Trip-based Models Critique

State-of-the-art Methods:

Activity-based Travel-demand Modeling

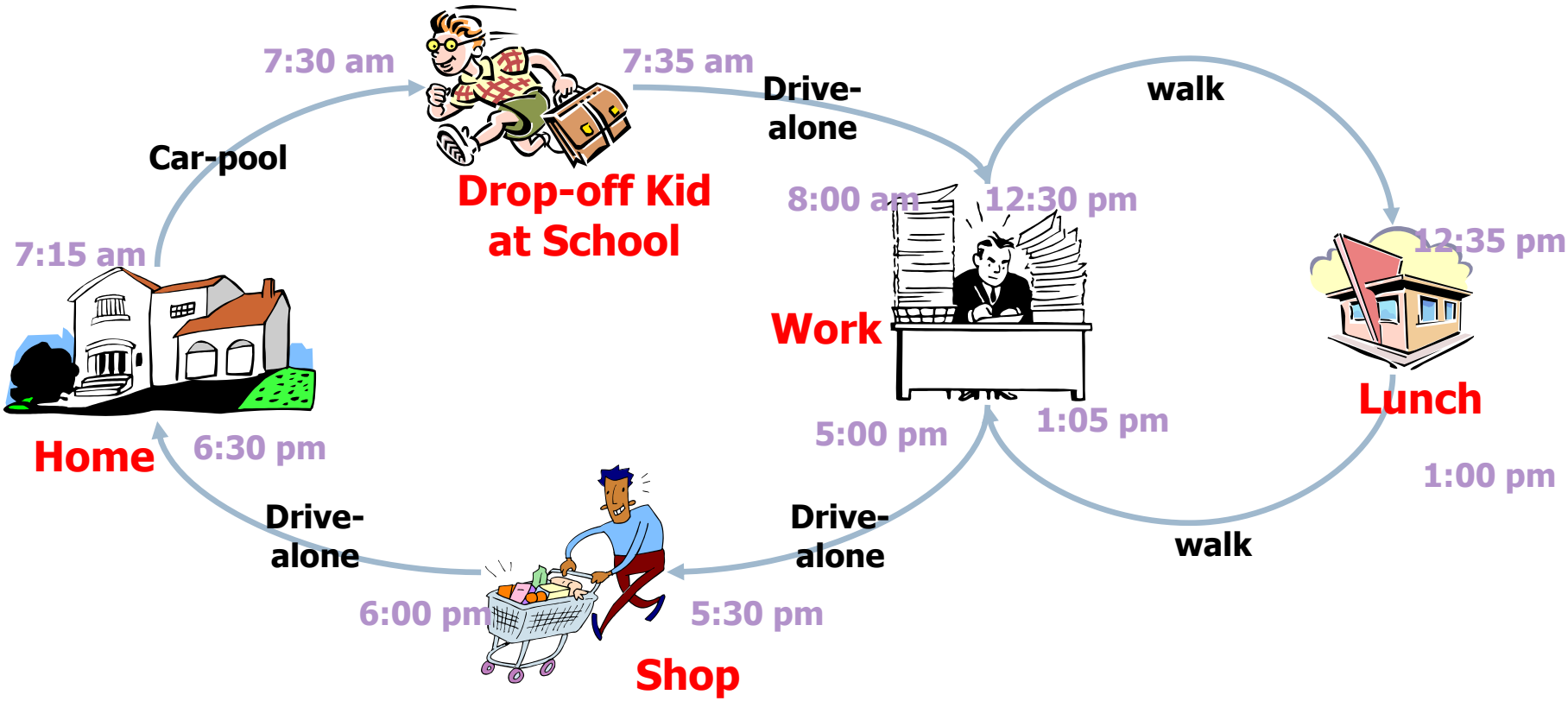
1. Critique of the current “four-step” methodology
    1. Measurement of travel-demand and modeling approach
    2. Incorporation of traveler characteristics
    3. Representation of space and time
2. The activity-based approach: a conceptual overview
3. CEMDAP: An activity-based travel-demand simulation system

References:

- TMIP website: http://tmip.fhwa.dot.gov/about/
- Metropolitan Travel Forecasting: Current Practice and Future Direction http://onlinepubs.trb.org/onlinepubs/sr/sr288.pdf

Critique of the Trip-based Approach: Measurement & Modeling

Consider the travel pattern of a person.....



Critique of the Trip-based Approach: Measurement & Modeling

The trip-based method views this person's travel as:

One Home-based Other trip

H → Drive → A1
Peak

One Home-based Shop trip

H → Drive → A2
Peak

Four Non home-based trips

P3 → Drive → A3
Peak

P4 → Drive → A4
Peak

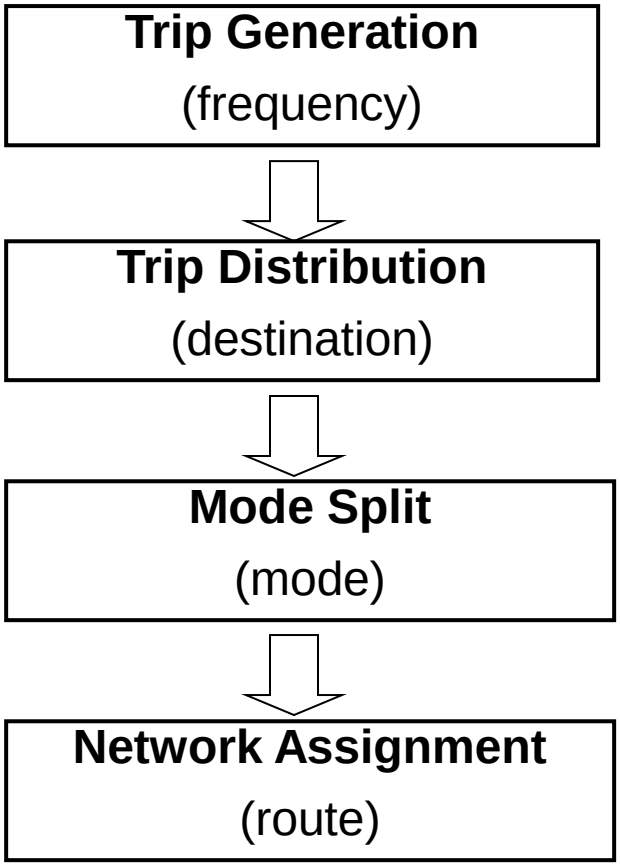
P5 → Walk → A5
Off Peak

P6 → Walk → A6
Off Peak

Critique of the Trip-based Approach: Measurement & Modeling

The analytical modeling procedure is the “four-step” process

- **Socio-economic characteristics**
- **Land-use patterns**
- **Transportation system characteristics**



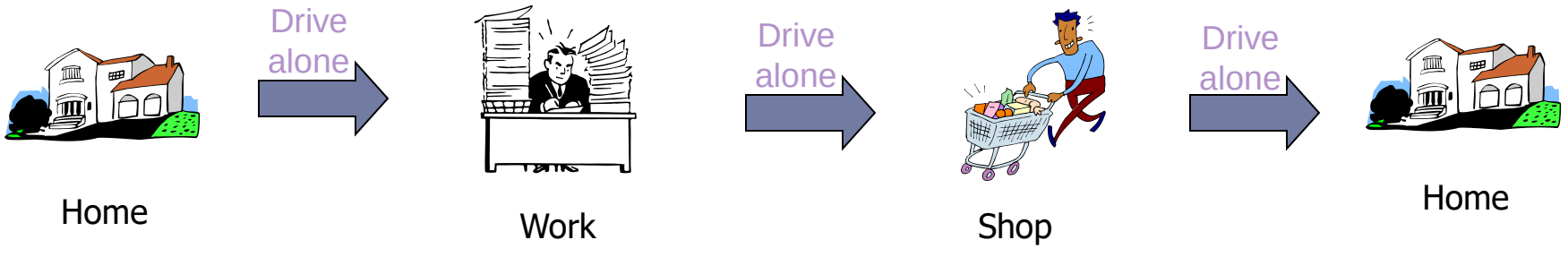
Link flows, speeds, travel times, transit-ridership, etc.

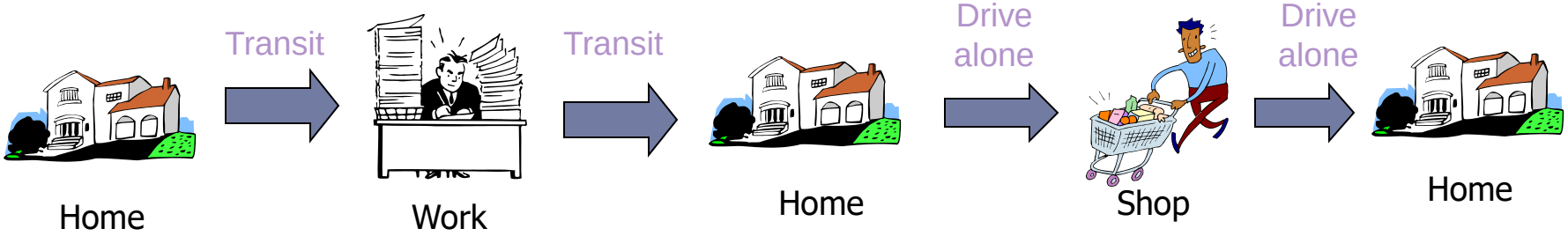
What is the problem with this Measurement & Modeling Approach?

- The fundamental role of travel-demand models is to enable us perform quantitative assessments of the impacts of policy actions
- The “actions” being considered these days may invoke complex behavioral responses from travelers which cannot be adequately captured within a trip-based framework
- Some illustrative examples…..

Critique of the Trip-based Approach: Measurement & Modeling

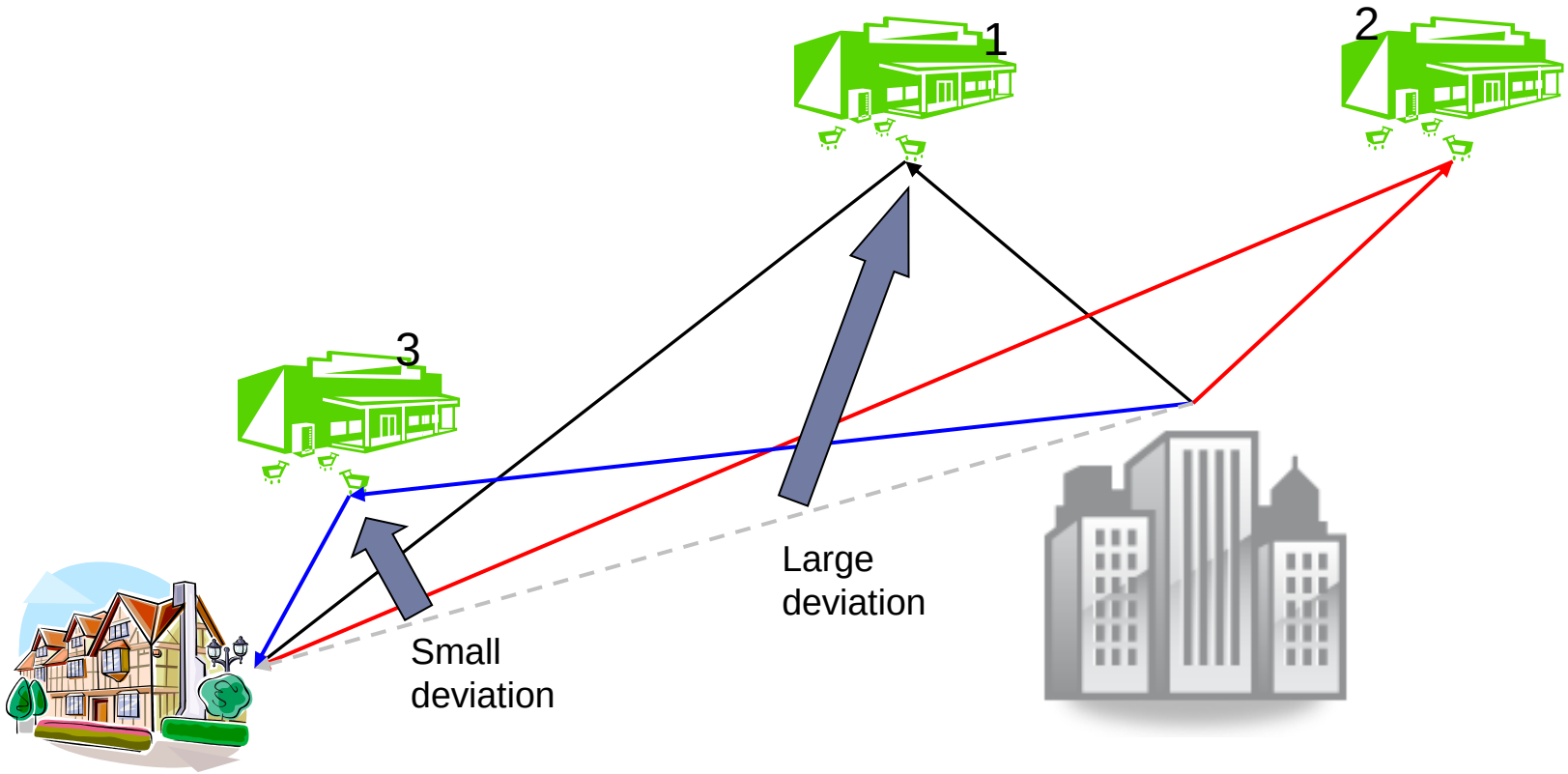
Inconsistencies in Trip Generation Rates





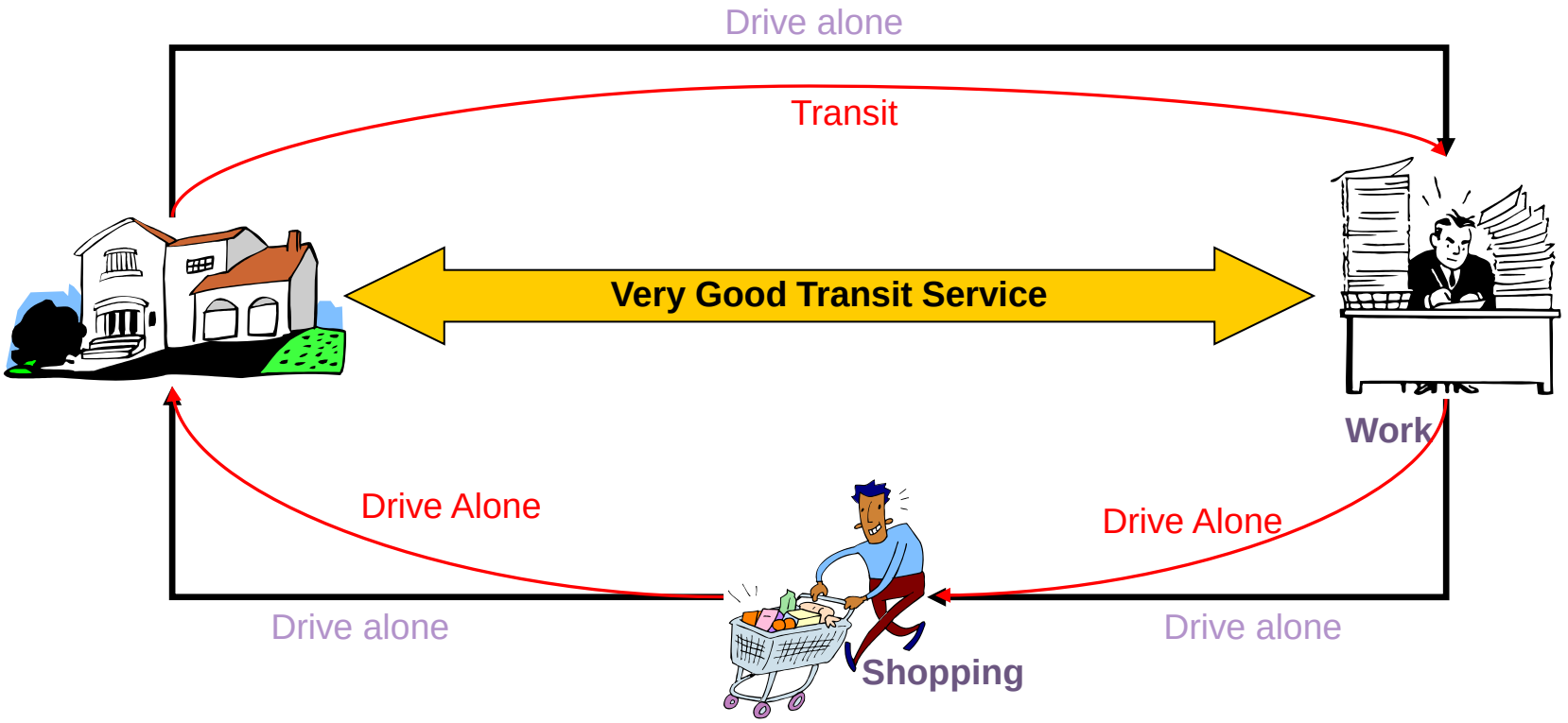
Critique of the Trip-based Approach: Measurement & Modeling

Inconsistencies in Predicting Destination Choice



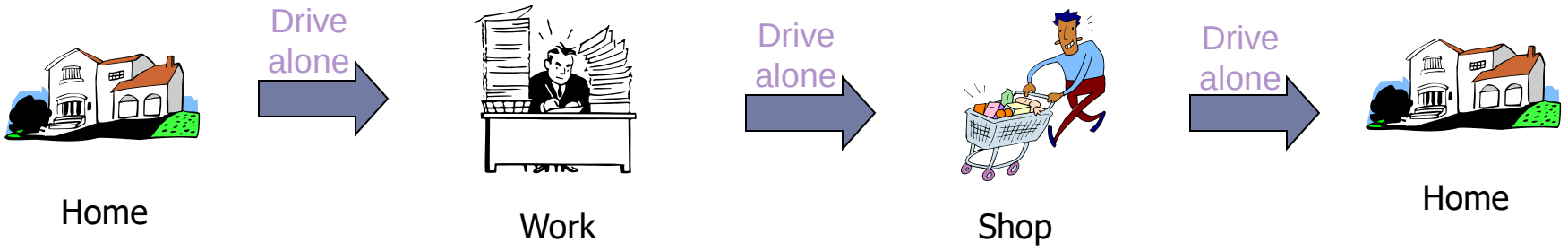
Critique of the Trip-based Approach: Measurement & Modeling

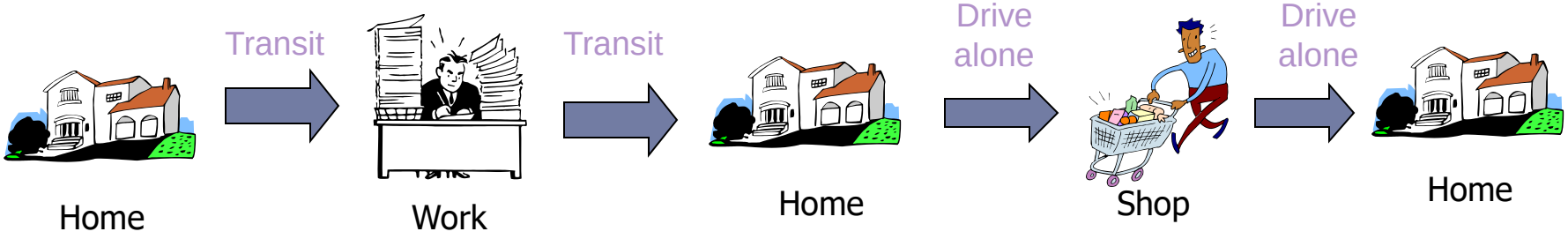
Inconsistencies in Predicting Mode Shifts



Critique of the Trip-based Approach: Measurement & Modeling

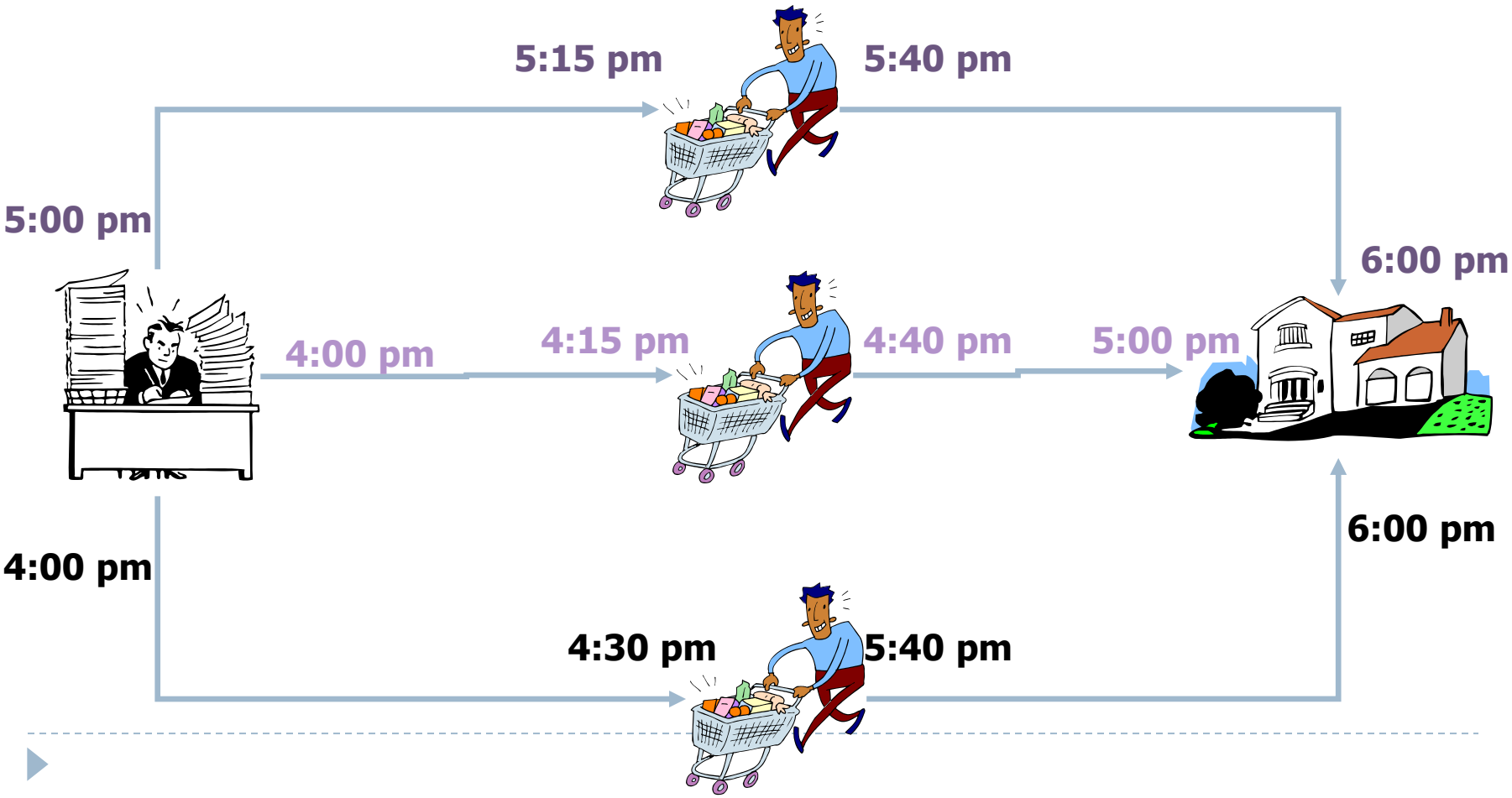
Inconsistencies in Predicting mode shifts (alternate responses)





Critique of the Trip-based Approach: Measurement & Modeling

Treatment of Time of Day of Travel



Critique of the Trip-based Approach: Measurement & Modeling

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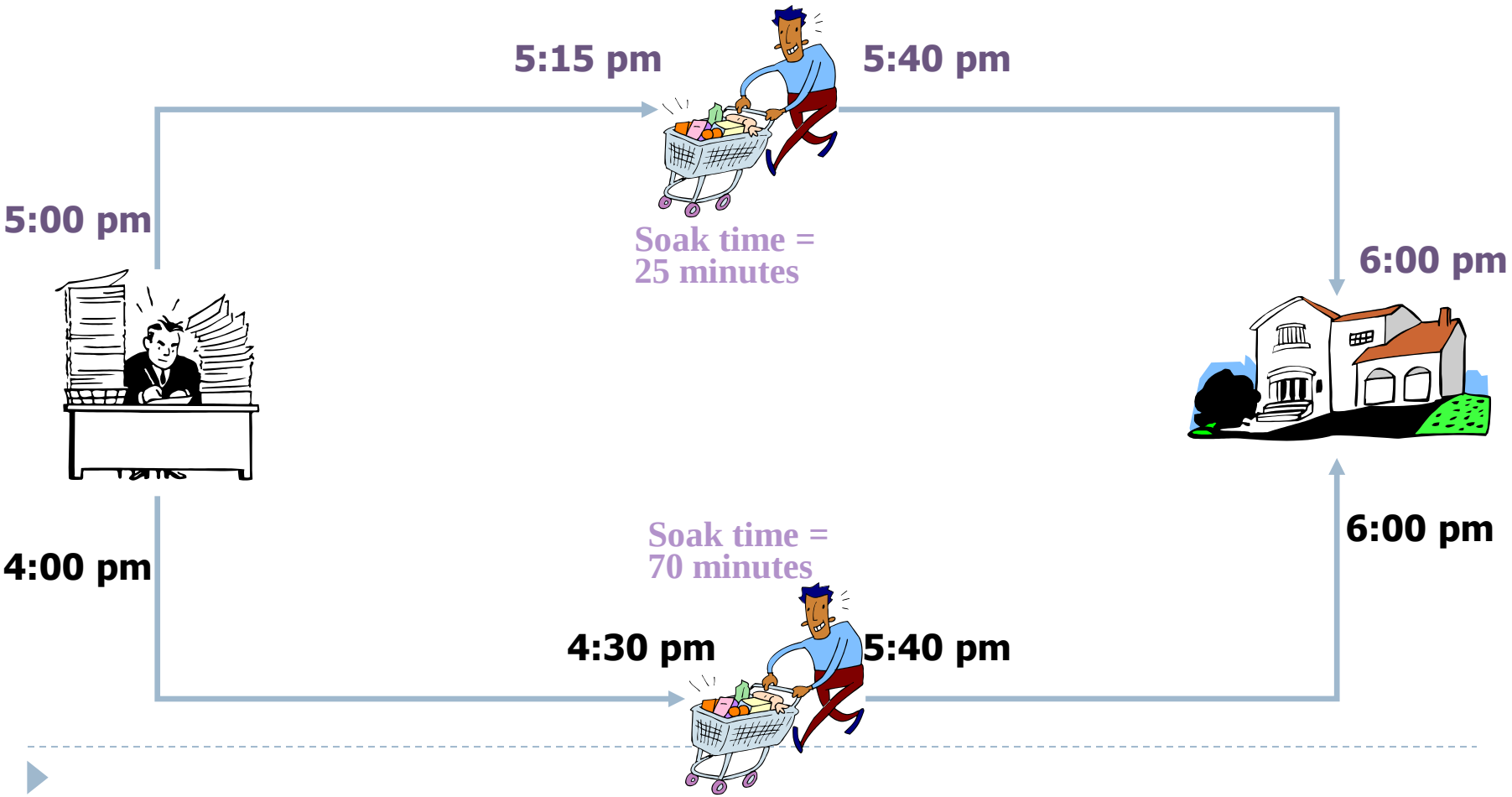
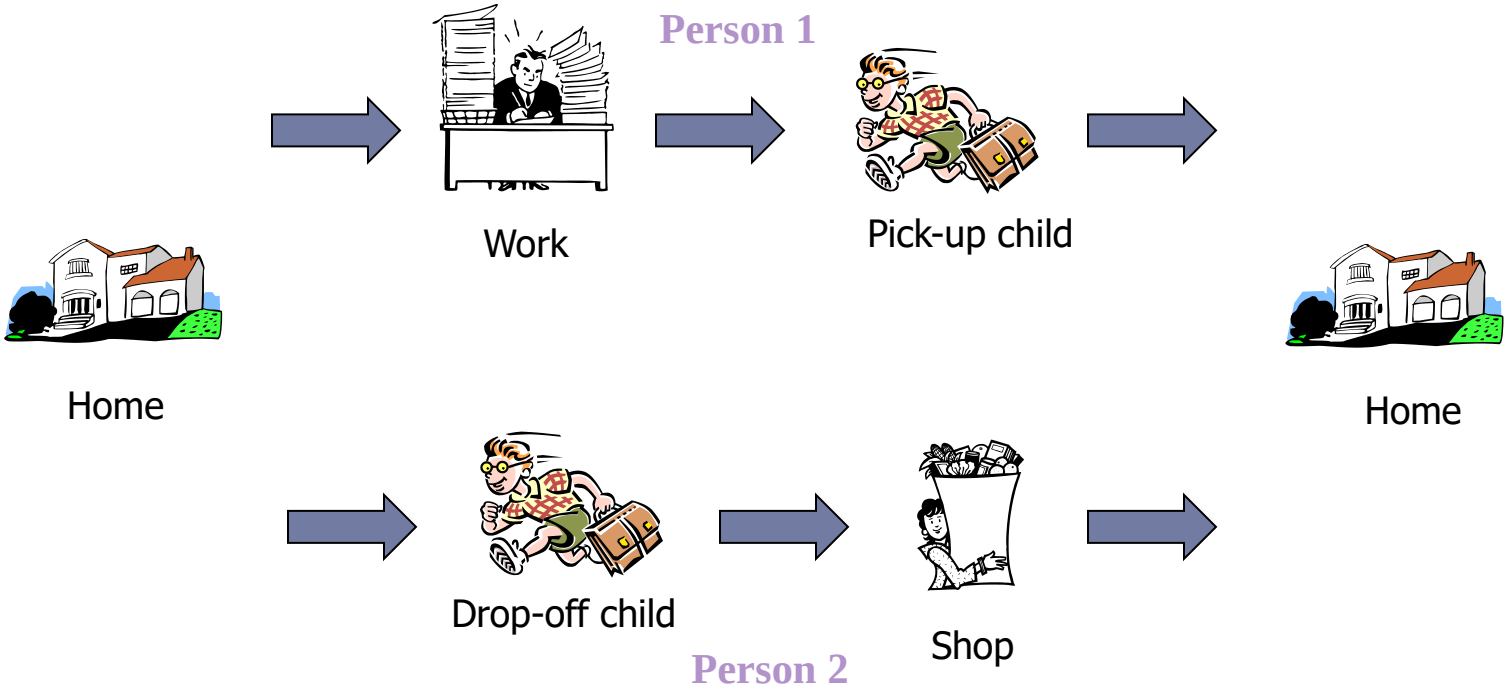


Critique of the Trip-based Approach: Measurement & Modeling

Inter-personal dependencies and Indirect effects



Critique of the Trip-based Approach: Measurement & Modeling

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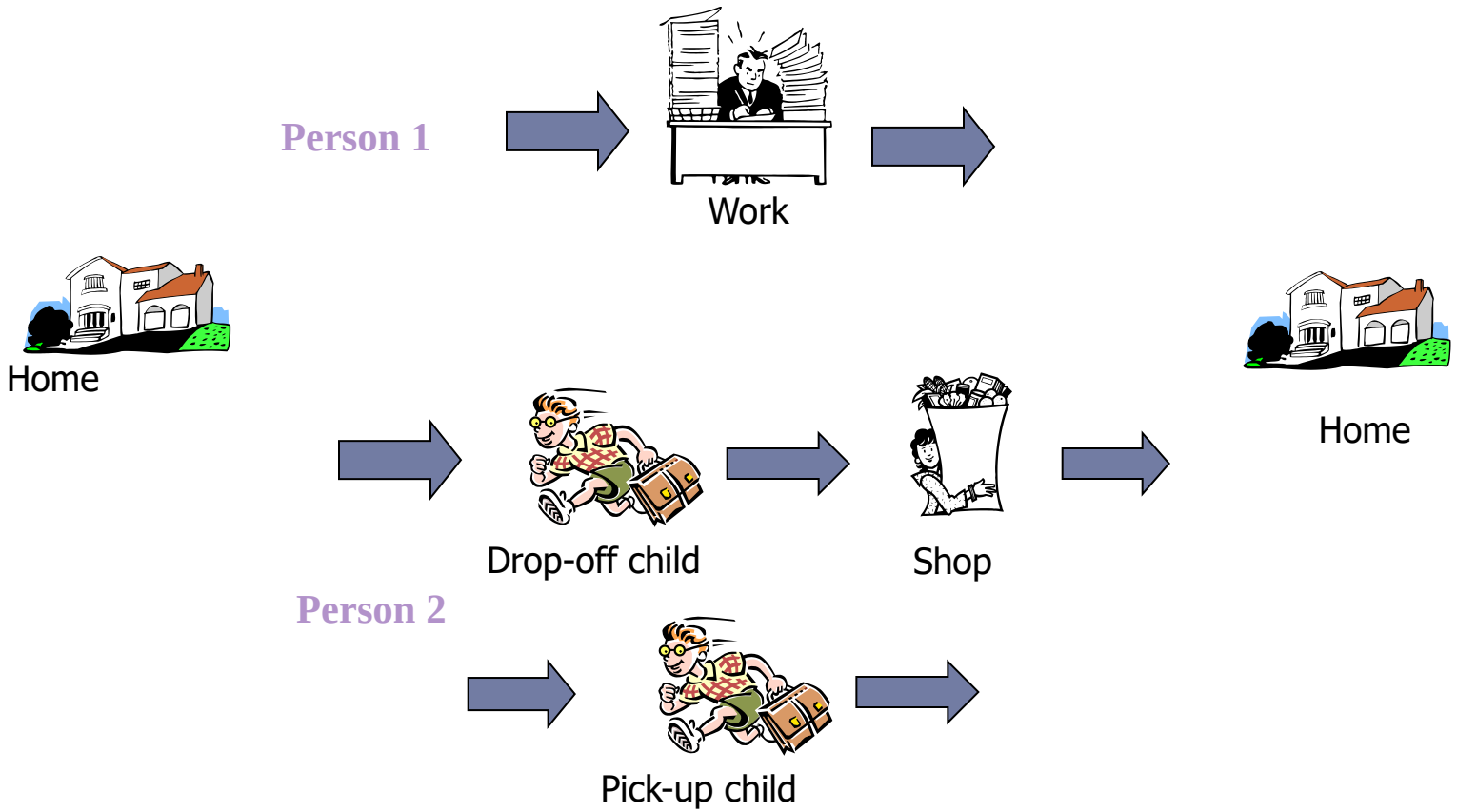
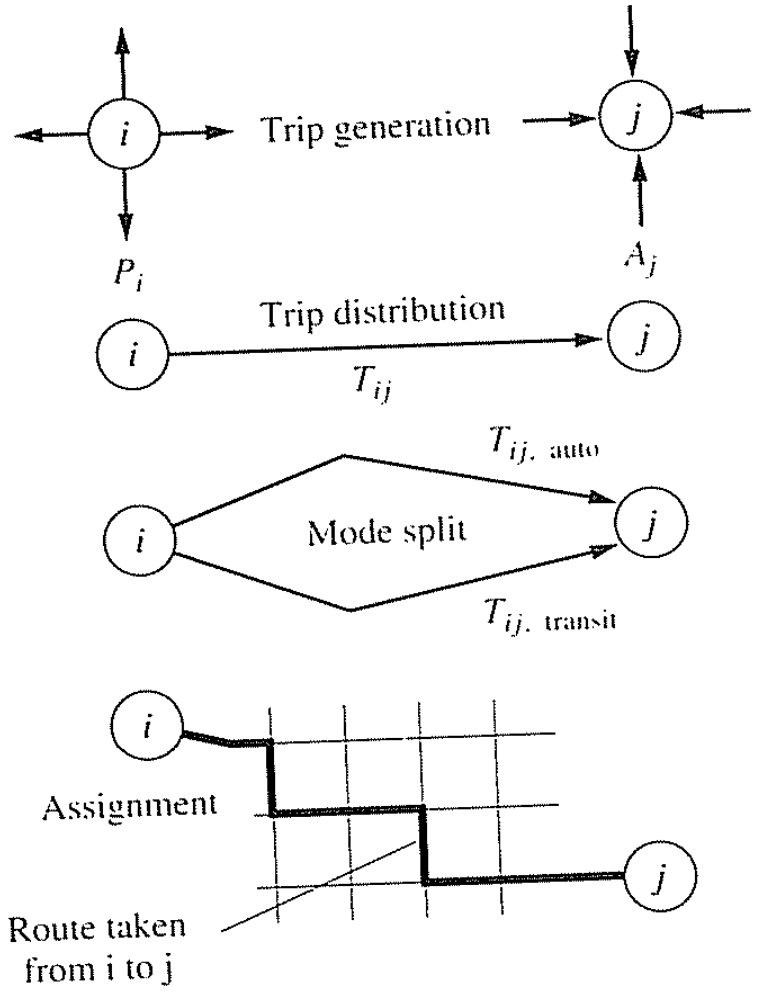


The Four Step Process is an "aggregate" approach

1. Trip Generation
   - How many trips from/to a zone
2. Trip Distribution
   - Links trips into flows between pairs of zones (trip tables)
3. Mode split
   - Mode share for trips between each pair of zones
4. Traffic Assignment
   - Load trips into the network

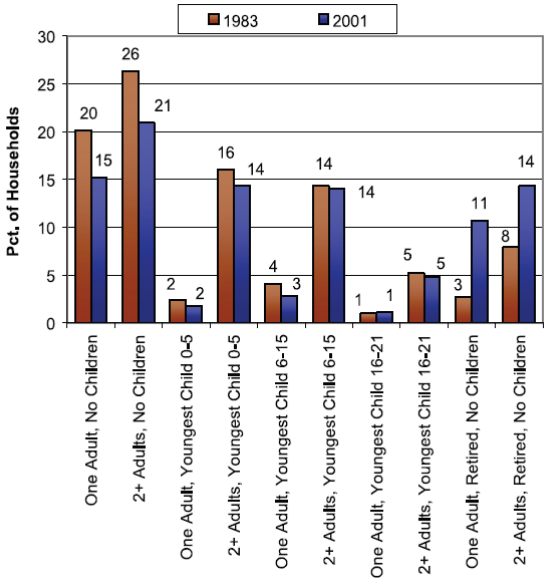


Source: Meyer and Miller (2002)

Critique of the Current-Day Four-Step Models

Do not incorporate the characteristics of the traveler effectively

- Limited in capturing the changes in travel patterns because of socio-economic shifts

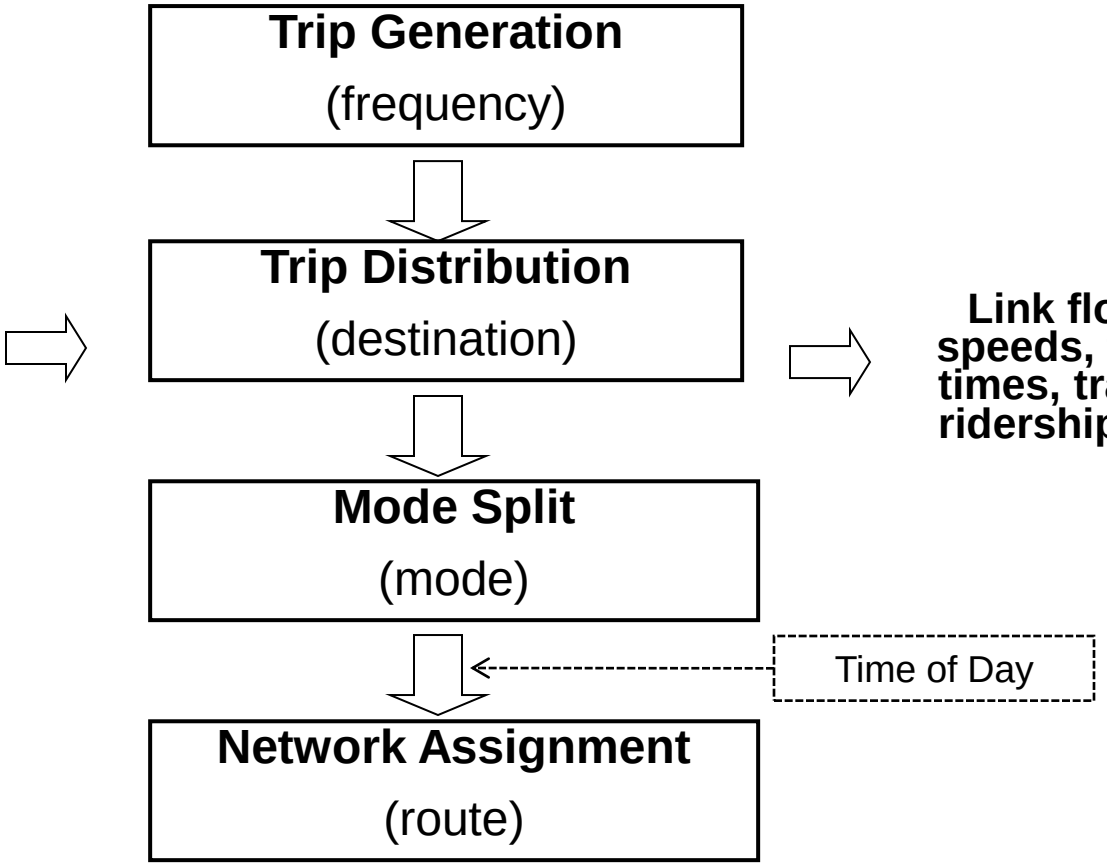


http://www.trb.org/Conferences/ReauthorizationData/Issues.pdf

- Limited in capturing the differential responses of people to policy actions
- Limited in the ability of address equity issues

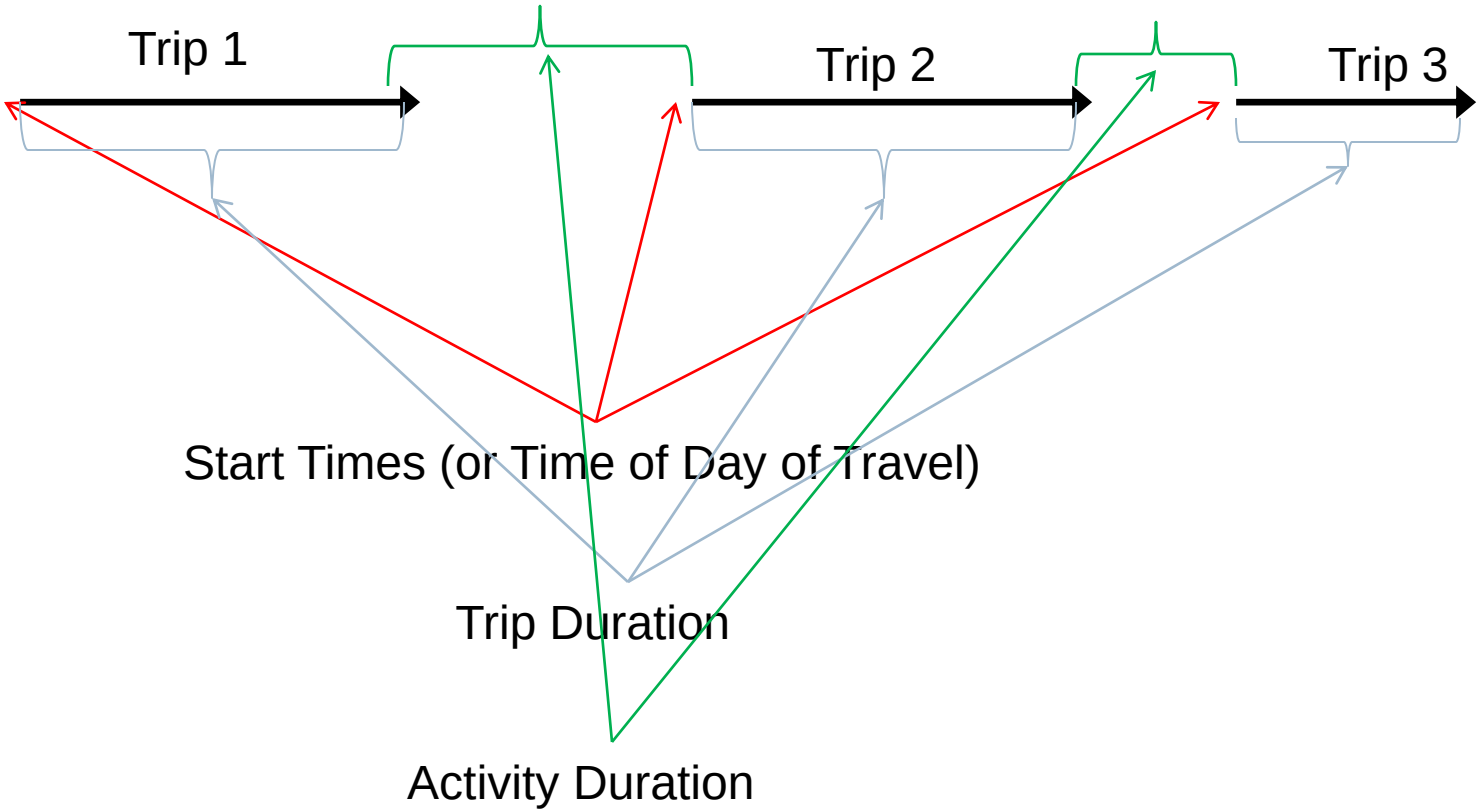
Where is the time element?

- **Socio-economic characteristics**
- **Land-use patterns**
- **Transportation system characteristics**



Link flows, speeds, travel times, transit-ridership, etc.

What are the other time elements?



Critique of the Current-Day Four-Step Models

Representation of Time

- Trip-based approach is very limited in its treatment of time – viewed simply as a “cost” of making a trip
- Time-of-day of travel is not adequately captured
- Evaluating infrastructure development *versus* dynamic operations require very different temporal resolutions for the demand

Critique of the Current-Day Four-Step Models

Representation of Space

- Currently space is represented as TAZs -Effects of intra-zonal travel is not modeled
- Required resolutions are different:

  Large-scale land-use changes *versus* mixed-use developments

  Highway system changes *versus* transit / non-motorized system changes

Critique of the Current-Day Four-Step Models: Summary

1. Issues with:
    1. Measurement of travel-demand and modeling approach – “ad-hoc” and statistical as opposed to behavioral
    2. Incorporation of traveler characteristics
    3. Representation of space and time
2. Results in inaccurate forecasts
3. Predicts unrealistic & biased effects of policy actions

Critique of the Current-Day Four-Step Models: Summary

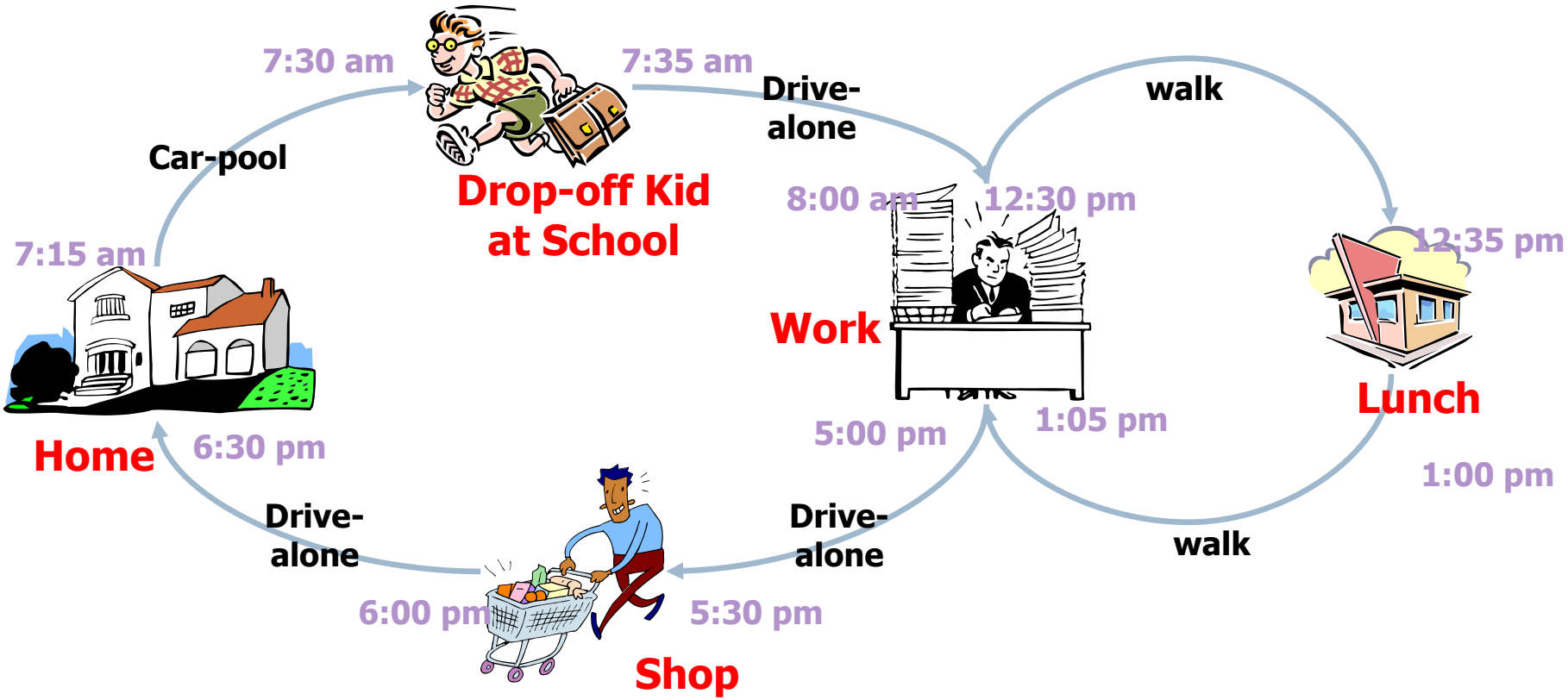
1. The four-step model system was developed to support infrastructure planning/prioritization decisions
2. The model system was developed in an age (1950s-1960s) with limited computational capabilities
3. The current-day focus of planning is on demand-management strategies – making the most efficient use of available resources as opposed to adding additional infrastructure
4. Today, our analysis and computational capabilities are enormous compared to the 1950s
5. Both the planning needs and availability of resources today are very different today
6. Need for better modeling approaches is critical!

Legislative Impetus

- Clean Air Act Amendments 1990 (CAAA)
  - http://www.epa.gov/air/caa/
- Intermodal Surface Transportation Efficiency Act, 1991 (ISTEA)
  - http://ntl.bts.gov/DOCS/ste.html
- Transportation Equity Act for the 21st Century (TEA-21), 1998
  - http://www.fhwa.dot.gov/tea21/index.htm
- Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), 2005
  - http://www.fhwa.dot.gov/safetealu/summary.htm

The Activity-based Approach

The activity-based method views the travel pattern as.....



The Activity-based Approach

The conceptual modeling procedure is……..

(1) **Activity Generation:**

Choose what out-of-home activities have to be undertaken during the day incorporating relevant constraints

Drop-off Kid at School

Work

Lunch

Shop

<u>Space constraints:</u>

Location of home, school, and work are fixed

<u>Time constraints:</u>

School and work timings

Total time = 24 hours & that includes time for sleeping, eating etc.

<u>Inter-personal constraints:</u>

Household task allocations

Joint travel of household members

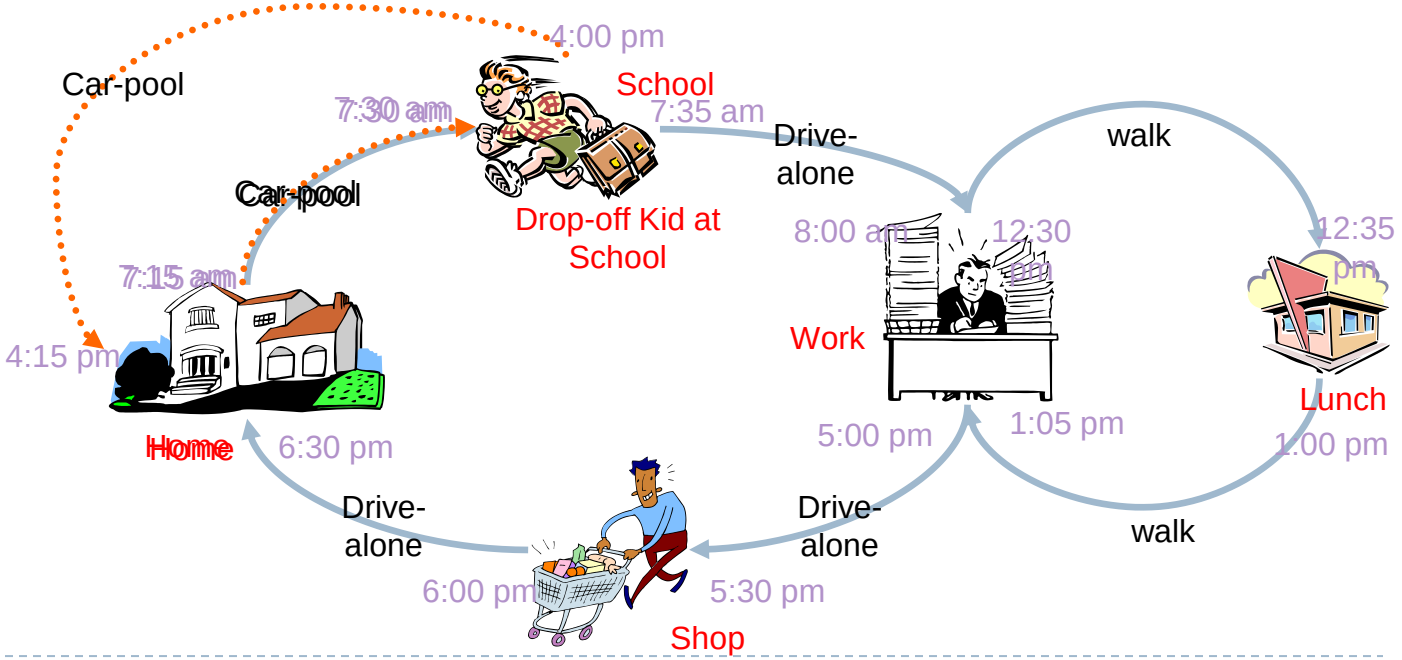
The Activity-based Approach

The conceptual modeling procedure is……..

(2) **Activity Scheduling:**

Sequence the activities into a “chain” or “pattern”.

Travel is a consequence of this sequencing – the need to move from one location to another at certain times of the day to participate in the different activities



Contrasting Trip-based and Activity-based Methods:

Summary of Conceptual Differences

Trip-based

- ✓ Treatment of travel as though demanded on their own right
- ✓ Individual trip is the unit of analysis
- ✓ Internal consistency of the travel pattern NOT guaranteed
- ✓ Impacts of personal and household constraints not captured
- ✓ Represents time as simply a cost of making a trip and time-of-day of travel is not captured adequately

Activity-based

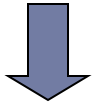
- ✓ Treatment of travel as a derived demand
- ✓ Activity-travel pattern is the unit of analysis
- ✓ Ensures internal consistency of the activity-travel pattern
- ✓ Accommodates the impacts of various constraints on activity-travel decision making
- ✓ Models travel within the context of overall daily time-use (both durations and time-of-day)

Contrasting Trip-based and Activity-based Methods:

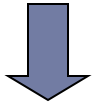
Summary of Modeling Differences

Trip-based

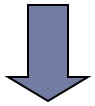
Number of HB and NHB trips



Zonal-level trip attractions & gravity model for trip-end locations



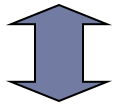
Mode for each trip



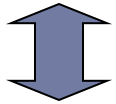
Time of day using peak and off-peak factors

Activity-based

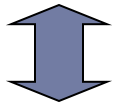
Generation and sequencing of activities



Location of activity participation

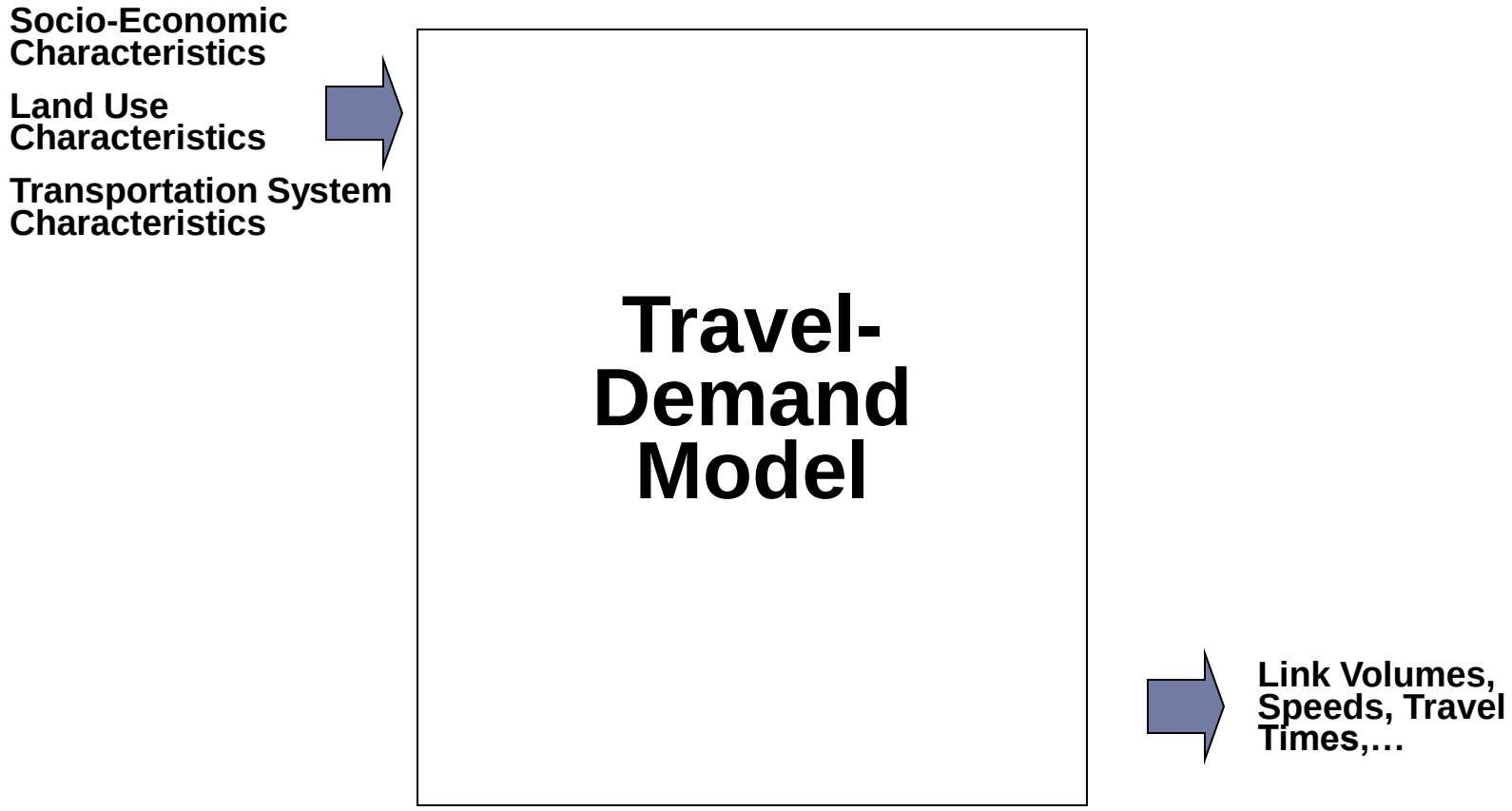


Mode for linked trips (tours)



Duration and timing of activities and travel

Contrasting Trip-based and Activity-based Methods:

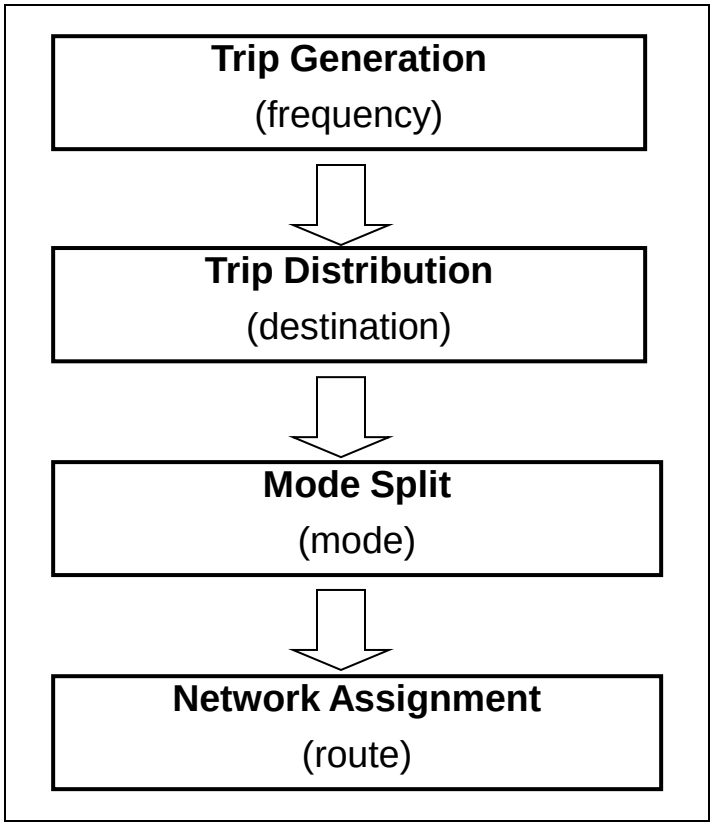


Contrasting Trip-based and Activity-based Methods:

Socio-Economic Characteristics

Land Use Characteristics

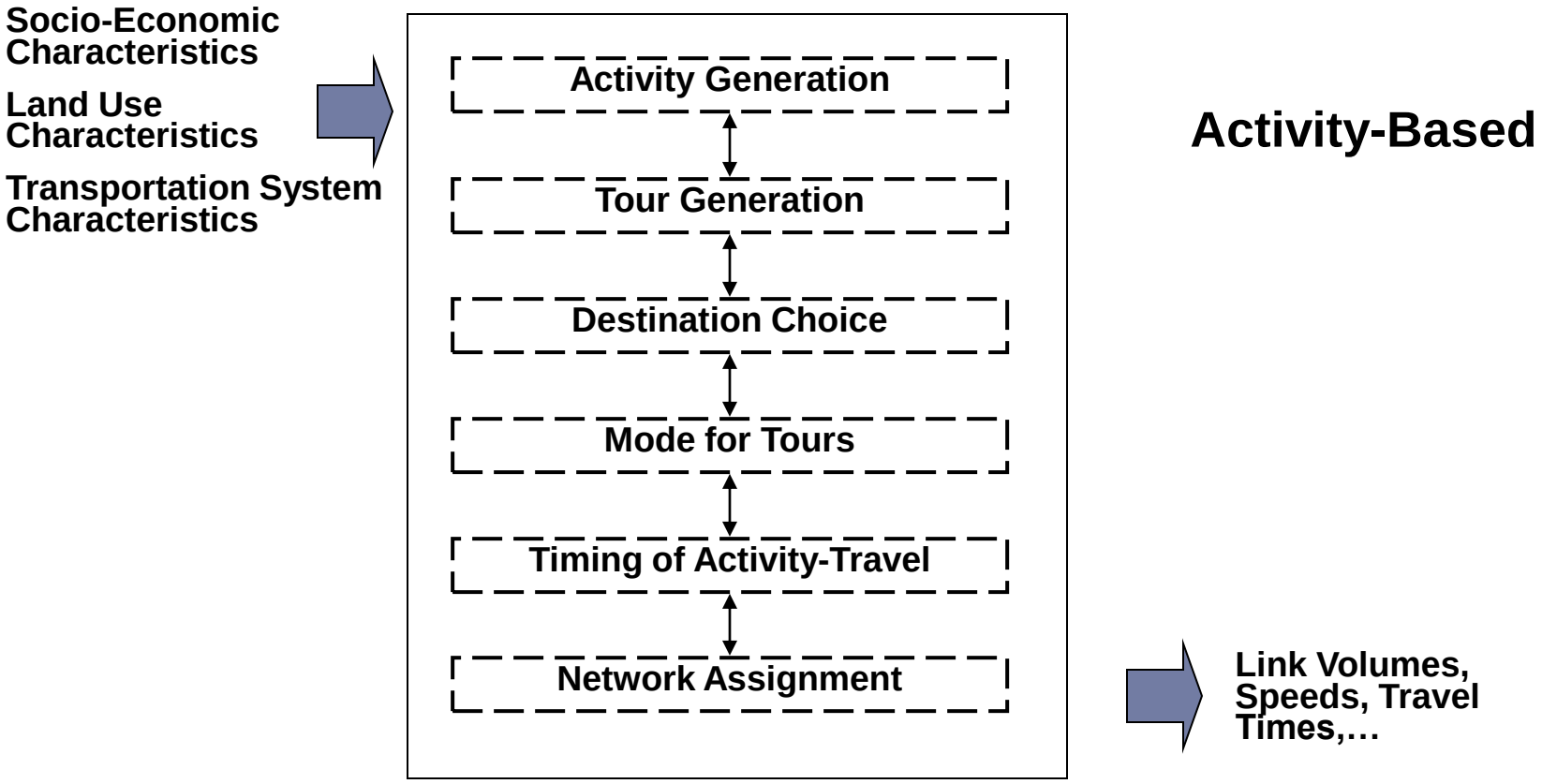
Transportation System Characteristics



Trip-Based / Four-Step

Link Volumes, Speeds, Travel Times,…

Contrasting Trip-based and Activity-based Methods:



Activity-based Modeling Methods

Unlike the trip-based approach, there is no one single activity-based modeling methodology….

- CEMDAP — http://www.ce.utexas.edu/prof/bhat/FULL_CEMDAP.htm
- FAMOS — http://www.public.asu.edu/~rpendyal/FAMOS%20Users%20Guide.pdf
- ALBATROSS — Arentze and Timmermans (2004) Transportation Research Part B 613-633
- TASHA — Miller and Roorda (2003) Transportation Research Record 1831, pp. 114-121
- Portland METRO Model
- San Francisco Model
- New York Model
- Columbus Model
- Denver Model
- Atlanta Model

http://www.trb.org/Conferences/TDM/papers/BS1A%20-%20Austin_paper_bradley.pdf