The Derivation of Initial Speeds in Travel Demand Models

Travel model network speeds are a significant and influential attribute of the travel demand model (TDM) development process. Network link speeds are one of the two attributes (i.e. speed and distance) for determining network travel times that are traditionally utilized in three steps of the TDM development process: trip distribution, mode choice and traffic assignment. Some models also utilize accessibility measures in trip generation. Accurate speed data are essential for:

- Models that utilize a feed-back process in the model structure to derive congested weighted speeds,
- Models that use time-of-day traffic assignments,
- Models that attempt to matched observed speeds at different volume conditions,
- MPOs that develop congestion management plans,
- Urban areas that conduct mobile source emissions modeling, and
- Studies that analyze network alternatives for corridor analysis studies.

The following is a synopsis of the contributions made on the topic of speeds, with a specific focus on determining initial speeds and the collection of speed data that supports the derivation of initial network speeds.

Determining Initial Speeds

Specific speed data that is inventoried to support the derivation of initial network link speeds as noted by contributors to the e-mail list include:

- Observed speed data by time-of-day (based on speed and travel time studies),
- Posted speed limit data, and
- Uncongested free-flow speeds representing off-peak travel speeds.

Based on contributions to the e-mail list, the speed values noted above are then used in one of three ways:

- The speed value may serve as the actual network speed that is subsequently utilized throughout the model without modification to the original value,
- A relationship between the inventoried speed data and an initial network speed value is formulated to derive the input network speed value, or
- The data serves as the initial speed for deriving a congested weighted speed through a sequential feed-back loop procedure.

Apart from forming the basis of deriving initial link speeds, it should also be noted that the inventoried speed data is also used to develop speed-flow relationships that are used to create specific volume-delay equations (e.g. by facility type for different time periods) for the traffic assignment step.

Speed Data Collection Methodologies

The derivation of initial network speeds is reliant on the inventory and collection of observed speed data which can be a considerable data collection effort. Based on contributions to the e-mail list, relatively few study areas have collected or are actively collecting comprehensive speed and/or travel time data. Only the Atlanta, Georgia and Portland, Oregon study areas provided

detailed information regarding their speed and travel time data collection efforts. For the Atlanta region, these efforts include:

- Collecting speeds at specific locations for different time periods and days of the week for different facility types (and area types), and
- Collecting point-to-point travel times using a "floating car" method for different time periods (e.g. morning peak, evening peak, and mid-day time periods).

Additional data collection methods noted by contributors include:

- Utilizing loop detector data on freeways to determine speed-flow relationships as well as travel times,
- Utilizing toll transponders to automatically collect travel times,
- Acquiring speed and travel time data from vehicles installed with GPS devices (e.g. private vehicles, taxis, or municipal vehicles), and the potential application of,
- Utilizing video technology to collect speed-flow relationships, volumes and travel times.

Each of the methods noted above incur associated costs and challenges. The floating car method and GPS data can be expensive to implement and retrieve. Speed data from loop detectors can contribute spot speed data that may not have any correlation to the length of the segment. Video technology to either distinguish and follow individual cars or read license plates is expensive to implement and may not be completely reliable. Additional information regarding the floating car methodology, speed-flow surveys and data inventories that have been documented in the e-mail list discussion follows.

Floating Car Methodology:
In a floating car procedure, a driver attempts to mimic the same speed as a majority of drivers in the corridor. The travel times from the Atlanta study were obtained using specialized GPS equipment with specific checkpoint locations. As noted by a contributor, prior to the deployment of GPS technology, travel time (and subsequently speed) was collected with pen and paper using a stop watch.

Speed-Flow Surveys:
Speed-flow surveys are also conducted by some study areas to quantify the relationship between speeds and traffic volumes by facility type (and area type) for different time periods. This data is used to calibrate a set of locally developed volume-delay equations. For freeways, information from loop detectors has been utilized by two study areas in the e-mail contributions.

Arterials, though, offer greater challenges associated with acquiring the average segment speed. The use of loop detectors for speed and flow information is highly dependant on the juxtaposition of the loop detector with respect to the intersection. The speed collected at a mid-block detector will be (in most cases) very different from speed or travel time data collected from intersection to intersection. For arterials, Portland Metro also noted the use of the "average car method with GPS transponders attached to probe vehicles measuring mid-block speeds, upstream from intersections" (e.g. floating car procedure). Traffic counters were used to obtain the necessary count data for those segments studied.

Some contributors indicated that observed speed/travel time data need to be augmented with additional data on delay at intersections. This is especially evident in the discussion regarding the calibration of volume-delay equations. Collecting delay data at intersections, though, was acknowledged to be an enormous and probably unrealistic option. The potential use of video technology to collect this information was noted by two separate contributors. The North Texas Tollway Authority (NTTA) indicated that fixed cameras along with specifically developed software has been deployed to detect speeds that are used to provide continuous updates to the speed/LOS/flow maps on the NTTA website.

Inventorying Posted Speed Limit Data and Free-Flow Speed Data:
The Atlanta region also noted that the posted speed limit by segment is inventoried and used as one of the five variables applied to a scoring system to determine the facility type, capacity and free-flow speed of the facility. Free-flow speeds represent the typical operating speeds on a facility during low demand or the speed that would be encountered by a driver during periods with little or no congestion.

The derivation of free-flow speeds is typically based on known information such as the posted speed or observed speed data. Typically, the free-flow speed for access controlled facilities such as interstates, freeways, and directional ramps is higher than the posted speed limit for these facilities. Whereas, "… for signalized urban streets, the free flow speed is normally much less than the speed limit due to the influence of traffic signal delays, driveway disruptions, etc." as one contributor noted. Four other large study areas indicated the use of previously observed speed data or are actively collecting speed data to quantify free flows speeds by facility type or develop speed-flow relationships by facility type (e.g. freeway and arterial).

Conclusions
Based on contributions to the e-mail list, it appears that the desire to acquire reliable speed data is one that resonates throughout the travel model community. However, it does not appear that a consensus exists on which speed data to include in the highway networks as the initial speed; rather, it appears to be highly dependant on available data and the level of familiarity the local area has with the data. With the broader adoption of feed-back loops in model structures, free-flow speeds appear to be increasingly utilized to derive congested weighted time-of-day speed results from the equilibrium assignment process.