TRANSIMS Training Course at TRACC

Transportation Research and Analysis Computing Center

Part 2

Modeling of Street and Transit Networks in TRANSIMS

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- Description of IntControl
- TRANSIMS Network Tables in Detail
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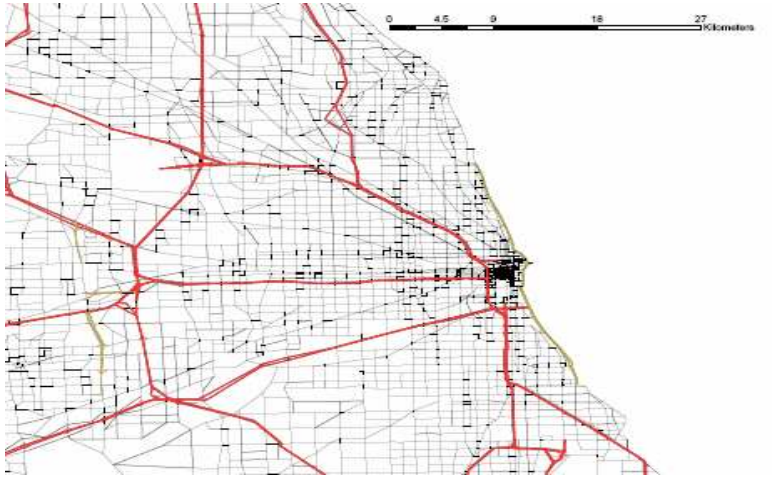
Introduction

- The TRANSIMS Transportation Network provides detailed information for the router and the microsimulator about:
  - Streets
  - Lanes
  - Intersections
  - Connectivity
  - Signals
  - Parking
  - Transit Stops
  - Transit Routes
  - Land Use Activity Data



- Major TRANSIMS Network Tables
  - Node Table
  - Link Table
  - Pocket Lane Table
  - Parking Table
  - Activity Locations Table
  - Process Links Table
  - Transit Stops Table
  - Lane Connectivity Table
  - Signals and Phases
  - Unsignalized Nodes

The TransimsNet Utility

- TransimsNet converts typically available road network tables into a much more detailed network for use in TRANSIMS
- Input tables for TransimsNet are
  - Nodes Table
    - *Node identifiers*
    - *The x and y coordinates in UTM meters (with an optional z)*
  - Links Table
    - *Links are identified by the start and end node identifiers*
    - *Length of the link (in meters)*
    - *Number of lanes in both directions (meters per second)*
    - *Speed limits in both directions (meters per second)*
    - *Link capacities in both directions (vehicles per hour and link)*
    - *Facility types in form of typical strings (MAJOR, MINOR, etc)*
    - *Vehicle types separated by "/" characters*
    - *Toll cost fields*

The TransimsNet Utility

- Zones Table (for the center coordinates of traffic analysis zones)
  - *Zone identifiers*
  - *The x and y coordinates (in meters)*
  - *Area type identifier (for up to 8 area types)*
- Shape Point Table
  - *Applies to the link table*
  - *Provides shapes to the links to better follow road segments*
  - *Contains x and y coordinates of shape points for each applicable link*
- Keep Nodes Table
  - *TransimsNet tries to remove unnecessary nodes by placing them into the newly generated shape point table*
  - *Nodes listed in this table are preserved even if no links connect to them (can be necessary for transit routes and similar)*
- Turn Prohibition Table

TRANSIMS Tools - Conversion of Road Networks

Sample input tables for:

- Nodes
- Links
- Zones
- Shapes (not shown)

NODE	X_COORD	Y_COORD
1945	428121	4748132
1946	424938	4753691.5
1947	412534	4746420
…		
5001	327590.3	4581616.5
5002	327595.4	4581687.5

ZONE	X_COORD	Y_COORD	AREATYPE
1	446306.5	4638415	1
2	446724.4	4638426	1
3	447302.5	4638440	2
4	447672.9	4638431	2
5	448209.2	4638283	2

ANODE	BNODE	LENGTH	LANES_AB	LANES_BA	SPEED_AB	SPEED_BA	CAP_AB	CAP_BA	…
1945	19688	4409.60	3	3	24.58	24.58	2430.0	5400.0	…
1946	11223	1367.94	3	0	29.05	0.0	6000.0	0.0	…
1947	8666	6099.41	2	2	24.58	24.58	4000.0	4000.0	…

TYPE	USE	TOLL_AB	TOLL_BA	STREET
ZONECONN	AUTO/TRUCK/WALK	0.0	0.0	I-90
ZONECONN	AUTO/TRUCK	0.0	0.0	I-88
ZONECONN	AUTO/TRUCK/BUS	0.0	0.0	I-55

The TransimsNet Utility

- TransimsNet takes a number of parameters to generate an extensive set of properly correlated network tables for use in the router, microsimulator, and other related tools
  - A matrix of pocket lane lengths for facility type versus area type
  - Criteria for signal placement based on facility types and area types
  - Criteria for stop sign placement based on facility types and area types
  - Criteria for placing activity locations along suitable links
  - Intersection setback distance
  - Activity location side offset
  - Minimum link length
  - Maximum length to x/y ratio
  - Maximum connection angle
  - Controls for the treatment of unnecessary nodes
  - Controls for adding U-turns to dead-end links
  - Specification of the first external zone (see next slide)

The TransimsNet Utility

- Area Types
  - TRANSIMS allows for up to 8 area types provided as part of the traffic analysis zone table
  - Area types describe areas with similar characteristics, such as rules for placing signs, signals, pocket lanes, and other road features
- External Zones
  - External zones are different from regular traffic analysis zones, providing a mechanism to feed external traffic onto the network.
  - External zones must be specified as the last zones (the zones with the highest identifiers) in the input zone table
  - Node identifiers with x and y values identical to the zone centroids must be placed in the node table
  - Regular network nodes have typically identifiers that start at a higher number, e.g. in the Chicago model, with 5000
  - That leaves enough identifier space for the 1961 zones with corresponding node identifiers (external starts at 1950)

The TransimsNet Utility

- TransimsNet produces the following network tables from the limited set of input data
  - Nodes
  - Links
  - Link Shapes
  - Activity Locations
  - Parking Lots
  - Process Links
  - Pocket Lanes
  - Lane Connectivity
  - Sign Warrants
  - Signal Warrants
  - Link-Node Equivalencies
- This is an intermediate set of network tables. The network will be completed by IntControl and TransitNet (next slide)

The IntControl Utility

- TransimsNet produces
  - Sign Warrants and
  - Signal Warrants
- These are intermediate tables that may need to be edited by the user to more closely specify the locations of traffic controls such as signals and signs
- IntControl uses these tables to create
  - Unsignalized Nodes
  - Signalized Nodes
  - Timing Plan
  - Phasing Plan
  - Detector
  - Signal Coordinator
- This completes the road network for vehicular traffic (nodes and links for transit should be included and coded in the input files already)

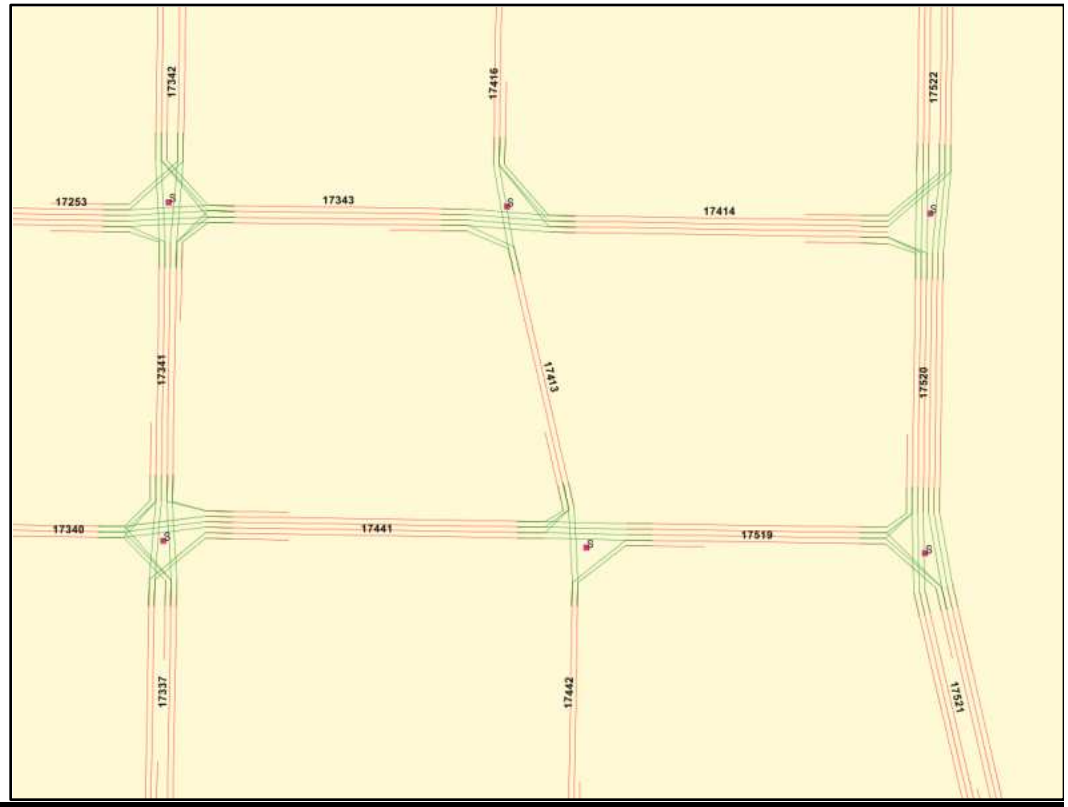
Network Tables

- More details on many of the previously mentioned network tables are provided on the following slides
- Most of these tables can be converted to GIS shape files for easy visualization

Network Tables - Nodes

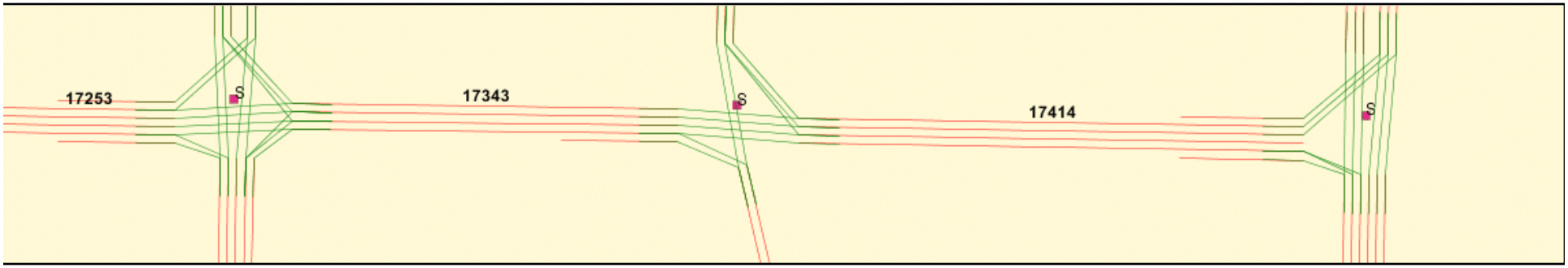
- Network nodes are placed onto the roadway network where
  - The roadways form an intersection
  - The roadway branches out
  - A change in the number of permanent lanes occurs
  - A road ends

- A node defines the location of an intersection, but intersection properties are defined in other network files for e.g.
  - Lane connectivity
  - Traffic signals
  - Pocket lanes
  - Lane Restrictions



Network Tables - Links

- Links are placed on the network to represent node interconnections
  - Links represent roadways, walkways, rail lines, etc.
  - Links always connect two nodes
  - Links are bidirectional unless specified as unidirectional
  - Each node can be connected to several links
  - Links can be multi-modal, e.g. light rail on city streets
  - Links are used to specify road and intersection properties
    - *Posted speed limits and free speeds*
    - *Number of permanent lanes*
    - *Functional classes*
    - *And many more details*

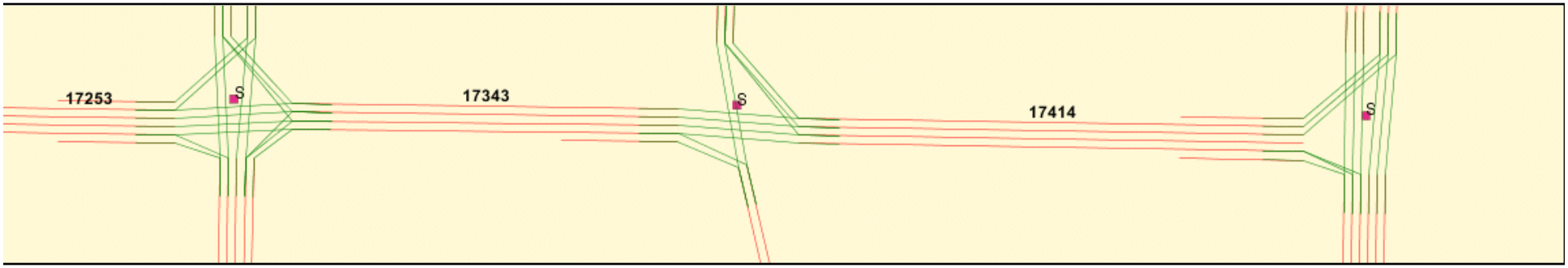


Network Tables - Links

- Properties of network links
  - Street names
  - Identifiers for the nodes connected by this link
  - Number of lanes on the link in each direction
  - Number of pocket lanes on the left and right in both directions
  - Effective length of the link (including curvature)
  - Setback distances from the center of both intersections
  - Default speed limit for vehicles traveling in each direction
  - Default free flow speed for vehicles traveling in each direction
  - Functional class of this link
    - *Freeway, Expressway, Arterial,*
    - *Local, Ramp, Walkway, etc*
  - Default lane connectivity at both end nodes (link to link)
  - Vehicle types allowed to use link (separated by "/")
- TRANSIMS supports shape points on links for curved road segments using a special shape point table

Network Tables – Pocket Lanes

- Pocket lanes are more finely described as
  - Turn, merge, and pullout lanes
  - Permanent lanes that are not present for the entire length of a link
- Properties of pocket lanes
  - Identifier of the node toward which the pocket lane leads
  - Identifier of the link on which the pocket lane lies
  - Starting position of pocket lane
  - Lane number of pocket lane
  - Types: T = turn pocket; P = pull-out pocket; M = merge pocket
  - Length of the pocket lane

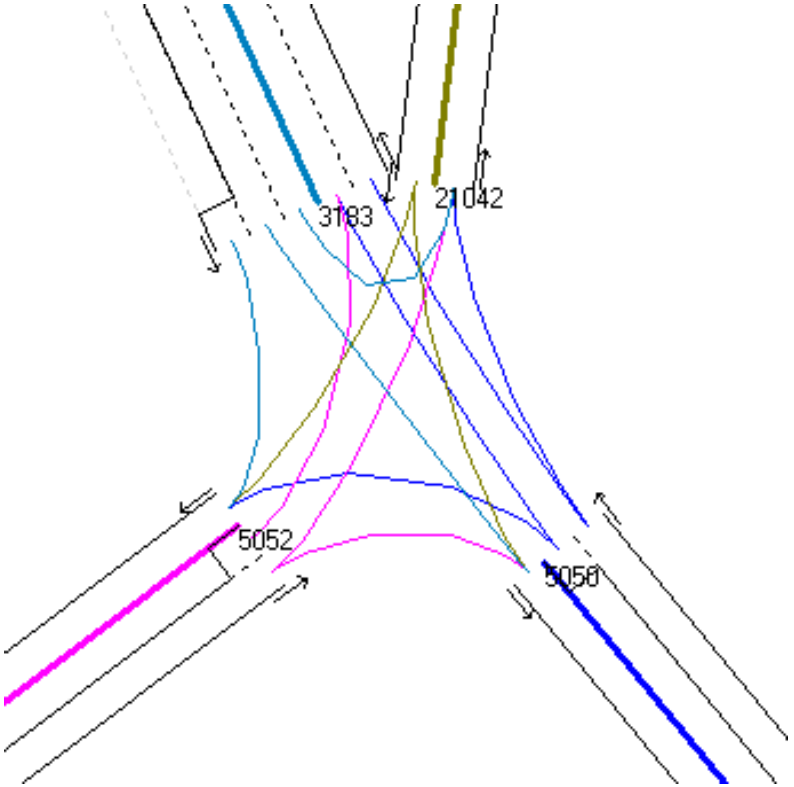


Network Tables – Lane Use and Speed Restrictions

- Lane use can be restricted according to a number of criteria
- Properties of lane use records
  - The corresponding link identifier and lane identifier (0 means all lanes)
  - The node towards which the lane leads
  - The vehicle type to which the restriction applies
  - The type of restriction
    - *High occupancy lane, bicycle, auto, truck, bus, rail*
  - The start and end time of the restriction
- *In addition to speed limits and free speeds in the link table, further modifications can be made for each lane* ***Not in Version 4***
- *Properties of speed restriction records are*
  - *IDs of the node and link towards which the lane leads*
  - *The vehicle type to which the restriction applies*
  - *Speed limit and free speed*
  - *The start and end time of the restriction*

Network Tables – Lane Connectivity

- Lane connectivity records specify all the movements allowed at a node
- Properties of lane connectivity records
  - The node identifier
  - The incoming link identifier
  - The outgoing link identifier
  - The lane number of the incoming lane
  - The lane number of the outgoing lane
- This information is essential for the router and the microsimulator and is not typically found in existing network data
- Tools exist to create automatic connections, but manual editing is important to ensure correct representation of intersections



Network Tables – Traffic Signals

- Just like on a real street network, traffic signals are essential to support the effective flow of traffic in a simulated network
- Traffic signals are described with a set of tables
  - Signalized node table
  - Phasing plan table
  - Timing plan table
  - Detector table
  - Signal Coordinator table
- Programs exist to place traffic signals heuristically (TransimsNet, IntControl)
- Traffic signals and traffic signal coordination require a significant amount of work to create a representative simulation
- Traffic signal data is hard to obtain
- Traffic signal timings and phases may change during the course of a day

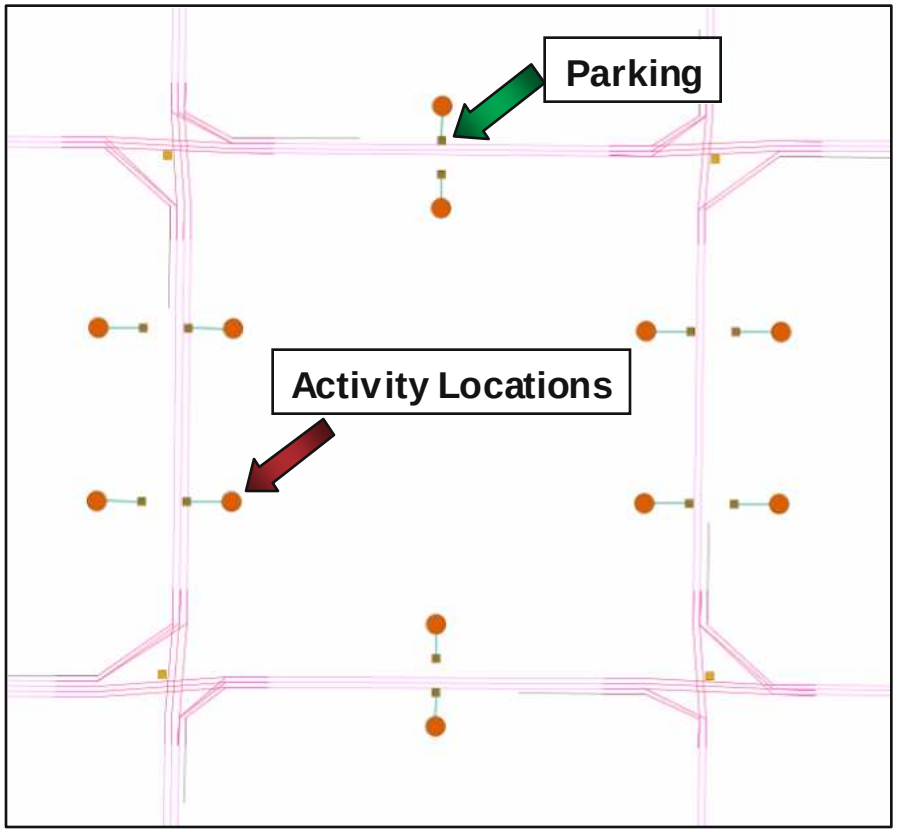
Network Tables – Unsignalized Intersections and Turn Prohibitions

- Unsignalized intersections may have “Stop” or “Yield” signs
- Programs exist to place intersections heuristically (TransimsNet, IntControl)
- Properties of unsignalized intersection records
  - The node identifier
  - The link identifier
  - The type of sign
    - *Stop, Yield, None*

- Turn prohibitions can be specified in detail
  - The identifier of the node
  - The identifier of the incoming link
  - The identifier of the outgoing link
  - The start and end time for this prohibition

Network Tables – Parking Locations

- Vehicles enter and exit links at parking locations
- Programs exist to place parking heuristically (TransimsNet)
- Links may have
  - Many or no parking locations
  - Real or generalized parking
- Parking locations are typically placed
  - On all roads except freeways and ramps
  - Several activity locations and
  - parking lots on each side of
  - each link
- For highly populated areas
  - Parking may be specified more precisely
  - Consider proximity to activity locations

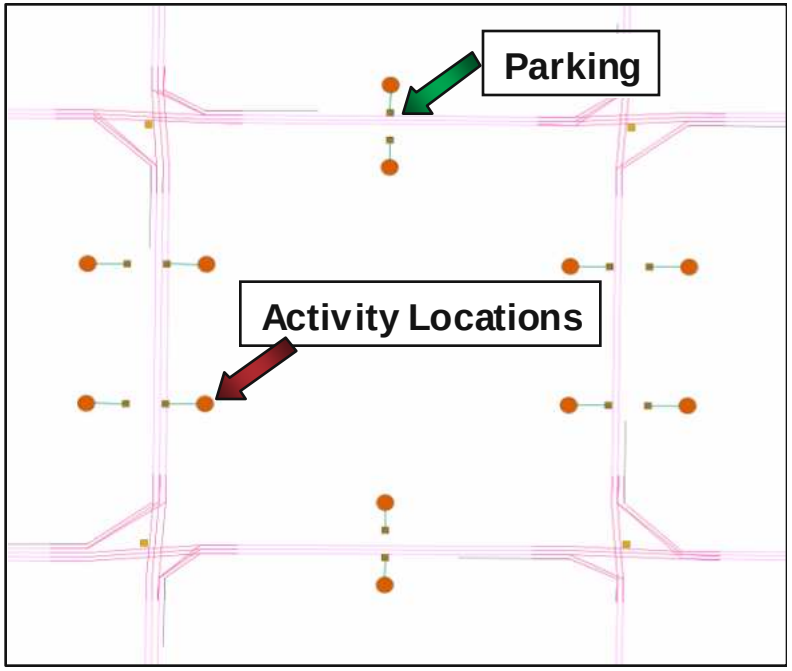


Network Tables – Parking Locations

- Properties of parking locations
  - Identifier of the node toward which vehicles are traveling
  - Identifier of the link on which the parking place lies
  - Location of the parking location
  - Type of parking location
    - *parallel on street, head in on street, driveway*
    - *parking lot, park & ride lot, network boundary*
  - Number of vehicles the parking place can accommodate
  - Toggle indicates whether parking place represents generic parking
  - Type of vehicles allowed to park at parking place
    - *private auto, motor carrier, bicycle*
    - *paratransit, bus, streetcar*
    - *light-rail transit, any vehicle type*

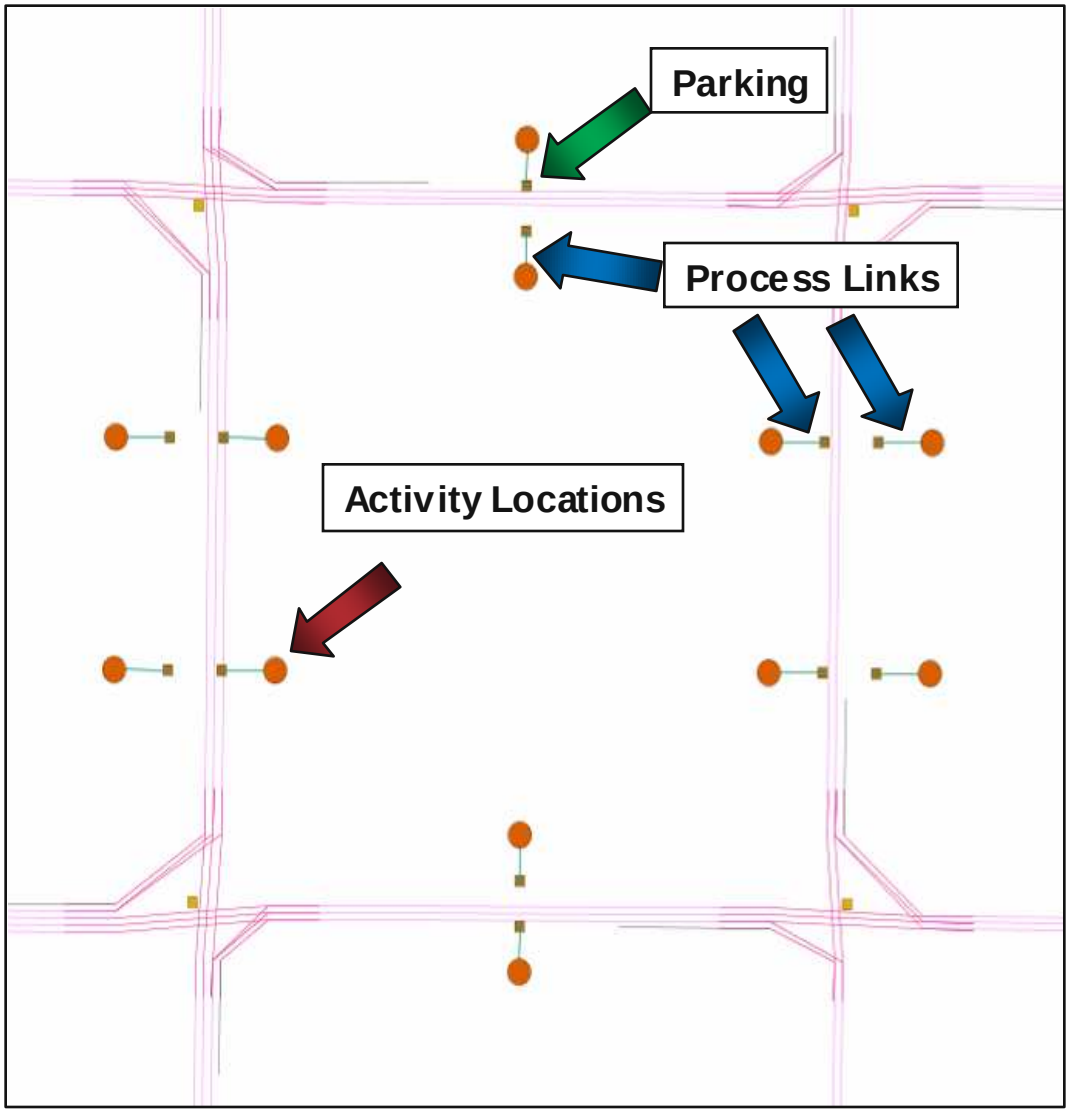
Network Tables – Activity Locations

- Activity locations will be discussed in more detail in other presentations
- They are essential as the beginning and end of each trip and provide the actual precise location for any activity (home, work, school, hospital, etc.)
- Properties of activity locations
  - The identifier of the node toward which vehicles are traveling
  - The identifier of the link on which the activity location lies
  - The traffic analysis zone number in which the activity lies
  - The census tract number in which the activity lies (optional)
  - The census block group number in which the activity lies (optional)
  - The distance of the activity from the node toward which vehicles are traveling
  - The x-coordinate of the activity location
  - The y-coordinate of the activity location
  - The z-coordinate of the activity location (optional)



Network Tables – Process Links

- Process links allow for traveler movement between
  - Parking locations
  - Activity locations
  - Transit stops
- Process links are unidirectional; therefore, two process links are typically necessary to connect locations
- Process links can be interpreted as walk links (in addition to the specific walk network)
- They have associated delays and costs



Network Tables - Process Links

- Properties of process links
  - Identifier of the accessory from which the virtual link leaves
  - Type of accessory from which the virtual link leaves
    - *Activity, Parking, Transit*
  - Identifier of the accessory to which the virtual link leads
  - Type of accessory to which the virtual link leads
    - *Activity, Parking, Transit*
  - Delay incurred when traveling across the virtual link
  - Cost incurred when traveling across the virtual link

Network Tables – Transit Stops

- Where passengers board and leave transit vehicles
- Multiple transit lines may share a transit stop
- Can be connected by process links to
  - Other transit stops
  - Parking locations
  - Activity locations
- Properties of transit stops
  - Name of the stop
  - Identifier of the node toward which vehicles are traveling
  - Identifier of the link on which the stop takes place
  - Location of the stop
  - Types of vehicles for which this is a stop
  - Type of stop (stop or station)
  - Number of vehicles the stop can handle simultaneously

Network Tables – Transit Routes

- This table specifies the list of stops and other details on how the transit vehicle travels
- Properties of transit routes
  - Number of stops
  - Specific transit type
    - *Bus, trolley, streetcar, rail, etc.*
  - The identifier of the transit stop
  - The identifier of the link on which the transit stop lies
  - The identifier of the toward the vehicle travels
  - The identifier of the transit zone in which the stop is located
- Transit driver plan
  - List of nodes in order of route
- Transit schedule and transit zone tables
  - Departure and arrival time tables
  - Costs of travel by zone, if specified

Data Availability

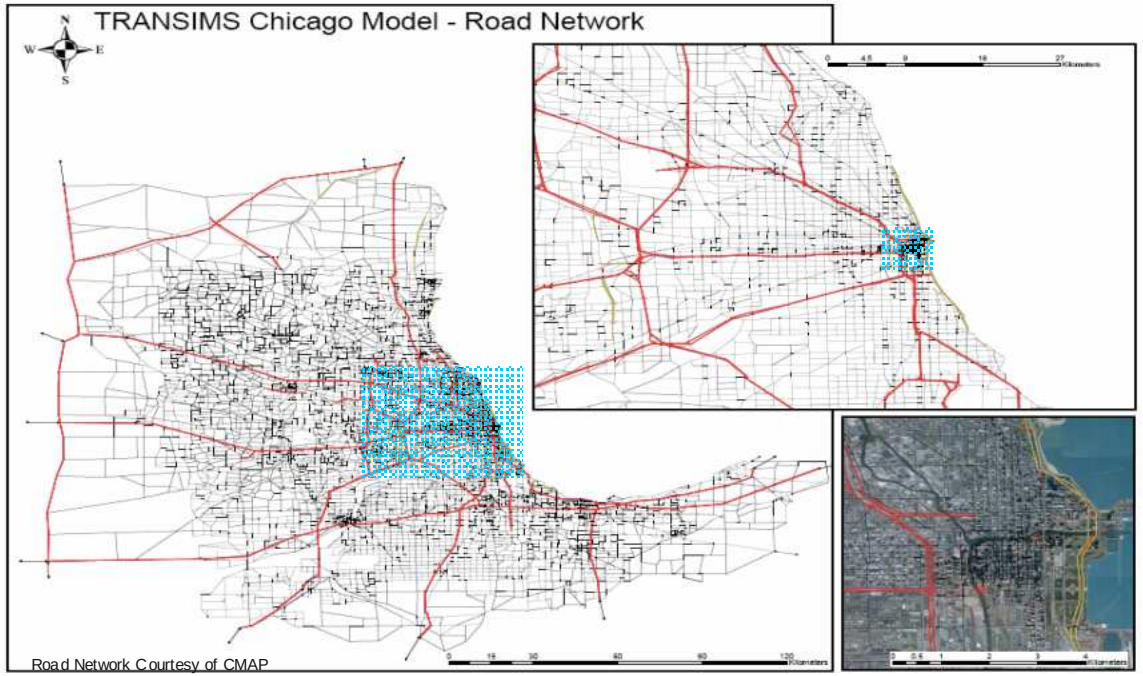
- Network tables are extensive and their preparation requires a large effort
- The basic nodes and links can often be imported from existing MPO models
  - Node and link conversion may require scripting for
    - *Conversion between coordinate systems*
    - *Cross-referencing between different data sets*
    - *GIS processing to join or partition regional data sets*
- Some information typically cannot be found at MPOs
  - Activity locations, parking locations
  - Network details such lane connectivity and traffic signals
- MPOs do typically have reasonable data for
  - Transit, road enhancement projects
  - Network enhancement plans and projections into future years

Example: Chicago Metropolitan Area

- The Chicago Metropolitan Agency for Planning maintains a road and transit networks in a database for regional planning
  - Can be used to project the network features into the future based on planned highway and transit projects
  - Can be extracted in many different formats, including tabular formats suitable for TRANSIMS processing

- Road Network Tables
  - Nodes
  - Links
  - Zones

- Result shown on the right has been derived with the ArcNet tool from the functional CMA TRANSIMS model



Recap of a Typical Network Conversion Procedure

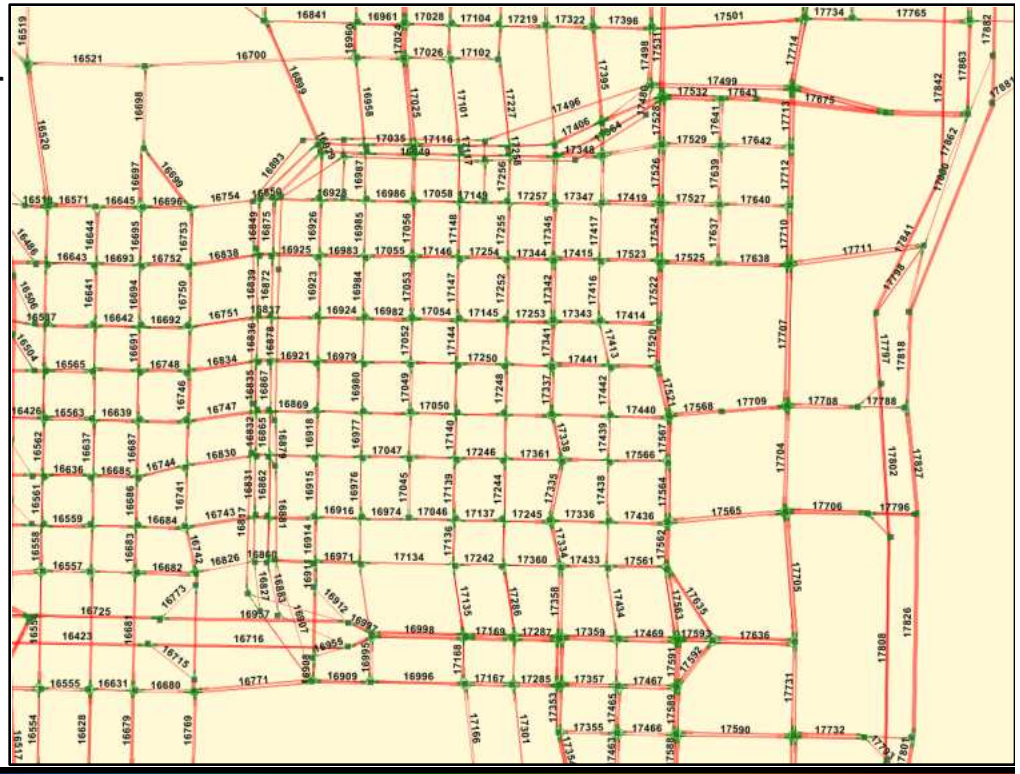
- TRANSIMS provides three tools for road network conversion
  - TransimsNet
  - IntControl
- The input data is expected in 4 (1 optional) input files for
  - Nodes (northing and easting in the appropriate zone)
    - *Conversion can re-project between typical state plane and UTM coordinate systems as well as plain long/lat coordinates*
  - Links
    - *Generic connections between the nodes specifying speed limits, number of lanes, use restrictions, street names, and similar*
  - Zones
    - *Traffic analysis zone centroids for supplying zoning information to generic activity locations being generated*
  - Shape Points
    - *If available, the shape of links can be provided in form of shape points as well (also used for approach angles and similar)*

Recap of a Typical Network Conversion Procedure

- The conversion is performed in two steps (TransimsNet and IntControl)
- TransimsNet performs most of the work, which consists of
  - Reformatting of node and link data into appropriate TRANSIMS network tables
  - Automatic generation of pocket lanes and connectivity records based on the functional classes of intersecting roads
  - Automatic creation of the locations of traffic signals and traffic signs according to functional classes of intersecting roads (creating warrants)
  - Creation of parking locations and activity locations based on functional classes and geometric constraints using zoning information
  - Creation of objects such as process links between parking and activity locations
  - Removal of extraneous nodes (turning them into shape points)

Typical Network Conversion Procedure

- After TransimsNet has created the warrants for signals and signs, the user has a chance to edit the resulting files to add more details, such as the types of signals, adding and deleting signal positions, and more
- IntControl is used to created details phasing and timing information for all signal warrants and generates the detailed TRANSIMS files for both signs and signals
- The resulting network is suitable for direct use in TRNSIMS, both in the router and microsimulator
- ArcNet can be used to turn the TRANSIMS network tables into a format suitable for us in ArcGIS and other GIS applications such as uDig
- TransitNet performs a similar conversion for transit networks



Credits and Acknowledgements

- GIS visualization materials were mostly developed at Argonne based on the TRANSIMS tools developed by AECOM for USDOT
- Chicago road and transit network data used in some of the examples was provided by the Chicago Metropolitan Agency for Planning
- USDOT provided the funding for the development of these training materials
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- Some figures have been developed for USDOT by Prof. Antoine Hobeika, Virginia Polytechnic Institute, Civil and Environmental Engineering
- The presentation is loosely based on materials provided by USDOT at a training course in November 2006