NETWORK-BASED ROUTE RIDERSHIP FORECASTING METHODS

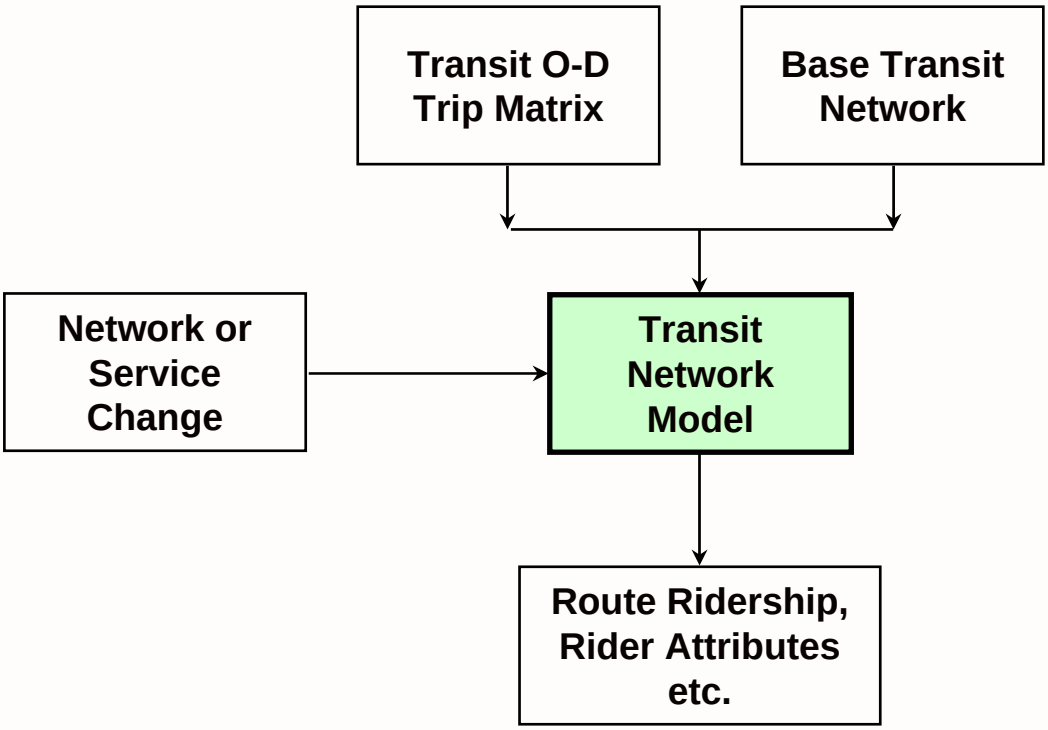
Outline

1. Components of Network Modeling Computer Packages

2. Example Modeling Systems
   (a) MADITUC
   (b) EMME/2

3. Major Sub-Models
   (a) Route Assignment
   (b) Mode Choice

Generalized Network-Based Modeling/Analysis Approach



Transit Network Model Capabilites

- **Interactive computer graphics for network editing & display**
- **Network database management system**
- **Network assignment procedure**
- **Flexible display & output of results & base data**
  - **plots & reports**
  - **screen displays, printer & plotter hard copies**

Transit Network Database

- Geocoded transit links & nodes
- "Mapping" of transit lines onto network links & nodes
- Transit line attributes
  - headways (by service period)
  - travel times (by service period)
  - "mode" of service (bus, subway, etc.)
- System attributes
  - operating cost data
  - energy consumption data
  - fares

Transit Origin-Destination Flow Matrix

- **Three Levels of Analysis:**

1. **Fixed Transit Flows**
   - use observed current transit o-d flows obtained from area-wide survey (e.g., Telephone survey)
   - assumes demand for transit will not change as service changes (at least in the short run)
   - typical approach currently adopted

2. **Variable Modal Split, Fixed Total Demand**
   - use observed current total (all modes) o-d flows
   - apply a modal split model to determine transit flows
   - preferred approach for significant service changes
   - not, however, generally operational

3. **Variable Total Demand & Modal Split**
   - requires full demand modeling capability (i.e., Generation, distribution, modal split)
   - not generally necessary for transit service planning, since total o-d flows are unlikely to change significantly during service planning period

Typical Package Outputs

- **Link and line volumes**
- **Boardings by link, line, node**
- **O-D travel times**

  - in-vehicle
  - out-of-vehicle (walk, wait, transfer, etc.)
- **Revenues, operating costs, energy consumption by link or line**
- **Revenues, operating costs, rider characteristics by origin or destination zone**

Outputs may be displayed in tables, reports, plots (network or zone based).

Examples Of Transit Network Modeling & Analysis Packages

1. MADITUC

Modele d'Analyze Desagregee des Itineraires en Transport Urban Collectif

or

Model for the Disaggregate Analysis of Itineraries on a Transit Network

- **Developed at the Ecole Polytechnique, University of Montreal (Robert Chapleau)**
- **Requires "Montreal-style" O-D survey data, including transit route choice information**
  - **does <u>not</u> have general demand modeling capabilities**
- **Designed specifically for transit service planning**
- **Is "line-oriented" rather than "link/node- oriented" in design**
- **Uses "all-or-nothing" assignment combined with detailed determination of network access/egress points**
- **Runs on mainframe/minicomputer & PC's**
- **Requires SAS for data analysis & graphics**
- **Used in 4 Canadian cities**
  - **Montreal, Quebec, Toronto, Winnipeg**

Examples of Transit Network Modeling & Analysis Packages, cont'd

2. EMME/2

Equilibre Multi-Modal,Multi-Modal Equilibrium/2

- Developed at the Centre for Transportation Research, University of Montreal (Michael Florian)
- Developed as a general regional transportation modeling package
  - can be used to generate transit O-D flows from a travel demand model
  - or, can input observed transit O-D matrix
  - link/node oriented in its design
- Two types of transit assignment available
  1. "Aggregate" zone-to-zone flow multipath assignment procedure
     - generally not precise enough for transit route planning applications
  2. "Disaggregate" point-to-point trip assignment procedure
     - intended to be comparable to MADITUC
     - probabilistic (multipath) assignment
- Commercially available package
- Runs on mainframes, minicomputers, microcomputers
- "Stand-alone" package

Transit Route Assignment Procedures

- **Assignment procedures "assign" origin-destination trips to specific paths through the transit network, thereby "loading" the specific transit routes with riders.**

Two major approaches to transit assignment exist:

1. **All-or-nothing assignment, in which all flow for a given orgin-destination pair is assigned to a single path, with this path being the least "cost" (travel time, etc.) path between the origin and the destination.**

2. **Multi-path assignment, in which several attractive paths between an origin and a destination are identified, and the flow is split probabilitically over these paths.**

For all-or-nothing to be plausible, need:

- **simple and low-density transit network**
  - **little choice in access points**
  - **little choice in path on transit network**

Transit Route Assignment Procedures

- **Assignment procedures can also be either:**

  1. **Aggregate, in that they assign total zone-to-zone flows on a centroid-to-centroid basis.**

  2. **Disaggregate, in that they can assign individual trips from "actual" geocoded origin points to "actual" geocoded destination points.**

  --> Disaggregate assignment methods clearly preferrable for service planning purposes, providing sufficiently disaggregate transit trip data are available.

Logit Mode Choice Model

$$P_{it} = \frac{e^{v_{it}}}{\sum_{j=1}^{n} e^{v_{jt}}}$$

P_{it} = Probability that Individual t will choose Alternative i

V_{it} = "Systematic Utility" of Alternative i for Individual t

= $\beta_1 X_{it,1} + \beta_2 X_{it,2} + \ldots + \beta_m X_{it,m}$

$X_{it,k}$ = k^{th} Explanatory Variable (Travel Time, etc.)

β_k = Model Coefficient for Variable No. k

n = No. of Alternatives Available

m = No. of Explanatory Variables

Typical Variables In A Work Trip Mode Choice Model

- **Modal characteristics:**
  - In-vehicle travel time
  - Out-of-vehicle travel time
  - Out-of-pocket travel cost

- **Traveller characteristics:**
  - Income
  - Gender
  - Auto availability
  - Occupation