1.225J (ESD 225) Transportation Flow Systems

Operational Problems in Traffic Systems (Continued)

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Operational Problems

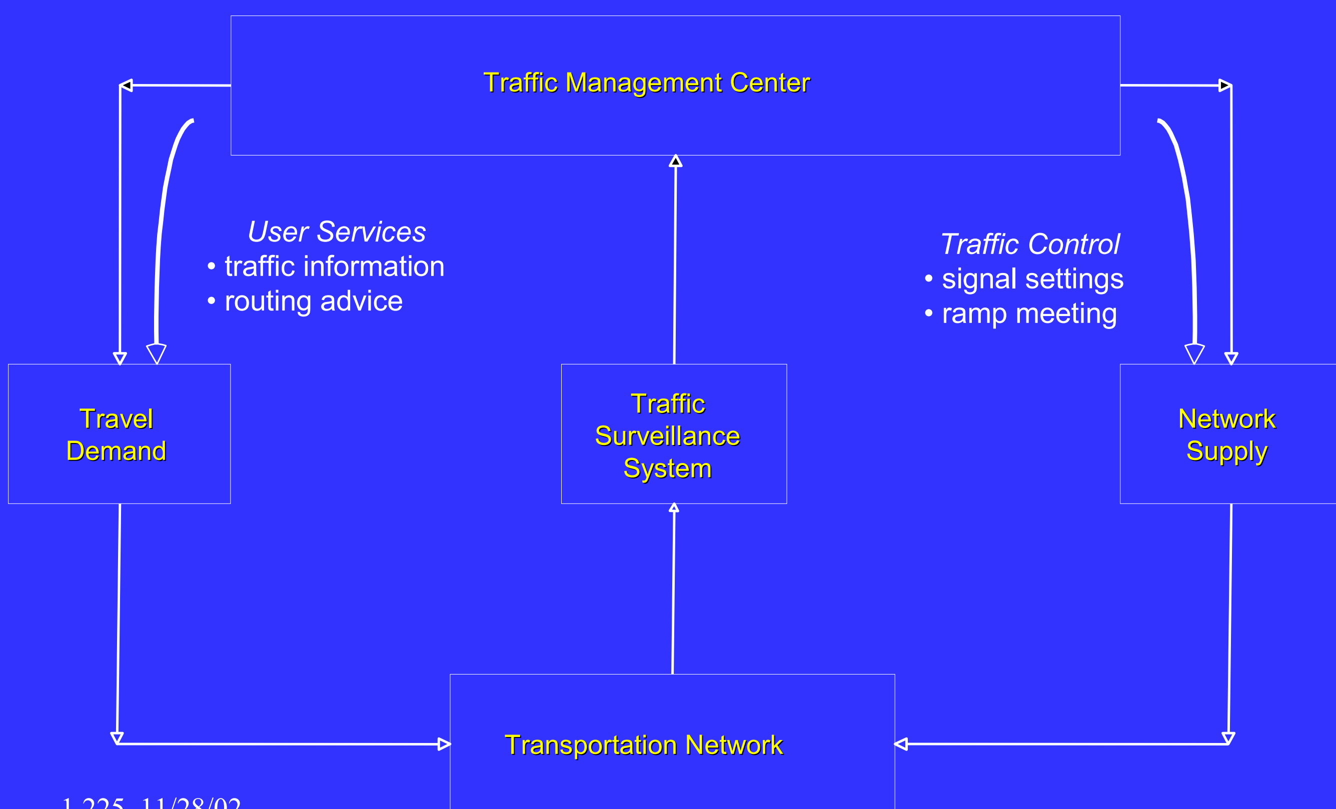
Part 1: Air Traffic Flow Management

- Introduction and conceptual definition of operational problems
- Ground-holding strategies
- Results from case study

Part 2: Road Traffic Flow Management

- Conceptual organization of road traffic management problems
- Integrated dynamic traffic control and assignment
- Results from case study

Information Technology and Transportation Systems Management



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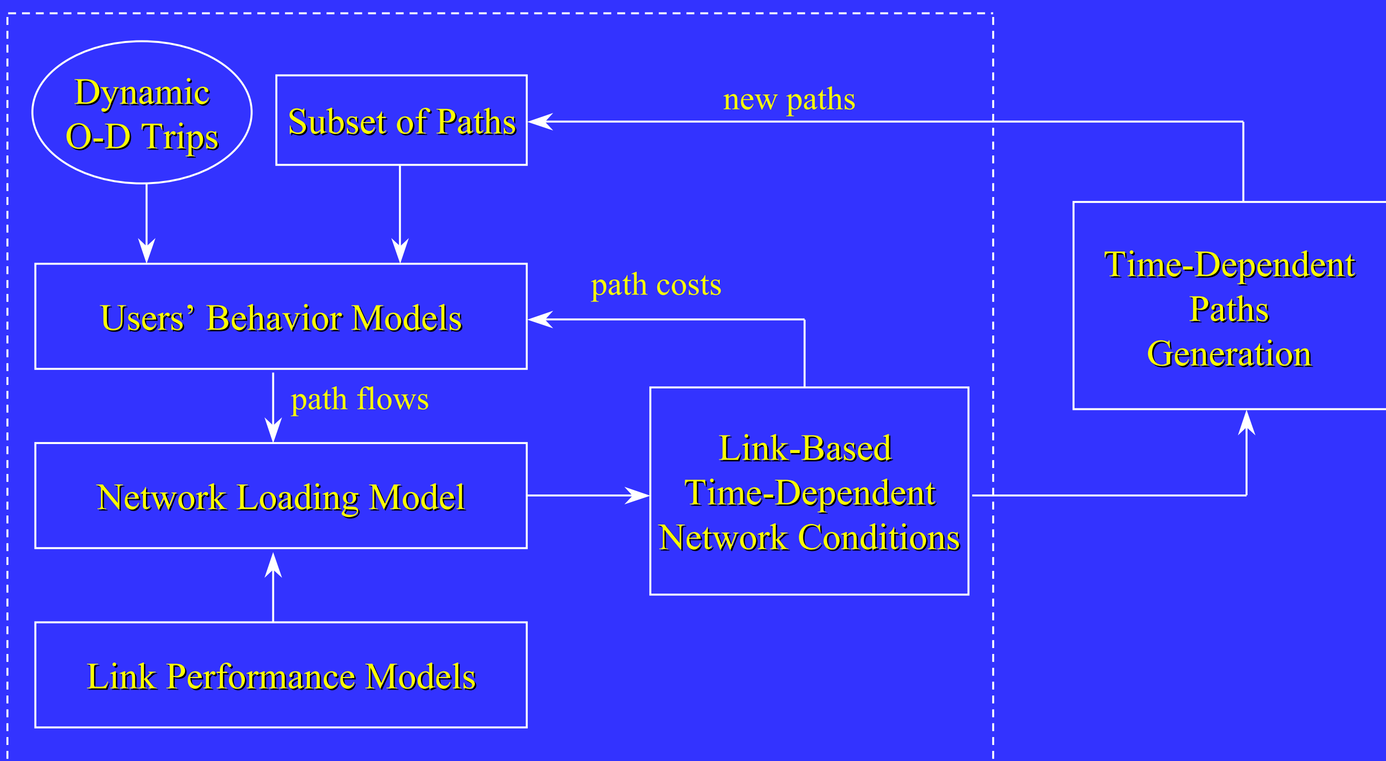
Desirable Properties of an ATMS/ATIS

- ATMS/ATIS should be responsive to:
  - "future" demand
  - potential adjustments in travel patterns due to information
  - variations in network capacity due to traffic control actions
- ATMS/ATIS should be based on "projected" traffic conditions to:
  - anticipate downstream traffic conditions
  - improve credibility

Traffic Prediction Approaches

- Statistical Methods
  - require no explicit assignment
  - are suitable for short intervals
- Dynamic Traffic Assignment Methods
  - incorporate driver behavior
  - require network performance
  - require time-dependent O-D flows
  - have high computational requirements

A Framework for (Analytical) Dynamic Traffic Assignment



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Time-Dependent Shortest Paths Computation

- Realistic networks: 20k road segments, 7k intersections, 700 destinations, 100 time intervals
- Time of known methods:
  - **Can be of quadratic** as a function of the number of time intervals
  - May take up to **25 minutes** for one destination
- Algorithm DOT:
  - **0.8 seconds** for one destination
  - Theoretically, this is the best one can do!
- Other avenues:
  - High performance computing implementations (10 to 20 times faster)
  - Exploit hierarchy of transportation networks (5 to 10 times faster)
- Combined effect: 100*10*5=5000

Types of DTA Models

- Microscopic traffic models (MITSIM):
  - Traffic is represented at the vehicle level
  - Vehicles are moved using car-following and lane changing models
- Mesoscopic traffic models (MesoTS/DynaMIT):
  - Traffic is represented at the vehicle level
  - Speed is obtained using models that relate macroscopic traffic flow variables
- Macroscopic (or flow-based) traffic models:
  - Traffic is represented as continuous variables
  - Speed is obtained using models that relate macroscopic traffic flow variables
- Analytical (flow-based) traffic models

Amsterdam Test Network

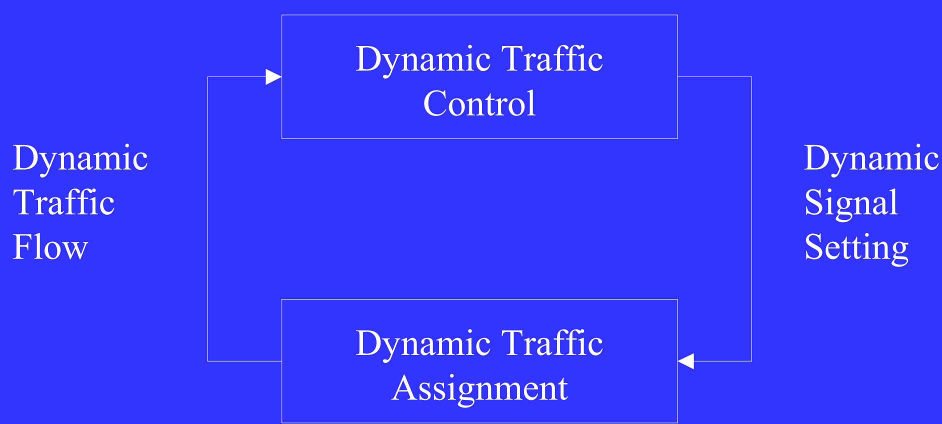
- 196 nodes, 310 links, 1134 O-D pairs and 1443 paths
- Morning peak: 2 hours and 20 minutes
- Discretization intervals: 2357 (3.50 sec each)
- Various types of users:
  - Fixed routes
  - Minimum perceived cost routes
  - Minimum experienced cost routes

Computer Resources Used

- Link variables: 25 Mbytes
- Path variables: 34 Mbytes
- Average time for one loading: about 3 minutes
- Saving ratio compared to known analytical methods: 1000
- Results are encouraging for real-time deployment

- MITSIM: 1.5 times slower than real time
- MesoTS: 16 times faster than real time
- Analytical approach: 45 times faster than real time

Interdependence of Control and Assignment



- Consequences of the conventional approach:
  - Sub-optimal signal settings;
  - Inconsistent traffic flow predictions.

A Case Study (cont.)

- Controls
  - current existing pre-timed control
  - Webster equal-saturation control
  - Smith P_0 Control
  - One-level Cournot control
  - Bi-level Stackelberg control
  - System-optimal Monopoly control
- Route Choices
  - A set of pre-determined paths (4 paths) for each O-D pair
  - Total of 400 paths
  - Demand is model using C-Logit

Results from Back Bay Case Study: Total Travel Time

Controls	Total Travel Time (mins)	Gap from System-Optimum (%)
Existing	11784	14.12
Webster	11781	14.1
Smith P_0	11566	12.02
Cournot	10642	3.07
Stackelberg	10504	1.73
Monopoly	10325	0