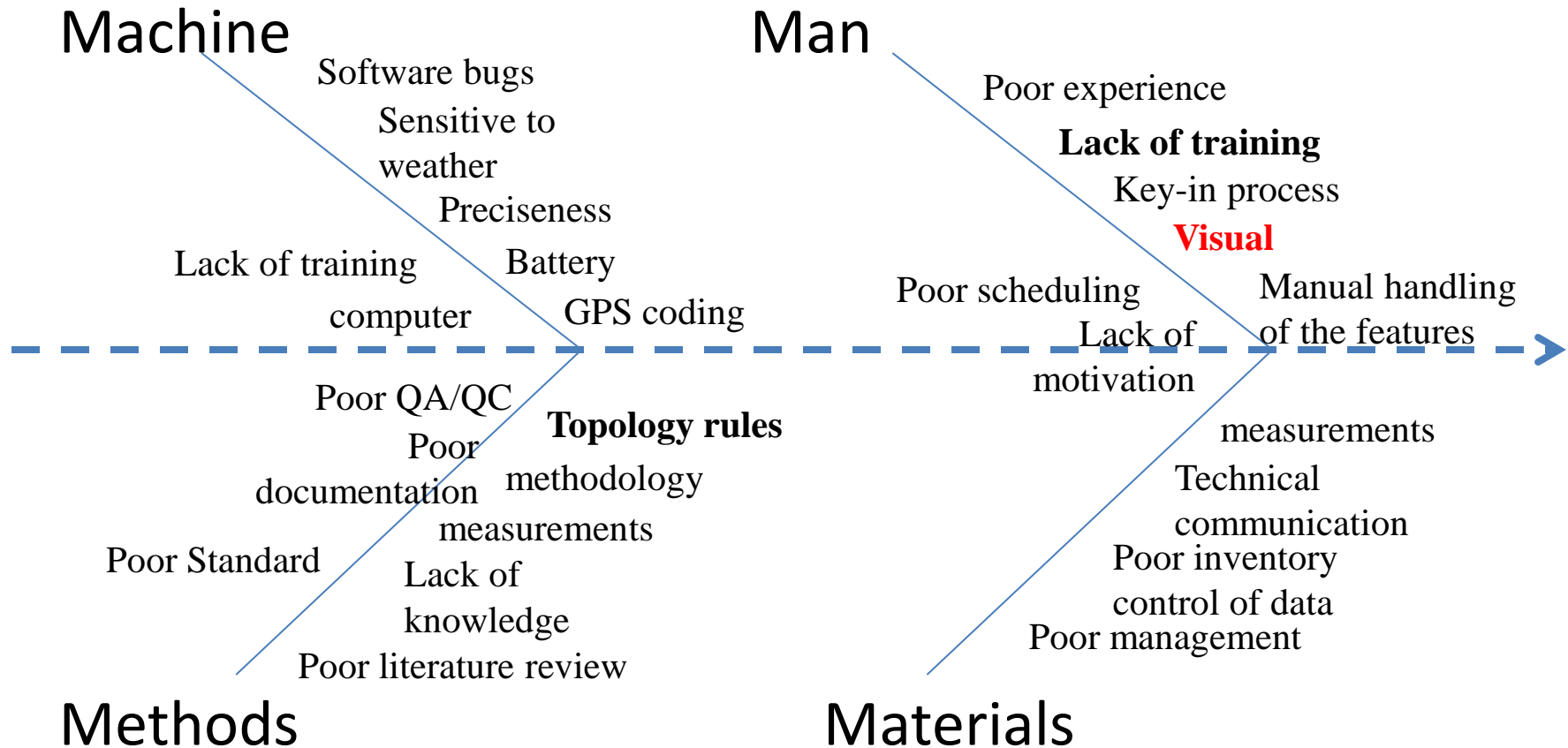
# Attribute Table

- Attributes (see Allison Butler (2008) for more information)

Field Name	Type	Length	Comments
SegmentID			Original Segment ID
SubSegID			Sub segment identification split from segment ID
Miles			Link length in miles
Route_Sign			Route sign from original file
Ownership			F:federal, S:state, C:courtney, T:township, F:forest, C:corp of engineers
Maintenance	Character		Which agency maintain the segment
Bridge	Character		Bridge ID
Screenline	Yes or No	1	If traffic counter was or is installed
AADT	Number		Average annual daily traffic
TAADT	Number		Truck average annual daily traffic
PavementType	Character		
One_Way	1 or 2	1	1: one way, 2:two-way; V:Variable
Way Type			N: non-CMC route, C:township, T: tribal, I:Interstate, U:US Highway, S:State highway
Capacity_ESAL	Number		Link capacity in unit of ESAL
Capacity_PCE	Number		Link capacity: passenger car equivalent
Direction_A	Number		Link node beginning
Direction_B	Number		Link node ending
Route ID	Character		Route for linear referencing
F_Mile	Number		From mile of the LRS
T_Mile	Number		End mile of the LRS

# Error Sources

- Sources Spatial Data Error



# Quality Assurance

- A set of shortest paths using random origin-destination pairs
  - Travel behavior
- Visual Inspection
  - Interstate highways and local roads
  - Different symbols to represent various facilities

# Lessons Learned

- Recognizing tedious and time consuming process
  - Increase utilization for long-term
- Setting topology rules / connectivity rules
- Standard process for team members
- Keeping records of correction activities
- Setting acceptance error rata
  - This is transportation modeling, not actual travel information
- Restricting removing or deleting original segments
  - Adding a new segment is acceptable.

# References

- Allison Butler (2008). *Designing Geodatabase for Transportation*, ESRI: Redlands, CA
- EunSu Lee (2013). *Statewide Freight Demand Modeling to Support Long-Range Transportation Planning in North Dakota*, A Transportation Research Board SHRP 2 Symposium, October 21-22, 2013. Dulles, VA.
- Susan Hanson and Genevieve Giuliano (2004). *The Geography of Urban Transportation*, Guilford Press: New York, NY.



# Q and A

Thanks for your attention!

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