Section 7

Summary, Conclusions and Recommendations

Mitretek Systems conducted five modeling studies to quantify potential ITS benefits and identify conditions under which these benefits may be realized. The studies provide estimates and analysis of ITS benefits that complement and go beyond findings that can be obtained solely from the results of deployments or operational tests.

The purpose, approach, and main findings of each of the five studies are summarized below in section 7.1. Some over-arching conclusions and implications from the studies are presented in section 7.2. Recommended next steps are presented in section 7.3.

7.1 Modeling Study Summaries

Table 7-l presents a condensed summary of study scenarios, goals and key results. Sections 7.1.1 through 7.1.5 provide a text summary and discussion of the five modeling studies and their results.

7.1.1 Benefits of Dynamic Route Guidance in Congested Urban Networks

The purpose of the study is to establish a quantitative relationship between network congestion and travel-time reduction benefits of a dynamic route guidance user service. The approach of the study is to employ the INTEGRATION traffic simulation model and the Urbansville test network (based on Detroit, Michigan) in a series of experiments. While holding the capacity of the roadway fixed, the value of route guidance is evaluated over a range of increasing demand levels. Network demand patterns and trip characteristics are comparable to current national averages. Measures of congestion such as average system commute speed either match or exceed current national averages. Congestion metrics measured for the lightest demand scenario match most current empirical national average data., while the heaviest demand scenario appears roughly comparable with 1994 Tokyo conditions.

A near-term route guidance user service is defined for Urbansville under the assumption of a uniform five percent market share. Route guided vehicles receive accurate reports of current link travel time conditions every ten minutes. The performance of the guided vehicles is compared with vehicles modeling the behavior of experienced commuters, who are assumed to know the fastest routes according to average conditions during the peak period. Two representative cases with non-recurrent congestion are studied in each scenario; an incident case and a case with heavier than normal demand. In these cases, the route guided vehicles have the opportunity to identify faster routes than the non-guided experienced commuters.

Table 7-1. Condensed Summary of Modeling Study Results

Study	**Benefits of Dynamic Route Guidance in Congested Urban Networks**
Scenarios	Morning peaking rush hour in Urbansville: 1997, 2002, 2012 demand
Goals	Quantify trip time savings for vehicles with dynamic route guidance under varying congestion
Results	- Benefits are greatest in moderate congestion, increase with trip length [§2.5.1, 2.5.2]
	- Trip-time reduction up to 13% when compared to experienced commuter traffic [§2.4]
Study	**Dynamic Route Guidance Compared to Advisory Messages**
Scenarios	High functionality ATIS (Dynamic Route Guidance) and low functionality ATIS (Advisory Messages implemented by Changeable Message Signs), Thruville and Thruville subset
Goal	Compare travel time reduction benefits of dynamic route guidance to advisory messages in incident scenarios with different levels of market penetration
Results	- 13-16% reduction in travel time for vehicles with dynamic route guidance [§3.3.4]
	- 8-11% reduction in travel time for vehicles responding to advisory message [§3.3.5]
	- Higher market penetration decreases user benefit, increases system benefit [§3.3.4, 3.3.5]
Study	**Impact of Network Surveillance on Dynamic Route Guidance Benefits**
Scenarios	Thruville subset, reduced percentage of probe vehicles providing surveillance information and reduced link reporting opportunities during incident conditions
Goals	Quantify percentage of probe vehicles required to support dynamic route guidance service
Results	- All benefits of route guidance can be provided with as few as 20% probe vehicles [§4.2.3]
	- Most (over 50%) benefits of route guidance realized with as few as 1% probe vehicles [§4.2.3]
	- Effectiveness of small probe populations can be augmented by more frequent updates [§4.3.2]
	- Reporting travel times only for congested links provides 90% of benefit at lower cost [§4.7.2]
Study	**Pre-Trip Mode Shift Benefits Assessment**
Scenarios	Rush hour on two mode (roadway vs. rail) sample network, various types of congestion (local and global, predictable and unpredictable)
Goals	Quantify user and system benefit of mode shifts enabled by pre-trip planning information
Results	- Under various non-recurrent delays, 15% market penetration induces 3-4% mode shift [§5.5.3-5]
	- Mode shifters cut travel time 11-35%; system travel time drops 2-7% [§5.5.3-5]
	- System-level benefits of pre-trip planning and route guidance are additive [§5.5.5]
Study	**Adaptive Signal Control Strategies**
Scenarios	Urbansville Commercial Business District rush hour with and without changes to traffic volume and direction, and a simple grid network
Goals	Compare average trip times for different adaptive signal control strategies compared to fixed signal timing plans
Results	- Less than 10% improvement over fixed signals when traffic follows expectations [§6.5, 6.6]
	- Dynamic corridor synchronization reduces average travel time 2 to 15% in other cases [§6.5, 6.6]
	- Actuated signals reduce average travel time 3 to 25% in other cases [§6.5, 6.6]

Note: The reference following each result indicates the section providing context and explanation.

Results from this study indicate that route-guided vehicles benefit regardless of level of congestion. However the amount of trip time savings achieved is dependent on network congestion conditions. Average trip time savings for route guided vehicles over experienced commuters in the am. peak period range up to 13% depending on overall traffic volume.

The results of this study have several implications for ITS benefit assessment.
First, route guided vehicles that receive reliable data on network conditions (including incidents or demand variation) gain up to 13% travel time savings over unguided vehicles which follow optimal routes based on average network congestion conditions. Route guided vehicles may exploit information about unexpected delays in the network related to incidents as well as variability in daily traffic patterns. In these cases, route guided vehicles can expect to cut delays by as much as 50% when compared with experienced commuters.

Second, route guided vehicles on average have the same performance as the highest-performing unguided vehicles. This implies that dynamic route guidance does not discover new, superior routes on the network which other travelers do not use. Instead, route guided vehicles gain benefit by avoiding the worst congestion in the network In a series of day-to-day simulations, route guided vehicles should experience a much smaller variability in trip time. In fact, this minimiration of the maximum travel time for the daily commute may be the most significant benefit of the dynamic route guidance system for the commuter driver.

Third, the results indicate that benefits of dynamic route guidance are directly related to the level of recurrent congestion in a network. This suggests that a near-term poor market for dynamic route guidance may evolve over time into a good market for these services. Likewise, a good market for a dynamic route guidance user service may deteriorate if overall network congestion reaches very high levels. This implies that for the most highly congested urban areas, demand management techniques will be necessary if dynamic route guidance is to retain its highest value.

7.1.2 Dynamic Route Guidance Compared to Advisory Messages

This study investigates the travel time benefits realized from implementing two types of vehicle guidance/information services. These services represent two ATIS market packages defined in the ITS Physical Architecture document. Dynamic route guidance, directing equipped vehicles onto shortest paths, represents the "Route Guidance" high functionality ATJS market package. Advisory messages, warning vehicles to avoid certain congested links, represent the "Broadcast Based ATIS" low functionality market package.

The study employs the INTEGRATION traffic simulation on the Thruville inter-urban network, based on the Delaware Valley inter-city corridor extending from Wihnington, Delaware to Trenton, New Jersey. Three scenarios are used to compare travel performance for a sub-population of vehicles in the network. First, a subset of the Thruville network based on the Cherry Hill, New Jersey region is used to study the effects of the two ATIS market packages under an incident condition. The second scenario introduces a major incident onto the full Thruville network to generate time-variant unexpected delay. Third, capacity along a section of freeway near Philadelphia is reduced for the entire simulation period. This scenario represents the network under conditions when a major roadway construction project is being implemented. In each scenario, the ability of dynamic route guidance (5% or 20% market penetration) and advisory messages (5% or 20% response rate) to reduce delay is measured.

In all scenarios, the dynamic route guidance market package alleviates over half the non-recurrent delay for equipped vehicles. This delay reduction represents a 13-16% reduction in travel time. The unequipped vehicles also experience a 1% reduction in travel time since guided vehicles are routed away from the incident. Vehicles responding to advisory messages receive a 8-11% reduction in travel time. Non-responding vehicles in this case also benefit slightly (1% travel time reduction) from the diversions of the vehicles responding to advisory messages.

The effect of increasing market penetration for route guidance and the percentage of drivers responding to advisory messages is a reduction in travel time benefit the vehicles that divert. This reduction is the result of more traffic on the alternate route. However, there is a concomitant increase in travel time benefit for unequipped and non-responding vehicles.

The magnitude of delay reduction achieved by advisory messages was found to be highly sensitive to the placement of the information dissemination devices. When these devices were placed where the cost of diversion was high relative to the delay induced by an incident, the information did more harm than good for those who responded to it (25% increase in delay). This result has several implications. First, the placement of variable message signs or beacon devices is most beneficial at locations where low cost diversion options are available to a significant fraction of the drivers. Second, if more information is provided about expected delays rather than the traditional "congestion ahead", it would enable drivers to make the better routing decisions. There is also the implication that network topology and traffic demand patterns will have a large influence on the relative advantages of high and low functionality ATIS.

7.1.3 Impact of Network Surveillance on Dynamic Route Guidance Benefits

This study examines the value of traffic information used for dynamic route guidance by varying levels of network surveillance. The study uses the INTEGRATION model to simulate incident-caused congestion on a subset of the Thruville network. The study varies the number of probe vehicles and the number of reporting opportunities by probe vehicles, thus varying the amount of surveillance information provided to the route guidance system. The average travel time of vehicles with dynamic route guidance is compared to that of unguided vehicles.

If unguided vehicles serve as probes, study results indicate there is effectively no degradation in the value of dynamic route guidance when the probe population decreases from 100% to as low as 20%. An unguided probe population as low as 1% can still provide over 50% of the benefit of full surveillance. The maximum time savings for guided vehicles is about 10% of trip time. At very low probe percentages, the value of dynamic route guidance can be increased by updating travel times more frequently than every ten minutes.

For an inter-urban corridor it is unlikely that a state or regional highway agency would install and maintain a complete array of link detection devices. Therefore, it may be more cost-effective to obtain network conditions from a relatively limited probe population than by a complete deployment of detection devices. The study also shows that the percentage of probes required to determine accurate network conditions is a function of the difference in travel time between preferred and alternative routes in the network.

If the percentage of probes on the network is small, guided vehicles are able to capture a greater percentage of the maximum benefit if the frequency of network condition reports is increased. If guided vehicles receive network condition reports every one minute, approximately 2% to 5% unguided vehicle probes are required to obtain more than 95% of the maximum possible travel time savings for this network.

If the only source of network surveillance is provided by guided vehicles acting as probes, those guided vehicles may experience longer travel times than unguided vehicles. This can happen after congestion caused by an incident has dissipated. The route guidance system does not learn that congestion has dissipated, however, because all the guided probes are still being routed to a longer alternate path. This risk may be alleviated by deliberately routing some guided probes along paths with non-recurrent delay or by guided probes choosing to ignore suggested diversions. These strategies have significant impact on guided vehicle performance levels, however. In a case where 1 in 10 guided vehicles do not divert, delay reduction for all guided vehicles (including those not diverting) drops by roughly 75%.

The study also shows that if probe vehicles report travel times only for links where normal travel times arc exceeded by more than 20% (exception reporting), 90% of the potential benefit to guided vehicles can be obtained. Exception reporting can reduce the load on the communications network significantly, but it requires maintenance of an in-vehicle database of historical travel times.

7.1.4 Pre-Trip Mode Shift Benefit Assessment

The purpose of this study is to quantify tbe relative benefit of a sophisticated pre-trip planning user service as compared to other congestion reduction strategies. The study currently is focused on the mode choice aspect of pre-trip planning. Mitretek has developed an evaluation framework named Smart-Shift, composed of a mode choice model and traffic simulation. For each scenario, the effects of roadway capacity reduction arc simulated using the INTEGRATION model, and the resulting link travel times are input to the mode choice model, causing some drivers to change modes. The simulation is run again with the new on and off-roadway demands. The framework can be used to evaluate the impact of a trip planning user service under both baseline, steady-state conditions and non-recurrent conditions such as incidents or unusually heavy demand cases.

A small two-mode test transportation network is employed in the study. The test network is composed of on-roadway and off-roadway network The off-roadway network is competitive for some origin-destination pairs and not competitive for other origin-destination pairs based on the topology of the network Therefore, mode splits vary significantly by time of departure and origin-destination pair.

Three scenarios examine the impact of atypical reductions in roadway capacity. Off-roadway capacity is not reduced. The “Rainstorm” scenario features a network-wide reduction of 25% in roadway capacity. The “Construction” scenario features a predictable, localized reduction in roadway capacity. An “Incident” scenario features an unpredictable, localized reduction in roadway capacity. In each case, the reduction in roadway capacity causes significant and roughly equivalent total delay for roadway travelers in the network

A range of congestion reduction strategies arc examined using the Smart-Shift framework Real-time mode shift is considered under three potential market penetrations (LOW, MED, and HIGH) based on a potential user base representing of 3%, 15%, and 70% of all trips in the network. Route guidance and real-time link capacity increase (corresponding to a reversible lane or shoulder lane) strategies arc also considered.

The results demonstrate that there is significant user and system benefit to real-time mode shifting in the test network At LOW and MED market penetrations, real-time shifts on the order of 0.64% of the traveling population are realized. Real-time shifters experience 1 l-37% travel time savings when compared with non-shifters with the same origins, destinations and trip start times. System travel time is reduced by l-7% in these cases.

At HIGH market penetrations, real-time mode shifters represent 15-21% of all trips in the network. Consequently, system travel time reduction is much higher: 12-218 when compared with the mode split associated with steady-state. User benefits are smaller, however, as the information is more widely distributed. In the rainstorm scenario, the predicted roadway conditions under the assumption of unaltered steady-state mode split are so congested that an over-shift to the transit mode results. In this case, system travel time is reduced, but the real-time shifters experience much worse travel times than their non-shifting counterparts. Anticipatory forecasting is demonstrated to correct for this condition while still maintaining a high level of system benefit.

Real-time mode shift provided comparable system delay reduction to the real-time capacity increase cases. In the rainstorm scenario, the MED market penetration cut system delay 15% while adding a lane to a freeway bottleneck reduced delay 8%. In the incident scenario, real-time mode shift (HIGH market penetration) in conjunction with route guidance is nearly as effective as the addition of a lane at the incident site (53% versus 71% delay reduction, respectively).

The results demonstrate that the Smart-Shift framework can be an effective tool in the evaluation of a trip planning user service. An important implication of the results obtained so far is that the value of pre-trip mode choice information in transportation networks with variable congestion conditions can exceed the value of other congestion mitigation strategies. Mitretek is currently employing Smart-Shift to analyze a larger network based on the Urbansville (Detroit, Michigan) network

7.1.5 Adaptive Signal Control Strategies

This study evaluates adaptive signal control strategies in an urban setting, using the THOREAU traffic simulation model. The Urbansville CBD network represents the Commercial Business District of Detroit, Michigan and the GRID network provides a sample scenario for comparison to INTEGRATION results. The purpose of the study is to identify conditions where ATMS provides a potential benefit over non-adaptive traffic signal systems and to quantify the benefit

Mitretek designed the first Urbansville study with several traffic demand scenarios and several ATMS strategies. The traffic demand scenarios included (1) the base scenario with southbound traffic predominating, (2) a scenario with reduced demand in all directions, (3) a scenario with increased demand in all directions, (4) a scenario with reduced traffic along southbound corridors and increased traffic along other corridors, and (5) a scenario with gradual transition between the first and the fourth scenarios.

A follow-on study expanded the results of the first study by including an additional increased volume level, additional intermediate amounts of change in traffic directionality, and combinations of variation in traffic volume and directionality.

Three ATMS strategies were modeled: (1) isolated signal optimization, determining optimal cycle lengths and phase splits, (2) dynamic corridor optimization, synchronizing signals along selected corridors, and (3) actuated signals, extending green lights based on real-time traffic counts and queue lengths.

The principal measure of effectiveness examined was the average trip time per vehicle. The major results arc summarized as follows:

1. When traffic follows an expected pattern, a set of fixed signal timing plans developed to optimize the flow of traffic given that demand performs well. Under these conditions, the reduction in travel time gained from adaptive traffic signals is less than 10%.

2. When traffic deviates from the predicted levels, either in total volume or in the direction of traffic flow, adaptive traffic signals can respond by changing signal cycle lengths, phase splits, and offsets. Adaptive signals can save 5-50% of the delay time, beyond the gains from a good fixed timing plan. Greater deviations from expectations provide the opportunity for greater benefits.

3. Actuated signals reduced travel times by 3-24% in all Urbansville scenarios but the heavy traffic scenario. Trip time savings ranged from 9-46% in the Grid scenario. Wherever there are gaps in traffic, actuated signals can take advantage of them by extending green lights for the busy approaches. As modeled, actuated signals require multiple presence detectors or cameras to measure queue lengths; when run using vehicle counts only, actuated signals performed poorly.

4. In the heavy traffic and changed direction cases, corridor synchronization can provide a significant benefit over the fixed plan because it can set cycle lengths and offsets dynamically to benefit the corridors with the greatest traffic. Travel times were reduced 5-14% in the Urbansville scenarios and 4-36% in the Grid scenarios. Simple vehicle counting performed as well as queue length detection and trip time reporting when selecting which corridors to synchronize.

5. Results from the THOREAU model closely match the results from the INTEGRATION model for the GRID scenario.

ATMS systems will most likely employ a hierarchical control strategy, mixing local optimization, actuation, and corridor optimization. Such a strategy is currently being implemented in THOREAU in the near future. Therefore, the benefits reported here are conservative and may be improved.

7.2 Conclusions Regarding ITS Benefits

Section 7.2 presents over-arching conclusions regarding travel time benefits of ITS that are supported in two or more of the five modeling studies presented. The impact of system variability and non-recurrent delay with respect to ITS benefit assessment is addressed (sections 7.2.1 and 7.2.2), followed by observations on the value of traveler information (sections 7.2.3 and 7.2.4).

7.2.1 Recurrent and Non-Recurrent Network Conditions

A common element in the experimental design of each study is the differentiation of ITS benefits under recurrent and non-recurrent conditions. For example, in the adaptive signal control study (section 6), a good fixed timing plan is first established for expected demand intensity and directionality. The impact of the adaptive control system is then measured against the good fixed timing baseline under demand conditions that deviate from expectation. Similarly, in the real-time mode shift study (section 5), the baseline for benefits estimation is derived from an established steady-state mode split. The value of roadway congestion information is then measured when roadway congestion conditions deviate from the expected, recurrent conditions. Similar elements may be identified in each of the studies.

Adaptive signal control strategies and traveler information services have positive impacts on system and individual efficiency (reduction in travel time, reduction in system delay) in both the recurrent and non-recurrent cases. The modeling studies, however, emphasize the value of lTS user services in terms of impact on non-recurrent delay rather than on recurrent delay.

This does not imply that the user services modeled arc of marginal value in the recurrent case. In a pre-ITS network, there arc likely inefficiencies in the way travelers assign themselves to the network (both in terms of mode and path choice). Likewise, typical signal timing plans in current signalized networks do not always reflect an up-to-date optimal plan with respect to average experienced demand. Clearly, ITS technologies, particularly automated data collection and network surveillance devices, can provide the data with which to make steady-state or recurrent network conditions more efficient.

One difficulty in establishing ITS benefits is establishing the baseline conditions necessary to make an accurate benefit assessment for ITS. As indicated above, there is a benefit of all the user services in the recurrent case. For a modeling study, however, establishing “pre-ITS” network inefficiencies presents the potential for unbounded inaccuracy in benefit quantification, since the state and magnitude of these “pre-ITS” inefficiencies is poorly known.

By measuring ITS benefits from the baseline of an efficient, optimized “pre-lTS” system, these studies attempt to avoid this trap. The potential ITS benefits identified in these studies are stated with respect to an optimal steady-state solution, providing a more reliable and conservative estimate of those benefits. Real-world benefits compared with dated or non-optimized systems may be higher.

7.2.2 Implications for ITS Benefits in the Non-Recurrent Case

Several key implications may be drawn from the studies with regard to non-recurrent congestion:

- Non-recurrent perturbations to the transportation system and the resultant delays can be significantly reduced by ITS user services such as traveler information and real-time signal control. For example, the adaptive signal control study demonstrates a 2-25% reduction in travel time under perturbations to demand intensity and directionality. Vehicles that bypass incidents in an inter-city corridor network because of low or high functionality route guidance systems can reduce travel delays by 50% or more in some cases.

- The ITS user services examined have higher benefit in terms of travel time and delay reduction when the network experiences a greater deviation from expected conditions. A highly variable system is likely to be a good candidate for these ITS user services. Conversely, a highly predictable system may not be a good candidate for deployment of these services, unless there are significant underlying inefficiencies in steady-state control or assignment. In a highly predictable system, congestion occurs day after day in the same locations with similar magnitudes, so traffic control systems and experienced travelers' plans develop over time taking the anticipated congestion into account.

- The impact of ITS may be most strongly perceived by the traveler not in average delay avoided, but in the reduction of &lay on outlier days, that is, days with significantly higher than expected delay. This also implies a reduction in variability in trip duration and better predictability of travel.

- Under non-recurrent delay, lTS almost always provides travel time benefits to travelers in the network. The greater share of the benefits accrue to travelers subscribing to ITS user services but travelers without also experience travel time reduction. In other words, ITS generally not only does no harm to the aggregate system but often improves it, all while providing significant benefits to ITS user service subscribers.

7.2.3 Value of Traveler Information

Four studies deal specifically with traveler information. In these cases, the travelers attempt to assign themselves efficiently to the network (both in terms of mode and path) in light of the most recent information on network conditions. Several key implications may also be drawn:

- The value of information to the individual user decreases as size of the population receiving that information increases. The value of information to the overall system, however, generally increases as the size of the population receiving that information increases. This effect is seen in the real-time mode shift study, the network surveillance study, and the study comparing route guidance to advisory messages.

- One exception to this proposition, however, occurs when such a large population reacts to the information that the system may actually have worse performance (as in the mode shift study). In these cases, however, predictive forecasting techniques that anticipate traveler behavior can be employed to blunt this effect. The simple techniques employed for anticipatory prediction in the mode shift study indicate the value of such approaches. However, significant work remains to be done in determining both how such approaches might be implemented and the effectiveness of these techniques in a real-world environment.

- The value of traveler information is proportional to the value of the alternative opportunities available. As shown in the congestion study, if access to good alternative routes is restricted by queues of vehicles spilling back, the value of diversion decreases. From the system perspective, if no alternatives exist, then there is no value in reallocating demand. In other words, in the non-recurrent case, there must be some relatively uncongested, alternative path or mode to absorb reallocated demand. A similar condition is encountered in signal control. The optimal allocation of intersection capacity in real-time assumes that there is some underutilized phase of a signal cycle that can be reallocated to another phase.

- When the cost of diversion (or mode shift) is high, then the timeliness of travel time estimation is more critical. The effect of timeliness of information dissemination in an incident case is discussed in detail in section 4.

- The potential benefit of traveler information systems is highly dependent on network topology and conditions. The studies on dynamic route guidance and advisory messages further confirmed that the amount of benefits to be gamed from these services depends greatly on the level of congestion in the network the length of the trip, trip timing, and availability of alternate routes (roughly estimated by the particular origin and destination of a trip). The studies provided insight into the relationships between incidents, congestion, and route guidance benefits, particularly by showing the impact of not being able to access alternative routes without first being delayed in congestion. Under the assumption of a near-term market (e.g., 5% route guided vehicles), the (user optimal) route selection strategy had no adverse affect on unequipped vehicles, and perhaps even slightly helped them.

7.2.4 Impact on Near-Term ATIS User Services

The ATIS studies generally assume that current information on traffic conditions (e.g., link travel times) are known throughout the network Therefore, a surveillance infrastructure (fixed or probe-based) must exist to provide this information. Such extensive and accurate information does not currently exist in any metropolitan or interurban network Perhaps one of the most positive results of these studies for ATIS user services is the relatively small number of unguided probe vehicles (1 %) needed to support adequate network surveillance in the inter-urban incident case. Clearly, without information on network conditions, these user services could not be supported (representing a potential roadblock to ITS development).

The results of the route guidance functionality study and the network surveillance study are positive for near-term ATIS deployment in other ways as well. In most cases, significant benefits can be realized with limited in-vehicle route guidance functionality. Of course, these modeling results are limited to studies of inter-city corridors. It remains unclear if the same results, especially in the area of dynamic route guidance functionality, would be obtained in a generalized urban network.

Another positive result is the preliminary indications of complementary effects between concurrent ITS user services. In the real-time mode shift study, the effect of combining the route guidance and real-time mode shift hints at potential synergies between pre-trip and en-route guidance services. Mitretek plans to explore these complementary effects and potential synergies in future modeling studies.

7.3 Recommendations

Recommendations for addressing key needs in ITS benefits assessment are presented in section 7.3.1. Specific task recommendations for near-term ITS benefits assessment are presented in section 7.3.2.

7.3.1 Assessing Key Needs for ITS Benefits Assessment

One of the major goals of ITS is to provide time savings to travelers. However, since the impact of ITS technologies is only partially understood to date, policy makers at the federal level have initiated a two-part effort to address ITS travel time benefit assessment.

First, there is a need to identify, quantify, and demonstrate ITS benefits in the near term. The near-term effort is the identification of ITS benefits employing current understanding, models, and data. Part of near-term assessment involves empirical measurements from operational tests or other deployments. The five studies presented in this document are also part of the near-term assessment work at Mitretek.

A parallel effort is the development of new models, data and understanding to address ITS benefits that cannot currently be addressed through available tools. A comprehensive review of federally-sponsored traffic modeling projects summarizes the progress of this development program (Glassco, 1995a). Another initiative (Rathi, 1995) surveys potential future approaches for model development.

From the results and implications of the current modeling study, Mitretek has identified three key needs for ITS policy makers considering both near-term assessment effort and the model development effort:

- ***A research effort to develop a better understanding of underlying traveler behavior and traveler perception of ITS benefits.*** As discussed in section 7.2.2, until underlying inefficiencies in traveler network assignment can be identified, the potential impacts of ITS on recurrent congestion cannot be accurately estimated. As presented in section

7.2.3, ITS has the potential for significant impact on non-recurrent congestion. However, there is currently poor understanding of how travelers perceive the value of travel time reduction. For example, little research is available identifying perceived travel time benefit tradeoffs such as a one-tune 30 minute reduction in non-recurrent delay versus 30 days of a l-minute reduction in travel time.

- ***The development of better data and metrics &scribing real-world non-recurrent delay.*** Currently, relatively poor data is available on system travel time variability with respect to average experienced conditions. These data and metrics will be key to identifying potential high-payoff ITS deployments and to improving the utility of modeling efforts (both short-term and in model development).

- ***Tool development for and assessment of integrated ITS user services.*** As expected, there is considerable interaction between ITS user services. As demonstrated in these studies, these interactions may have both positive and negative impacts on benefits. Understanding and quantifying these relationships will be key to guiding high-payoff lTS deployments.

7.3.2 Near-Term Assessment of ITS Benefits

The role of modeling in the overall Mitretek ITS benefits assessment program is presented in section 7.3.2.1. Recommended modeling studies for near-term ITS benefits assessment are presented in section 7.3.2.2.

7.3.2.1 Near-Term ITS Benefit Assessment Activities at Mitretek

The five modeling studies presented in this document are components of an on-going ITS benefits assessment effort at Mitretek (figure 7-l). Modeling activities compose one of three primary benefit assessment work areas for Mitretek. Empirical benefits review and meta-evaluation studies compose the other two work areas.

Mitretek has been active in the collection of real-world, empirical ITS benefits. A review of empirical benefits appears in ***ITS Benefits: Early Results*** (Roberts and Shank, 1995), assembling measured benefits resulting from ITS deployments. Key parameters and assumptions from those real world deployments have been employed within the modeling studies. For example, data from the INFORMS operational test was used to estimate responding population size for the ATIS functionality study.

Mitretek is also conducting quantitative studies of ITS benefits using statistical analysis rather than simulation. These meta-evaluation studies (Evanco, 1996) examine the safety impacts of improved incident detection, rural may&y, and automated commercial vehicle inspection.

Within the modeling studies work area, evaluations are organized by user service but are components of an integrated ITS benefits modeling effort. The five studies reported in this document are a subset of the overall on-going effort The recommended modeling studies presented in section 7.3.2.2 are also included in figure 7-l.

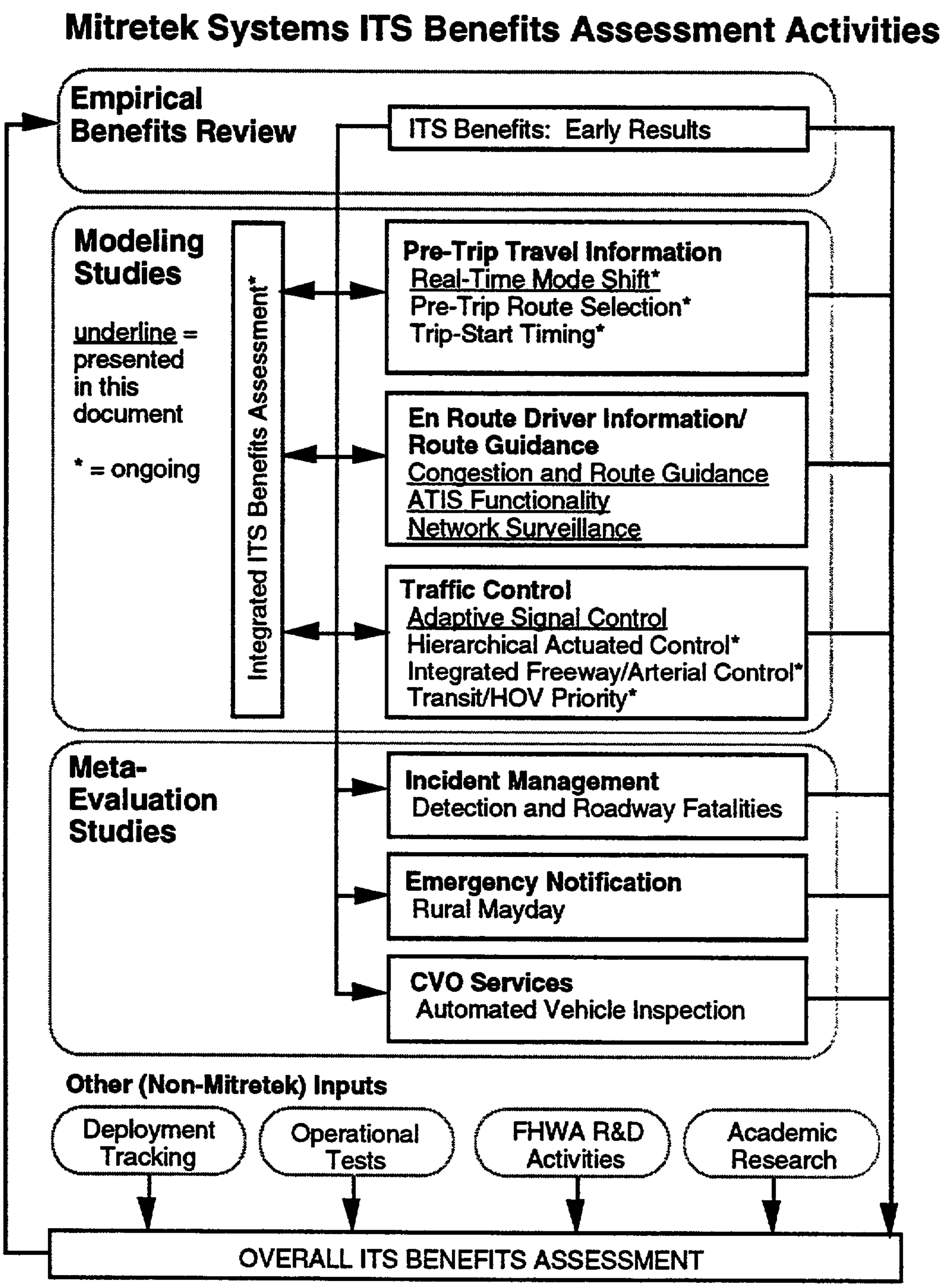

Figure 7-1. Mitretek ITS Benefits Assessment Effort

7.3.2.2 Recommended Near-Term Modeling Studies

The recommended near-term modeling studies address important aspects of integrated ITS user services, either within a user service or across multiple user services. They represent the highest potential payoff studies that can be mounted within the near-term tune frame, and involve only modest extensions of current capability.

- **Pre-Trip Travel Information: :** The real-time mode shift study using the Smart-Shift evaluation framework presented in section 5 of this document is the first study in this area The study indicates that there may be significant benefit in multi-modal information services. The evaluation methodology should be employed on other realistic, large-scale networks such as Urbansville. Smart-Shift should also be augmented to add pre-nip route selection and trip-start timing to the current capabilities for pre-trip mode shifting. The framework could then be used to investigate potential conflicts or synergies among these three aspects of a pre-trip planning user service.

- **Traffic Control:** An aspect of this user service, adaptive signal control, is addressed in section 6. The results of this study indicate that optimization routines employing corridor optimization or advanced actuated control arc effective in reducing non-recurrent delay. Hierarchical control systems combining components of both corridor optimization and advanced actuation may have significant merits. These potential benefits should be explored with some additional simulation-based research, including coordination with the RT-TRACS evaluation work sponsored by the Turner-Fairbank Highway Research Center.

- **Integrated Traffic Control:** Integrated freeway/arterial control represents another area for near-term modeling evaluation. Mitretek is currently evaluating this aspect of traffic control in conjunction with MVA and Associates, examining potential synergies or conflicts between freeway ramp metering and adaptive arterial control. The study has a related component exploring the impact of providing transit or HOV priority within the integrated freeway/arterial environment.

- **Integrated ITS Benefits Assessment:** Employing the Smart-Shift framework (section 6) in an incident test case, the effects of real-time mode shift and route guidance user services am demonstrated to be complimentary in reducing system delay. The case assumed a 20% market penetration for route guidance and a mutually exclusive population of real-time mode shift subscribers representing 70% of the traveling population. With the two user services reaching a combined 90% of the travelers, non-recurrent delay arising from an incident was cut by roughly 50%. This is a significant and encouraging result. However, currently there is little research on quantifying benefits or identifying conditions where ITS user services have complimentary effect. Integrated ATIS user services (both pre-trip and en route) and integrated ATIS and traffic control should be incorporated into the Smart-Shift evaluation framework. This framework could then be employed in a near-term assessment of integrated user services.