Traffic Decision Support: Aspirations and Practical Challenges

Gary T. Ritter
IPAM Workshop IV: Traffic Decision Support

November 16-20, 2015
My Background

- Former Director, Advanced Transportation Technologies, U.S. DOT Volpe National Transportation Systems Center
  - Safe and Efficient Travel through Innovation and Partnerships in the 21st Century (SafeTrip-21) 2008-2010

- U.S. DOT ITS Senior Policy Task Force

- Charter member, Intelligent Transportation Society of America

- Advanced Technology Committee, American Society of Civil Engineers, Transportation & Development Institute
Traffic Decision Support

Safe and efficient trip decision-making needs timely information on alternatives, current (and to the extent possible anticipated) hazards and/or disruptions – regardless of the cause – as well as personal and societal costs for suitable options for a given travel purpose.

For most personal travel, trip time and cost decisions consider:

- Prevailing and anticipated road, traffic, and weather conditions
- Network alternatives (including access to preferential services or express traffic facilities)
- Intermodal connections
- Fuel price, tolls, and fees
- Parking availability / cost
- Environmental restrictions
- Traffic network productivity
Traffic Decision Puzzle Pieces

- Known knowns
  - Trip distance over network segments, including multi-modal linkages
  - Prevailing traffic, weather and road conditions (increasingly and more widely so)
  - Mean trip travel time / time of arrival, and associated variance
  - Scheduled events
  - Out-of-pocket costs

- Known unknowns:
  - Actual travel time
  - Unscheduled events
  - Impending incidents and disruptive impacts
  - Evolving impacts from decisions by others
  - Impact extent and duration until ‘normalcy’ is restored
Traffic Decision Support

Decision motives

Decision makers
Public Sector Aspirations

- **Traffic Safety**
  - Weather and Road Conditions
  - Curve / speed zone warning
  - Traffic congestion ahead alert
  - Intersection movement assist
  - Pedestrian / bicycle alerts
  - Blind spot / overtaking assist
  - ~34,000 fatalities annually
  - ~$100B economic burden
  - ~2B gallons wasted fuel
  - ~2B metric tons GHG

- **Efficient Mobility**
  - Optimal transportation network performance / productivity
  - Transit / ride sharing utilization
  - Avoid congestion and delay
  - Provide travel time reliability

- **Eco-Transportation**
  - Avoid wasteful fuel consumption
  - Foster low emission alternatives and informed travel decisions
  - Maximize persons and/or cargo moved per ton of GHG emission
Transit / Freight Aspirations

- **Operational Safety**
  - Weather / wind information
  - Road condition information
  - Traffic alerts / warning:
    - Blind spot
    - Lane departure
    - Forward collision
    - Curve speed / rollover
    - Drowsy / distracted driver
    - Bike / Ped conflicts

- **Operational Productivity**
  - Expeditious trips; efficient driver utilization
  - Fuel efficient, traffic-aware routing
  - Predictable travel and transit times
  - Efficient intermodal transfer operations
  - Parking availability when and where needed
Traffic Related Decisions

- **Personal Travelers** – trip frequency, where, when, route and mode choice, trip-chaining behavior
- **Traffic Managers / Engineers** – traffic signals, route designation, incident management, traffic reports
- **Fleet Dispatchers** – demand analysis, service planning, scheduling, routing, operating constraints, disruptions
- **Logisticians** – delivery planning, JIT scheduling, dynamic routing, optimization, distribution alternatives
- **Public Safety** – traffic law enforcement, emergency response, closures, detours, evacuation operations
- **Transportation Planners** – travel demand, traffic forecasts, congestion, modal split, safety and efficiency
Personal Decision Attributes

- Historically, limited reliance on traffic information for most trips; greater interest by younger generations
- Interest in traffic/travel information spikes when stuck in traffic or in unfamiliar/dynamic situations
- Willingness to participate in crowd sourced traffic monitoring – subject to privacy considerations
- Response to information correlates to perceived accuracy
- Expectation that traffic information be offered as a bundled service without a separate charge
Traffic Manager / Engineer

- Interest rooted traffic operations and control devices (signals, message signs, traveler information systems) and/or incident response
  - Interest in relatively fine-grain traffic data (i.e., intersection movements and throughput)
  - Interest in traffic safety, flow, travel time / delay, and congestion metrics

- Desire for video imagery or human observation to confirm and assess situations

- Limited willingness / ability to pay for routine traffic data; also limited expertise / time to make use of information

- Numerous, independent traffic jurisdictions; often face conflicting perspectives on addressing traffic problems
Fleet Dispatcher Attributes

- Situational awareness desire relative to sustaining on-time operations and labor rule compliance
- Rerouting typically limited by commercial vehicle and bus traffic restrictions
- Taxi / limo operators subject to traveler suspicion of indirect routings
- Recovery of traffic information cost varies – whether as a pass-through charges or through operating efficiency gains
- Communication links with vehicles afford possibilities in traffic probe data collection and exchange
Logistician Attributes

- Similar to fleet managers but operating at a larger scope and scale, with intermodal options

- Strategies to pre-position resources to minimize traffic related disruptions

- Keenly aware of costs and bottom line implications – United Parcel Service for instance:
  - 17 million parcels daily, throughout 200 nations, via air, rail, marine, trucks, and bikes
  - 5 minutes of traffic delay across U.S. operations costs $105 million annually
  - Traffic decision support covering 20% of fleet is saving 1.5 million gallons of fuel and eliminating 14 tons CO₂ annually
Public Safety Attributes

- Interest in traffic situational awareness and reporting during incident response and management

- Traffic information is vital to incident response yet incidental to public safety management overall
  - Interest in dynamic traffic routing for rail grade crossings and drawbridges

- Historical information can be rendered irrelevant as a result of catastrophes

- Degraded or destroyed infrastructure (and staffing) often impairs data access and distribution

- Situations can change rapidly, requiring dynamic planning and response capabilities
Transportation Planners

- Focus on archival and trend data more so real-time traffic information
- Interest in traffic meta data and data suitability / compatibility
- Focus on travel corridor and/or regional scale, with emphasis on overall capacity and efficiency
- Typically lack organizational responsibility and/or field capability for systemic traffic data collection
- Shared interest in traffic volume counts, vehicle weight / classification, and traffic speeds with transportation managers / engineers.
Traffic Decision Support
Milestones Over the Years

A long and winding road influenced by technology innovation:

- 1990's – TravTek (Travel Technology)
- 2008-2010 – SafeTrip-21
- 2015 Connected Vehicle Pilots
Electronic Route Guidance

- During 1960 – 1980, traffic-aware route guidance heralded as the most important urban traffic advancement in since freeways.

- If space age electronics could be used to transport a few men 200,000+ miles to the moon, why not use it to move hundreds of thousand people in cities.

- Urban Traffic Control Systems (UTCS) viewed as an enabler for computerized traffic signal control and centralized electronic traffic management.

- Dynamic traffic information a distinguishing ERG feature, with centralized computer processing.
ERGS

Electronic Route Guidance System (ERGS 1968-1970)

- ‘V2I’ concept developed by FHWA in cooperation with General Motors – derivative of GM Driver Aid Information and Routing (DAIR) system circa 1966
  - Vehicle destination code provided to traffic signal communications unit

- For a small network, daily cost benefits from delay reduction were estimated at $3,270 (~$19,200 in current dollars)

- Benefit advantage over static guidance offset when vehicle unit costs are greater than $135 (~$795 in current dollars)
ERGS Contemporaries

- Comprehensive Automobile Traffic Control System (Japan 1973-1979)
  - ¥ 7.3 billion (~$30 million; ~$120-150 million in current dollars)
  - Inductive loop data communication
  - 11% estimated travel time savings

- ALI - Autofarer Leitung und Informationsystem (Europe late 1970’s)
  - Ali-Scout (combination of ALI and AUTOSCOU'T) estimated to reduce travel time by ~5% as part of the mid-1990’s FASTRAC project in MI
TravTek (1992-1993)

- ~300 drivers
- 1,488 traffic network links
- traffic data via sensors and probes
- 1 min traffic updates

Select Findings (real-time traffic used but not evaluated)

- ~80% user favorability; perceived desirability highest for trips in unfamiliar areas
- Travel times reduced by up to 25%; but typical savings were <1.5 min given short trip lengths
- Willingness to pay: 50% take-rate at $1,000 purchase or $34 weekly rental; ~$250 and $6 weekly for traffic information alone
SafeTrip-21 (2008-2010)

- $30+ million public-private field test partnership
  - 20 private organizations
  - 17 state transportation agencies
  - 6 public sector planning and public transportation agencies
  - 2 research universities
  - thousands of travelers

- Multimodal applications
  - Smart phone road traffic probe monitoring
  - Foresighted ‘traffic congestion ahead’ driver alerts
  - Long-distance, multi-state corridor traffic-aware travel time ‘now-cast’
  - Corridor scale travel planning based on integrated ‘real-time’ traffic, transit, and parking data – along with cost and environmental factors
SafeTrip-21: Traffic Data

- 5,000 users in SF Bay Area
- Crowd sourcing feasibility
- Privacy sensitive sampling
- ~5% traffic stream sample
- Up-to-the-minute updates
- Real-time traffic flow map
SafeTrip-21: Trip Planner

- Integrated trip modal choices
  - Commuter Rail
  - BA Rapid Transit
  - Light Rail
  - Bus / BRT
  - Walk / Bike
  - Automobile

- Decision info:
  - Time
  - Cost
  - Carbon Footprint

- ‘Real-time’
  - Transfer Guide
  - Parking space
  - Routing update

U.C. Berkeley
SafeTrip-21: Travel Time

- I-95 Corridor
  - Portland, ME to Orlando, FL
  - INRIX Traffic Data
- Coverage
  - 11,000 road network segments
  - 4,700 freeway miles
  - 900 arterial miles
- Decision info:
  - Travel Times
  - Traffic Status Map
  - Transit options - BWI to/from DC
SafeTrip-21 Revelations

- Smart phones have disruptive potential; and challenged views regarding DSRC-exclusive V2V/V2I future, as well as public and private traffic data roles
- Probe traffic data is ascendant; attractive private sector potential due to scope and scalability attributes
- Crowd sourcing traffic data viable if privacy concerns overcome; ~5% of traffic stream sufficient in peak-period traffic conditions
- ‘Real-time’ multi-modal traffic / trip planning information derived irrespective of jurisdictions
- Marketing / meaningful benefits needed to attract and sustain voluntary data sourcing participants and/or users
- Travel information can prompt expectations – resulting in public agency ‘fear of success’
- Partnership can be mutually advantageous

Connected Vehicle Pilots

- Large-scale, multi-year, beginning in 2015

- Multi-phase:
  - Concept development
  - Proof of concept
  - Deployment & operations

- 2012-2014 Safety Pilot Counterparts

- I-80 Corridor – WY
- New York City – NY
- Tampa – FL
Connected Vehicle Pilot - WY

- **I-80 Corridor**
  - 400 mile route; 4,000-6,700 truck AADT
  - ~50 wind-related truck ‘blow-overs’ annually
  - Severe Wx and lengthy winter road closures
  - Other routes require 2-3 hours more driving

- **Applications**
  - Road Weather Advisories
  - Spot Weather Travel Impact Warning
  - Weather-Responsive Variable Speed Limit
  - Freight Dynamic Travel Planning
Connected Vehicle Pilot - NY

- New York City
  - ~240 high accident locales
  - 10,000 city / fleet vehicles
  - 12,700 traffic signals w/BSM
  - Traffic simulation model

- Applications
  - Red Light Violation Warning
  - Pedestrian in Crosswalk
  - Vehicle Turning Right in Front
  - Mobile Pedestrian Signal
  - Bike Basic Safety Message
  - Freight Dynamic Travel Demand and Performance
Connected Vehicle Pilot - FL

- Tampa
  - Reversible traffic lanes
  - Bus/Trolley signal delay
  - Rear-end and red-light running crashes
  - Pedestrian/bike road and trolley traffic conflicts

- Applications:
  - Wrong way traffic and curve speed warnings
  - Ped in crosswalk
  - Mobil pedestrian signal
  - Intersection movement assist
  - Intelligent traffic signals
    - ✓ Transit Signal Priority
Automated Traffic

- Conventional driving
  - Compensates for human driver inattention
  - Somewhat confounding for other drivers

- Traffic speed harmonization
  - Potential to improve highway throughput
  - Possible reductions in vehicle emissions with improved fuel economy

- Vehicle platoons
  - +15% truck fuel economy
  - + 200-300% freeway lane throughput; would require corresponding upgrades for freeway exits and downstream arterial streets
  - Cooperative V2V communications needed to stabilize vehicle separation
Practical Challenges

- Traffic decision support financing – in light of benefit and cost mismatches
- Traffic data collection, packaging, and distribution, with targeted valuation and monetization for diverse market segments
- Traffic modeling, simulation, and optimization – with predictive capabilities
- Traffic operations impact and recovery forecasting
- Cybersecurity and Privacy
- Data ownership, rights, and records management
- Information and liability

Challenges are what make life interesting. Overcoming them is what makes it meaningful.

http://www.quotesforthemind.com/
Opportunities

- Informed traffic decision making
  - Discrete, individualized traffic control strategies that relieve congestion disproportionate
  - Collaborative traffic decision optimization
  - Anonymous O-D data sharing

- Faster than real-time traffic decision support

- Distributed, cooperative shared control

- Gamification or other behavioral incentives
Questions