AN INTRODUCTION TO
INTELLIGENT TRANSPORTATION SYSTEMS

1.212

SPRING 2003

Professor Joseph M. Sussman

Mon/Wed 1-2:30

BLOCK 2

(Lecture 7)

ADVANCED TRAVELER INFORMATION SYSTEMS

Trafficmaster

Reliability

Driver Behavior

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MIT

March 3, 2003

TRAFFICMASTER UK (1)

- Components
  - Network of traffic sensors
  - Communication network
  - In-vehicle information units
  - National Traffic Data Center (operated by Trafficmaster) (NTDC)

McQueen, Bob, Rick Schuman and Kan Chen, Trafficmaster from Chapter 2, *Advanced Traveler Information Systems*, Artech House, Boston and London, 2002.

TRAFFICMASTER UK (2)

- Public-Private Partnership
  - General logistics on UKDOT (now DETR)
  - Originally M25
  - Now 15-year commercial license
    - England
    - Scotland
    - Wales
  - Initiated September 1900
  - March 2000
    - 2400 infrared motorway sensors (wireless, batteries)
    - 7000 passive traffic flow sensors for truck roads

McQueen, Bob, Rick Schuman and Kan Chen, Trafficmaster from Chapter 2, *Advanced Traveler Information Systems*, Artech House, Boston and London, 2002.

TRAFFICMASTER UK (3)

- Motorway Sensors
  - Measure speeds (averaging 6 vehicles)
  - If < 48 km, sensors communicate to NTDC
  - NTDC communicates to vehicles using wireless paging

McQueen, Bob, Rick Schuman and Kan Chen, Trafficmaster from Chapter 2, *Advanced Traveler Information Systems*, Artech House, Boston and London, 2002.

TRAFFICMASTER UK (4)

- Truck Roads (Arteries)
  - A lot of variation, unlike motorways
  - Use passive target flow measurements (image processing of license plate)

McQueen, Bob, Rick Schuman and Kan Chen, Trafficmaster from Chapter 2, *Advanced Traveler Information Systems*, Artech House, Boston and London, 2002.

TRAFFICMASTER UK (5)

- Information Delivery
  - Trafficmaster freeway
  - Traffic alert 1740
  - Trafficmaster YQ

McQueen, Bob, Rick Schuman and Kan Chen, Trafficmaster from Chapter 2, *Advanced Traveler Information Systems*, Artech House, Boston and London, 2002.

FREIGHT RELIABILITY

DRIVEN BY INVENTORY AND STOCK-OUTS

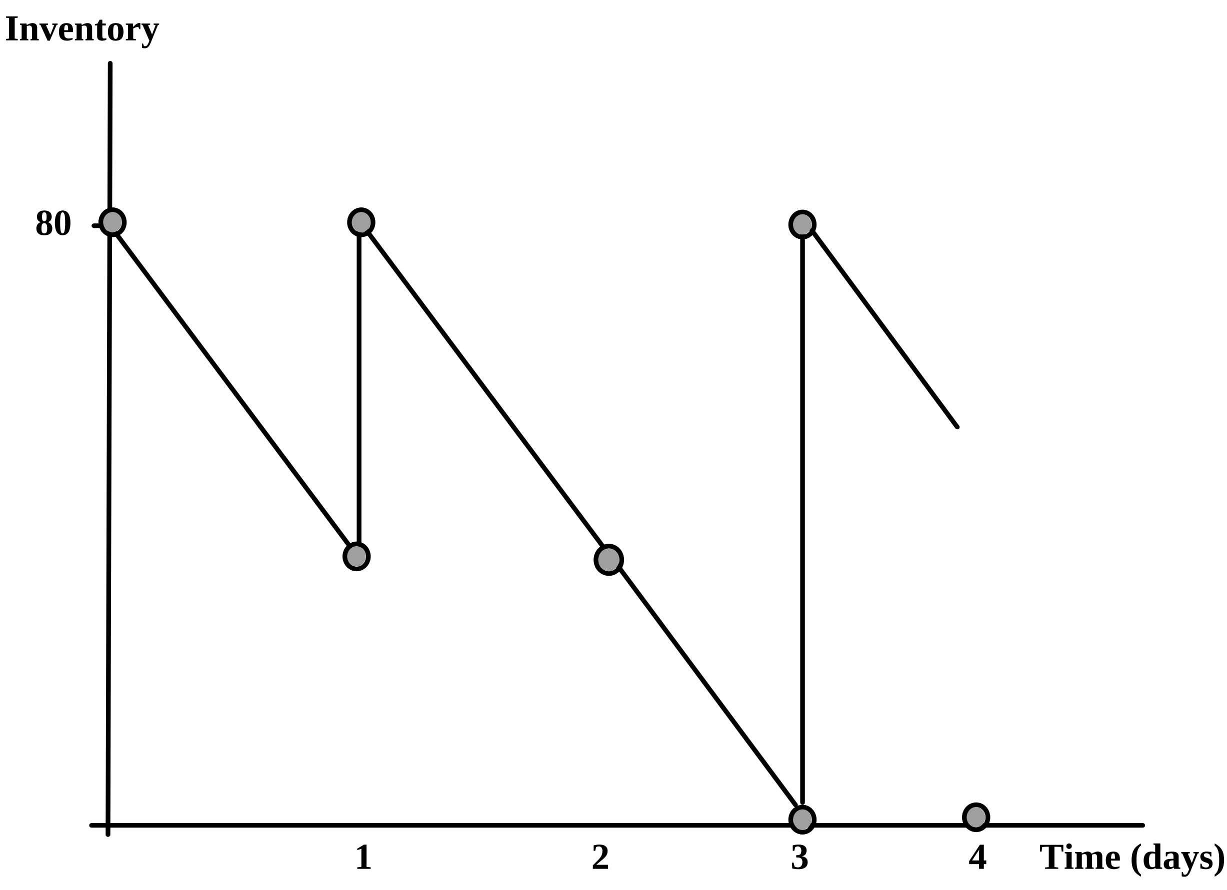
WHAT CAN GO WRONG?

Delays along the way -- service reliability

ISSUE: Stock-outs

WHAT CAN GO WRONG?
(CONTINUED)

So, perhaps the customer at B keeps a day's worth of inventory



Problems: Bigger Inventory
Warehousing Costs
Insurance Costs

A *BIG ISSUE* -- STOCK-OUTS

- WHAT DOES A STOCK-OUT COST?
  - Examples
    - GM Assembly Plant
    - Retail Store
    - Blood Bank

INVENTORY MINIMIZATION

- If one needs a greater amount of inventory because of unreliability in the transportation system *or* probabilistic use rate, you generate costs as a result of needing larger inventory to avoid stock-outs.
- We try to balance the costs of additional inventory with the costs of stock-outs.

TOTAL LOGISTICS COSTS (TLC)

Total Logistics Costs (TLC) =

f (travel time distribution, inventory costs, stock-out costs, ordering costs, value of commodity, transportation rate, etc.)

TRAVEL TIME DISTRIBUTION FROM SHIPPER TO RECEIVER

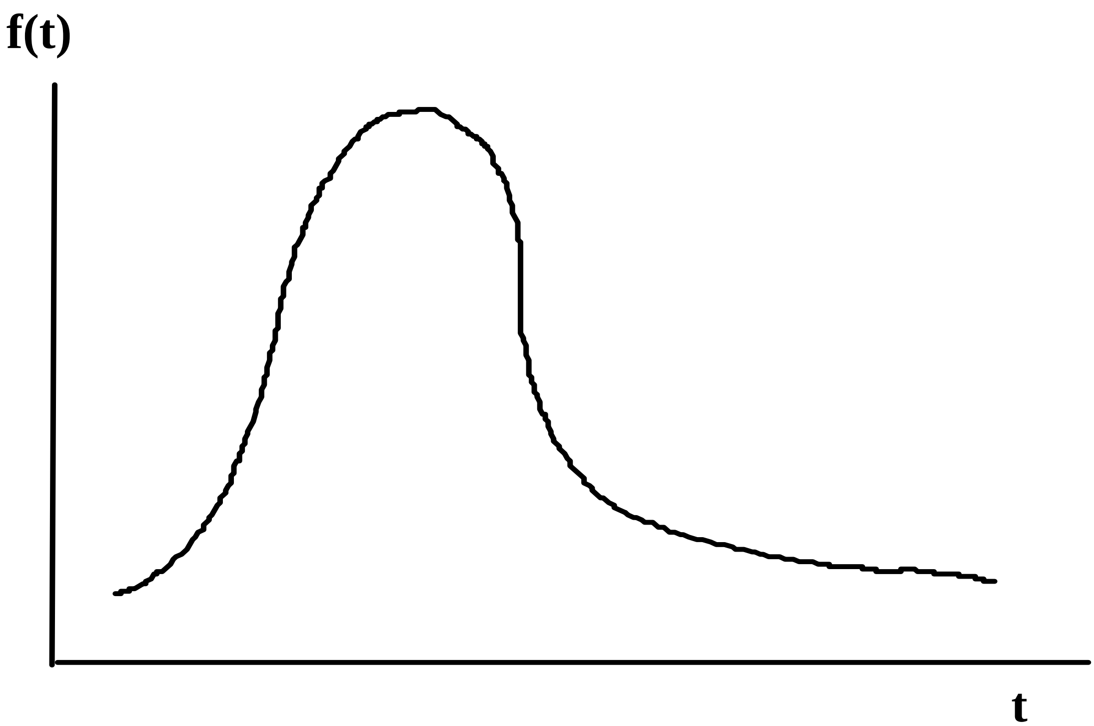


Figure 12.14

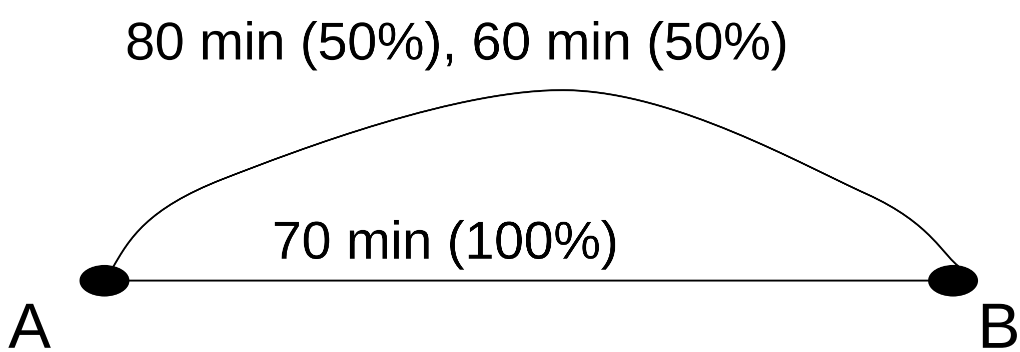
- This probability density function defines how reliable a particular mode is.
- TLC is a function of the travel time distribution.
- As the average travel time and variance grows, larger inventories are needed.

TRAVELER RELIABILITY

NOW IT IS TIME UTILIZATION AND NOT INVENTORY WE ARE CONCERNED WITH

- How can you deal with uncertainty in travel times?
  - Choose time when conditions are stable
  - Choose routes with stable conditions
  - Choose routes you know
  - Build knowledge through experiment
  - Minimize consequences safety margins
  - Get better information before the trip or en route

Bonsall, Peter, “Travellers’ Response to Uncertainty”, Chapter 1 in *Reliability of Transport Networks*, Bell and Cassir, eds., Research Studies Press Ltd., Baldock, Hertfordshire, England, 2000.

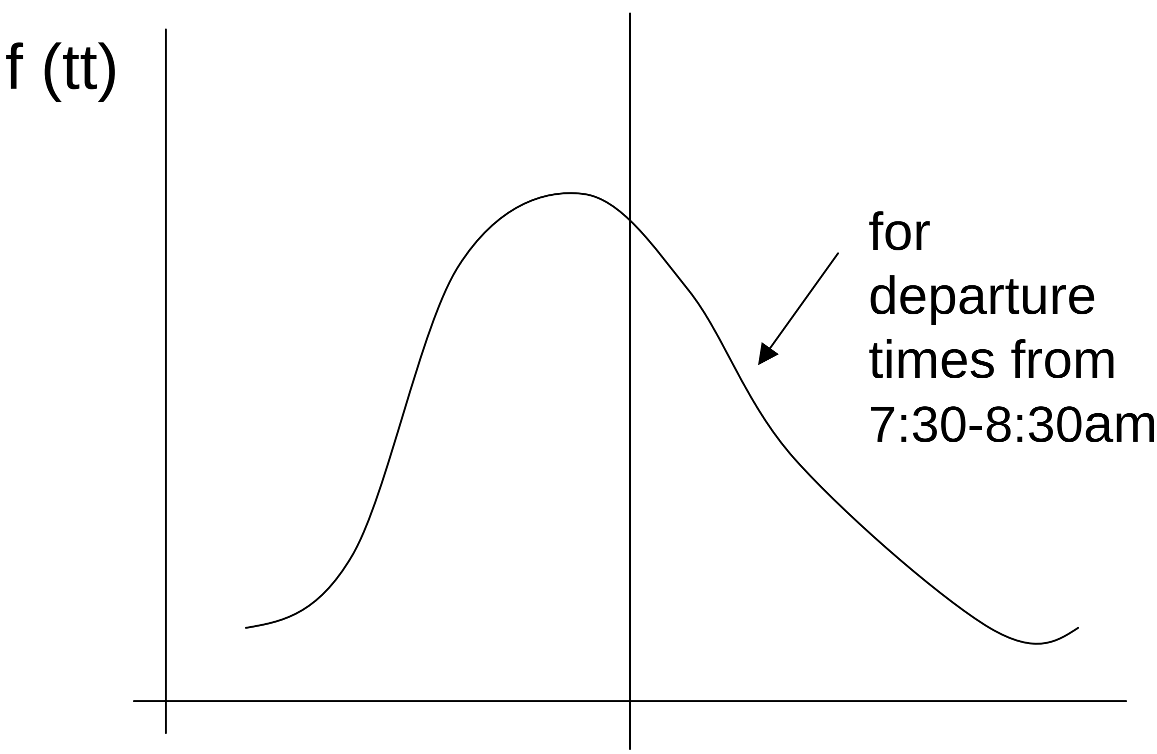


Risk Averse	Bottom
Risk Neutral	Either
Risk Prone	Top

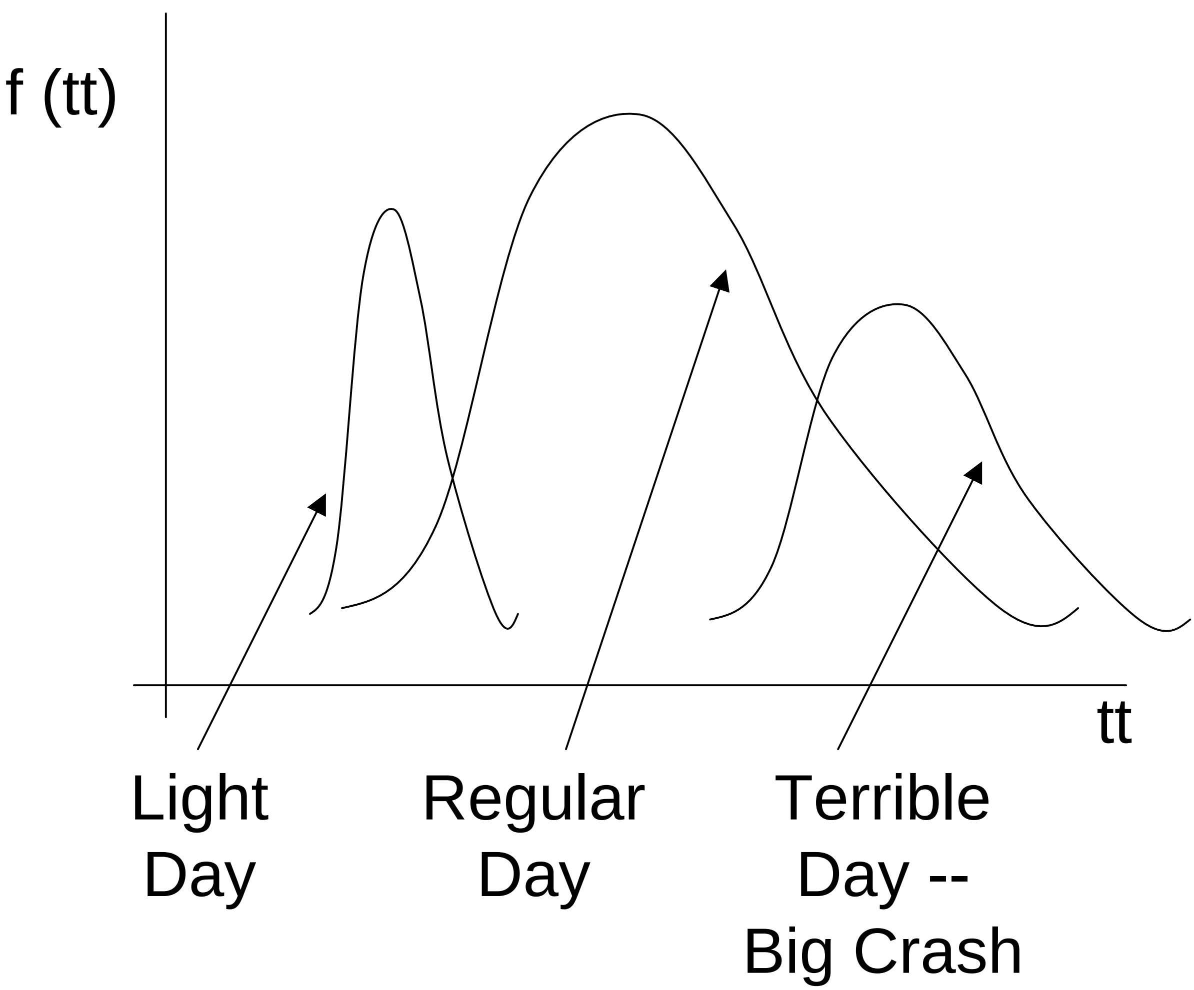
Think we should design unreliable systems for the thrill-seekers?

Yin, Yafeng and Hitoshi Ieda, "Assessing Performance Reliability of Road Networks Under Nonrecurrent Congestion", *Transportation Research Record 1771*, National Academy Press, Washington, DC.

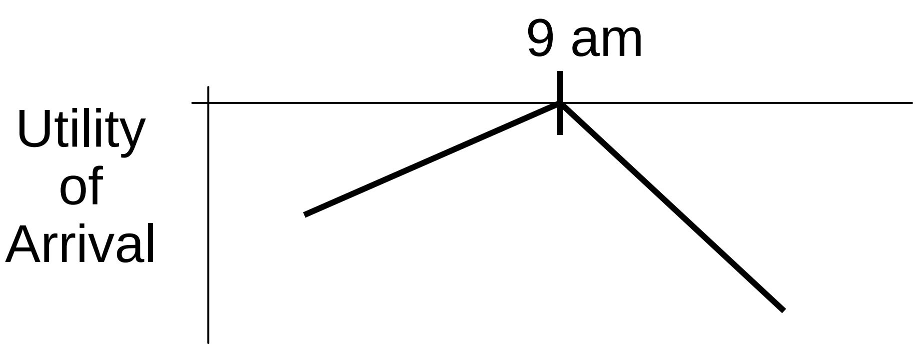
Desired Arrival Time = 9 am



What is the overall travel time distribution composed of?



With no traveler information, how would you decide when to leave?



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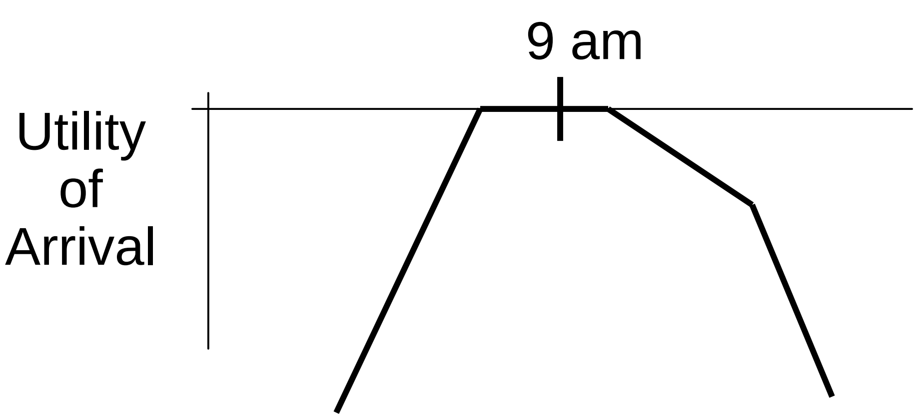

Suppose at 7:30, while still at home, you can find out what kind of a day it is

- Light
- Regular
- Terrible

What do you do, based on that information?

So, do you really save *actual* traffic time?

Maybe a little, but not much.

Does that mean there is no value to ATIS?

ATIS Non-User:
Travel Times Based on Past Experience

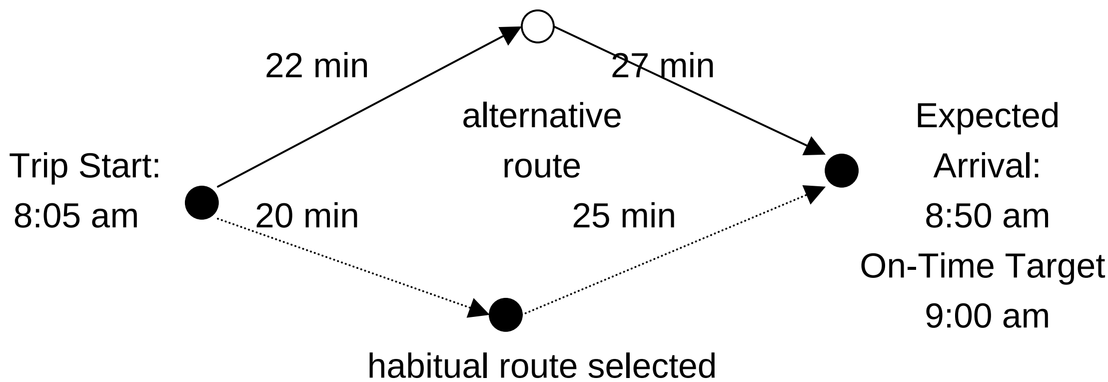

Figure ES-1: ATIS Non-User Route Choice and Trip Timing

ATIS User:
Reported Travel Times at 8 am

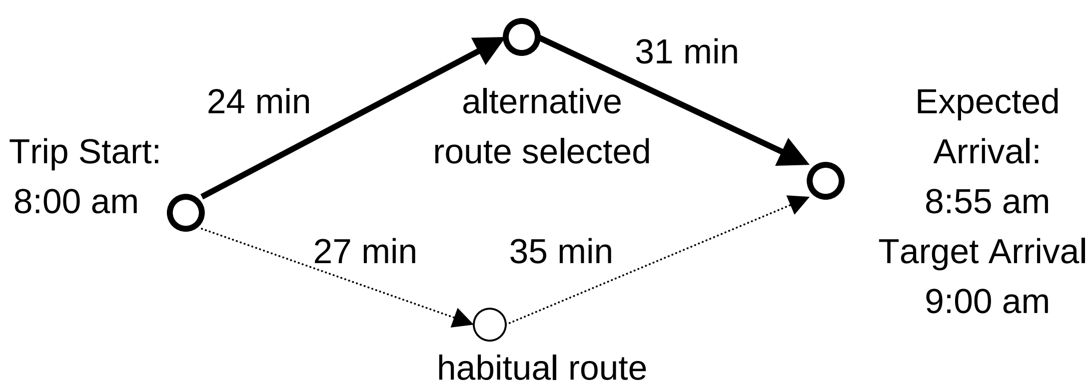

Figure ES-2: ATIS User Route Choice and Trip Timing

Wunderlich, Karl, Matthew Hardy, James Larkin, Vaishali Shah, "On-Time Reliability Impacts of Advanced Traveler Information Services (ATIS): Washington, DC Case Study", Mitretek Systems, McLean, VA, January 2001.

MITRETEK CONCLUSIONS

- ATIS benefits are *grossly understated* if only travel time savings are included.
- The value of improved on-time reliability is not easily nor directly monitized, but it is clear that many types of travelers can benefit from ATIS.
- Trucks delivering auto parts in a just-in-time manufacturing process may highly value any improvement in on-time reliability or reduction in early schedule delay.
- Commuters face an on-time requirement not only on the home-to-work leg of their daily trip-making, but increasingly on the work-to-home return trip in order to meet daycare pickup requirements and other commitments.
- Improved reliability and predictability of travel are also likely good surrogates for reduced commuter stress.

Wunderlich, Karl, Matthew Hardy, James Larkin, Vaishali Shah, “On-Time Reliability Impacts of Advanced Traveler Information Services (ATIS): Washington, DC Case Study”, Mitretek Systems, McLean, VA, January 2001.

MITRETEK CONCLUSIONS (2)

- Overall, ATIS use proved advantageous in efficiently managing the traveler's time. Specific quantitative examples selected from the Washington, DC, case study include:
  - Peak-period commuters who do not use ATIS were three to six times more likely to arrive late compared to counterparts who use ATIS;
  - Cases where ATIS clearly benefits the user (e.g., ATIS user on-time, non-user late) outweighed cases where ATIS clearly disadvantages the user by five to one;
  - ATIS users in peak periods are more frequently on-time than conservative non-users, yet they experience only two-thirds as much early schedule delay as non-users;
  - Late shock, the surprise of arriving late, is reduced by 81% through ATIS use.

Wunderlich, Karl, Matthew Hardy, James Larkin, Vaishali Shah, "On-Time Reliability Impacts of Advanced Traveler Information Services (ATIS): Washington, DC Case Study", Mitretek Systems, McLean, VA, January 2001.

Llaneras, Robert E. and Neil D. Lerner, “The Effects of ATIS on Driver Decision Making”, *ITS Quarterly*, Washington, DC, Summer 2000.

- Simulation Approach
  - 72 drivers
  - Ages 18-86
  - Equal number of males and females
  - Familiarity with actual roads (but this was a *simulation*)

THREE LEVELS OF ATIS

- No ATIS
- Basic ATIS
  - Descriptive information about incidents and congestion
  - Location, type of incident
- Enhanced ATIS
  - Basic plus the following
  - Alternative route
  - Incident details
  - Real-time traffic map
  - Live video traffic images

TWO TRAFFIC LEVELS

- Light
- Moderately Heavy

So, Six Experimental Conditions, Twelve Participants per Condition

Also, incidents built into the simulations

CONCLUSION

- ATIS influences en route driver decisionmaking
- Drivers will divert
- Travel time savings occurred as a function of ATIS features
- Same drivers did worse by diverting
- Travel level (light vs. moderately heavy) had little effect on driver behavior
- Maps work