Results of “innovate” scenario travel modeling

Introduction and purpose

The *GO TO 2040* plan, due to be complete in 2010, will make recommendations for policies, strategies, and investments in transportation and other fields. This document is part of a series that begins to examine potential plan recommendations by testing the effectiveness of “sample programs” of systematic improvements of different types.

In this case, a sample program for transportation investments was developed that is consistent with the general theme of the innovate scenario, which includes the use of new technologies and policy ideas. Each of the alternative regional planning scenarios subscribes to a different balance of capital and non-capital investment; this scenario includes both capital and non-capital investment in the area of technological improvements.

Before reviewing the remainder of this document, please read the following notes, which explain its purpose and limitations:

- Implementation: This document does not address the responsibility for implementing the sample program described here. This is very important consideration and will be addressed as a next step.
- Scenario context: Infrastructure investments will not be pursued in the absence of other strategies. CMAP recognizes that the benefits of the strategy are magnified when linked with other compatible policies. As a later step, the transportation infrastructure investments will be analyzed along with other strategies such as green building design; but for this series of documents, CMAP is attempting to isolate and examine the benefits of individual strategies.
- Specificity: The results of the analysis are not accurate at the individual facility level and further geographic detail beyond what is shown in this document cannot be given.
- Assumptions: To perform the analysis of the sample program described here, assumptions were made for appropriate locations for improvements and their effects. The purpose of the document is to allow these assumptions to be discussed and questioned.

The purpose of the analysis and modeling exercise is to determine, on a regional scale, where and to what degree systematic transportation improvements could be applied, how much such a program would cost, and how it will impact key indicators.

Key assumptions

Any regional analysis and modeling process involves making assumptions. The fundamental assumptions for the systematic transportation infrastructure investments associated with the innovate scenario involve the following:

- The definition and benefits of ITS and other relevant strategies;
- The method for determining locations for improvements to be made; and
- The transportation impacts and fiscal impacts of implementing the strategies.

The assumptions within each of these stages of analysis will be fleshed out in greater detail below.

The definition and benefits of ITS, pricing, and other innovative strategies

The strategies described in this document include:

Pricing

- Variable pricing on expressways (1)
- Variable pricing for parking (2)

Arterial operations

- Advanced arterial signal systems (3)

Advanced transit

- Transit signal priority (4)
- Arterial rapid transit (5)
- Traveler information services (6)

Other innovative policies

- Use of roundabouts and other innovative intersection treatments (7)
- Application of context sensitive solutions (8)
- Advanced vehicle technology (9)
- Alternative fuels (10)
- Pedestrian improvements as part of new development (11)

1. Variable pricing on expressways

Variable expressway pricing is one type of "managed lane" strategy; a paper describing managed lanes strategies is online at: http://www.goto2040.org/managedlanes.aspx. Implementation of the variable expressway pricing strategy requires that a number of lanes are set aside within an expressway, and tolls are charged at the level required to achieve a pre-defined performance objective, such as keeping traffic flowing at no less than a certain speed at all times. Pricing is actively adjusted as needed to achieve this objective.

Variable pricing is one way to maintain the capacity of a highway facility under variety of future scenarios. While implementers attempt to develop an expressway system that provides a network of relatively uncongested highway facilities into the future, we accept that the region will have growth and change that isn't foreseen. Congestion will occur on our highway system even when prior planning attempted to take into account all likely future conditions. Thus, highway facilities should be flexible enough to function under a variety of future scenarios. The ability to manage the use and operations of a facility assures that the facility can operate closer to its optimum usage over the life of the facility.

Pricing strategies may consider a number of aspects of demand to determine prices. Congestion pricing varies fees according to congestion and allocates capacity through a traveler's willingness to pay. Prices are usually set so that speeds do not approach congested levels. Variable pricing may also implement different pricing for different types of vehicles. For example, fees may encourage or discourage managed lane use by trucks during different periods of the day, or charge lower prices for high occupancy vehicles to encourage ride sharing. Variable pricing can be a simple differential between peak vs. offpeak tolls, or a complicate system of collecting real time data and adjusting tolls in a real time fashion.

Required investment

Variable priced lanes require substantial investment over and above a basic facility. This investment includes the cost of an enhanced facility, technology, and personnel. A larger, better-funded cadre of transportation operations personnel would be required. In addition, additional enforcement personnel would be required to enforce rules governing managed lanes.

Variable pricing can also generate revenue, unlike most transportation strategies. Research on the financial implications of variable pricing is still underway.

Supporting technologies

Managed lane strategies depend heavily on the successful application of several technologies which may include combinations of the following:

- Field Devices (Traffic sensors)
- Traffic Operations Centers
- Variable Message Signage (VMS)
- Overhead Lane Usage Signal Systems
- Closed Circuit TV (CCTV) Monitoring
- Electronic Toll Collection
- Lane Separation Systems: Fixed and Movable Barriers
- Enforcement – Video Assisted or Automated Ticketing
- Traveler Information for Pre-Trip Planning

Today, the region does enjoy a number of priced facilities known as tollways. The Illinois Tollway has installed electronic toll collection equipment for open road tolling, as well as toll differentials between trucks and automobiles. The tollway has a fairly complete system of lane traffic monitoring devices.

Expected outcomes

The most direct outcome expected from implementing variable pricing on the region's expressway is a reduction in expressway congestion and an increase in toll revenue. The biggest impact will be achieved if the pricing strategy is applied to facilities which are not tolled today. Additional revenue can be used to support supplemental public transportation providing drivers alternatives to using the expressway. It may also be used for improvements on parallel roadways which may be subject to increased traffic from drivers avoiding the priced facility. An interesting note is that pricing can be set to maximize the service level of the expressway or to maximize toll revenue, and these two price points are not the same.

By enabling higher travel speeds and reducing idling caused by congested conditions, managed lanes can reduce fuel consumption. If rideshare and transit services and facilities develop in conjunction or as a result of variable pricing strategies, there is potential for even further reductions in fuel consumption. By reducing travel delay along major thoroughfares, managed lane strategies can also reduce emission levels of volatile organic compounds (VOC)s and carbon monoxide. This improves air quality, with beneficial impacts on public and environmental health as well as stormwater quality. Reducing expressway congestion also reduces the likelihood and severity of crashes.

Additionally, there may be air quality benefits imparted through reduction of delay and associated vehicle idling; traditionally, low-income communities have suffered disproportionately high rates of asthma that some attribute to proximity to congested highway facilities.

Congestion pricing applications may be perceived as having an adverse affect on low-income people's ability to access expressway facilities. They may also force higher volumes of and/or heavy vehicle traffic onto densely settled arterial corridors. Yet low income people have also recognized the benefits managed lanes offer to mainline expressway systems, in terms of improved flow and travel speed. According to SANDAG, 80% of low-income drivers (below $40,000 annual income) approve of the application of HOT lanes to congested corridors.

<u>Application within the transportation model</u>

Within the transportation model, congestion pricing increased the cost of travel on congested expressways during their times of high congestion. This made travelers more likely to use alternative routes or change their mode of transportation.

2. *Variable pricing for parking*

Similar to variable pricing for expressways, variably priced parking is implemented to encourage or discourage travel behaviors. Variable pricing systems can be implemented in on-street parking, in public, and in private off-street lots. Unlike expressway pricing, whose main goal is to reduce congestion, variable parking pricing has a wider variety of goals, such as to reduce street congestion, to reduce parking lot congestion, to increase parking turnover, maximize revenue, or to favor priority users.

When we think of variable parking pricing, we typically think of CBD parking with the familiar early bird specials, monthly parking passes or parking meters. We don't often consider suburban areas where parking is rarely priced at all or free on-street parking. Implementation of a regional variable parking pricing program would require public and private decision makers to determine the charging structure and technology appropriate for the local circumstances. Where parking is priced, the methods in the following table are commonly used.

Summary of Parking Pricing Methods

Type	Description	Equipment Costs	Operating Costs	User Convenience	Price Adjustability
Pass	Parkers purchase and display a pass. Common for leased parking.	Very low	Medium	Medium	Poor to medium.
Single-Space Meters	Parkers prepay a mechanical or electronic meter located at each space.	High	High	Low to medium.	Mechanical meters: poor; electronic meters: good.
Pay Box	Parkers prepay into a box with a slot for each space.	Low	Medium	Low	Poor to medium.
Pay-And-Display Meters	Parkers prepay a meter, which prints a ticket that is displayed in their vehicle window.	Medium	Medium	Medium	Mechanical meters: poor; electronic meters: good.
Electronic Pay-Per-Space	Parkers prepay an electronic meter.	Medium	Medium	Medium	Very good.
In-Vehicle Meter	Parkers prepay to use a small electronic meter displayed in the vehicle when it is parked, that counts down minutes.	Medium	Low	High	Moderate
Attendant	Parkers pay an attendant when entering or leaving a parking space.	High	High	High	Good
Automated Controlled Access System	Parkers pay a machine when entering or leaving a parking space.	High	Moderate	Moderate	Good
Valet	Parkers pay an attendant who parks their car.	Low	High	High	Good
Automatic Vehicle Identification	System automatically records vehicles entering and leaving a parking area and can bill for use.	High	Medium	High	Good

This table summarizes various methods that can be used to collect parking fees. Source: Victoria Transport Policy Institute, July 2008 (http://www.vtpi.org/tdm/tdm26.htm)

Required investment

For the most efficient and convenient application of variably priced parking, investment over and above a basic facility may be required. This investment includes the cost of an enhanced facility, technology, and personnel.

Additional revenue will be collected where free parking is converted to priced parking. The amount of additional revenue will depend on the geographic extent and severity of parking fees. For parking capacity currently in the hands of public agencies, this revenue can be used to supplement alternative forms of transportation. For parking capacity in the hands of private industry, this will be another company profit stream. If the parking pricing is only implemented for public parking locations, the private parking market will likely determine that their own fees can be raised while maintaining a competitive position. Depending on the fee structure and reaction of drivers, the revenue impact on parking that is already priced is unknown. Work on the financial implications of this strategy is still underway.

Supporting technologies

Implementation of variably priced parking can use components of an advanced parking management system. Several technologies from the following list may be combined to support such a program:

- Field devices (sensors to track parking use and/or vehicles, display systems for drivers)
- Integration and operating software
- Electronic payment systems
- Power supplies for new equipment
- Communications infrastructure
- Methods to provide drivers with trip planning or reservation capabilities

Expected outcomes

The direct result of implementing variable parking pricing is to cause drivers to choose transit over driving, to drive at another time during the day, to choose a trip destination that is lower priced, or to not make the trip at all. All of these will change traffic patterns to between the trip origin and trip destination. Traffic volumes should shift, and transit ridership should increase. This should result in less congestion and decreased auto pollutant emissions.

Additional impacts can also be expected from such a policy. With active management of all parking, it is possible that the required number of parking spaces may decrease, reducing the amount of land dedicated to parking purposes. This land could be developed into other higher uses or left as increased green areas.

If parking information is provided to drivers, traffic can be reduced because cars are not circling areas looking for parking. In addition, there may be safety impacts as congestion is reduced in areas where variable parking pricing policies are implemented.

Application within the transportation model

Within the transportation model, variable pricing for parking was addressed by increasing the “fixed cost” of arriving at one’s destination by auto. The amount of increase varied, with the greatest increase being applied at the most congested times of day. (Costs are divided into two types: variable costs, which increase with distance, and fixed costs, which do not. For most trips, variable costs significantly exceed fixed costs.)

3. Advanced arterial signal systems

Advanced arterial signal systems are a technological approach to improving arterial operations, providing a way to add more “capacity” through system management rather than by adding lanes. Advanced signal systems coordinate signals along a corridor or within a large area to reduce travel delay. According to the National Transportation Operations Coalition (NTOC) studies have shown that the benefits of investing in signal timing outweigh the costs by 40:1. It is also estimated that poor traffic signal timing accounts for 5 to 10 percent of all traffic delay. (National Traffic Signal Report Card: http://www.ite.org/reportcard/)

Advanced traffic signal systems provide an adaptable system that detects and responds to traffic conditions, and may include a predictive capability, through the ability of signal systems to detect emerging traffic patterns, predict how they will develop over time, and preemptively make changes to signal operations in response. With the advent of vehicle infrastructure integration, advanced traffic signals will not only communicate with each other and with a traffic operations center, communications may take place between vehicles and traffic signals. For example, red light running crashes may be prevented by communicating to the approaching car that the light has changed, or by signaling a car entering the intersection that another car is about to run the red light. The capability of interacting with vehicles also allows transit and emergency vehicles to affect the operation of signals, allowing them to travel more efficiently over the roadways.

Advanced traffic signals systems are also capable of monitoring themselves, identifying malfunctioning equipment and notifying operators so malfunctions can be corrected quickly. Such systems are also easier to upgrade, maintain, and expand.

Required investment

While often referred to as a “low-capital” investment, a large investment must be made to implement this system. This size of the investment results from the cost of the infrastructure combined with the size of the network it must be applied to.

Supporting technologies

Implementation of regionwide advanced traffic signal systems requires a significant investment in:

- Field devices (signals, traffic surveillance)
- Communications infrastructure

- Integration and operating software
- Uninterruptable power supplies
- Operations centers to house staff and software
- Communications capabilities with the traveling public and other agencies

Expected benefits

Advanced traffic signal control systems have demonstrated benefits in several areas, including reduced congestion, reduced energy consumption, improved safety because of smoother traffic flow. According to the USDOT, traffic signal control systems:

• Decrease travel time by 8% - 25%, • Increase travel speed by 14% - 22%, • Reduce vehicle stops up to 41% • Decrease vehicle delay by 17% - 44%	• Decreased fuel used by 6% - 13% • Decreased HC emissions by 4% - 10% • Decreased CO emissions by 5% - 15%

Source: Developing Traffic Signal Control Systems Using the National ITS Architecture (ITS Joint Program Office U. S. Department of Transportation, February 1998)

As traffic is smoothed and stops are reduced, fuel consumption should decrease resulting in decreased pollution emissions. When unusual activities take place, such as sporting events or cultural events, traffic signals can respond to the new traffic conditions.

The ability of transit vehicles to keep to schedules should be improved. Emergency vehicles may have reduced response times.

Crash rates should decline. When crashes do occur, monitoring of traffic flows provides a way to detect incidents more quickly, so clearance times for incidents can be reduced. A large part of daily roadway congestion is caused by incidents.

Application within the transportation model

Within the transportation model, advanced signal control systems were assumed to be implemented in places with the highest degree of congestion. Capacity was added to the roadway system in these areas to simulate the effect of more efficient intersection performance caused by advanced traffic signal control. Capacity was added in relative proportion to the degree of congestion in these areas.

4. *Transit signal priority*

Transit Signal Priority (TSP) is a technology implemented to allow transit vehicles to pass through signal controlled intersections without delay, resulting in faster service and improved schedule adherence. As the name suggests, this technology relies on traffic signals for implementation. The TSP system is composed of four parts: 1) the transit vehicle-based request generator which signals a request for priority, 2) the signal-based detector that lets the signal system identify the location of the vehicle requesting priority, 3) software that evaluates the request and responds using various pre-determined strategies, and 4) software that keeps records, manages the system and generates reports. The result is that the traffic signal adjusts the cycle to provide a little more green to allow the bus to pass through without stopping, or shortens the red time as a bus approaches so the light turns green in time for the bus to pass through. The adjustment can be made to left or right turn lights, as well, and is handled in such a way as to minimize impacts on the other traffic using the intersection. The goal of TSP is to reduce the travel time impacts for transit vehicles moving through intersections.

Examples of measured benefits:

> *"In Tacoma, Washington the combination of TSP and signal optimization reduced transit signal delay about 40% in two corridors.*
>
> *TriMet (Portland, Oregon) was able to avoid adding one more bus by using TSP and experienced a 10% improvement in travel time and up to a 19% reduction in travel time variability.*
>
> *Due to increased reliability, TriMet has been able to reduce scheduled recovery time.*
>
> *In Chicago, PACE buses realized an average of 15% reduction (three minutes) in running time. Actual running time reductions varied from 7% to 20% depending on the time of day.*
>
> *With the implementation of TSP and through more efficient run cutting, Pace (Chicago) was able to realize a savings of one weekday bus while maintaining the same frequency of service.*
>
> *Los Angeles experienced up to 25% reduction in bus travel times with TSP."*

Source: Transit Signal Priority (TSP): A Planning and Implementation Handbook (Smith, Hemily, Ivanovic, May 2005)
http://www.itsa.org/itsa/files/pdf/TSPHandbook2005.pdf

<u>Required investment</u>

A modern, systemwide application of advanced transit signal priority requires a large investment in equipment. All vehicles and traffic signals must be appropriately equipped.

<u>Supporting technologies</u>

Implementation of regionwide transit signal priority requires a significant investment in:

- Field devices (signals, traffic surveillance through vehicle detectors and cameras)
- Communications infrastructure (on-board and vehicle based)
- Integration and operating software
- Operations centers to house staff and software
- Communications capabilities with the traveling public and other agencies

Expected benefits

Implementation of this strategy will reduce bus delay, improve scheduled adherence and decrease route travel time. This will also reduce trip planning time for transit users, because travel time variability is reduced.

TSP may also reduce vehicle requirements without reducing service frequency. This will save money by reducing the number of vehicles the transit agency needs to purchase and maintain, as well as the number of drivers needed to provide the service. Reducing stopping and starting will also lower fuel consumption, reducing emissions and costs.

Application within the transportation model

Within the transportation model, the speed of transit service on routes where TSP was assumed to be implemented was increased to be more competitive with the speed of automobiles. The initial identification of these routes was from modeling done for the 2030 RTP; these routes can be updated with new information from Pace and CTA.

The TSP strategy was assumed to be added "on top" of the advanced arterial signal systems strategy described above.

5. Arterial rapid transit

Arterial Rapid Transit (ART) does not refer to a single technology; it refers to a package of improvements used to improve a bus route. The package is generally assumed to include some dedicated right of way, transit signal priority, increased stop spacing, special bus stops and special branding to identify the route. Pre-boarding fare collection and level boardings to speed passenger loading can also be used. Intelligent transportation technology such as automatic vehicle location, scheduling and dispatch, and real time traveler information at stops, on vehicles and to personal devices is also commonly in use. ART service can be implemented on a route by route basis, with only one route being developed or a whole system of routes.

Transit signal priority can be implemented on any bus route without providing ART service, but most ART services require transit signal priority. Providing transit signal priority for ART eliminates travel time impacts of moving through intersections, but ART has the additional benefit of eliminating delay caused by traffic congestion interfering with bus movements between intersections, and delay caused by passenger loading. The enhancements result in bus travel that may be faster than auto travel, and is also more reliable.

There is a fine line between ART, as described above, and Bus Rapid Transit (BRT). For the purposes of this analysis, the following distinction has been made. BRT is defined as a service that uses a dedicated lane on an expressway for at least part of its route. As this requires major capital investment, a service that includes this characteristic is defined as a major capital project and treated outside of the scenario process, which is designed to address systematic transportation improvements.

Required investment

- Dedicated right of way, either dedicated lanes on a roadway or a separate facility.
- Stations, with platforms and platform access
- Special vehicles, branded and technologically equipped
- Parking

Supporting technologies

Implementation of region wide ART systems requires a significant investment in:

- Field devices (signals, automatic vehicle location equipment, security cameras)
- Fare collection
- Communications infrastructure (on-board, at traffic signals, at stations)
- Driver assist and automation technology (lane keeping, docking)
- Operations centers to house staff and software
- Passenger information

Expected benefits

Implementation of this technology will result in schedule adherence and reduced travel time. Bus ridership will increase, reducing auto traffic and pollution emissions.

Application within the transportation model

Within the transportation model, ART services are addressed in a number of ways. As described in the TSP strategy above, the speeds of transit vehicles are increased to simulate their favorable treatment at intersections; this happens to a larger degree with ART services than with TSP applications alone. To reflect improved station facilities and the use of fare prepayment, wait times are also reduced. Together, these improvements make the use of transit more attractive in these corridors and will attract more riders than conventional bus service.

6. Transit traveler information services

Traveler information services refer to a number of ways public transit agencies have developed to provide information to passengers. These methods are commonly internet based, telephone services, kiosks, and message signs at stations and in vehicles, Having travel information easily available makes transit travel more convenient for everyone and provides extra comfort to occasional travelers who may feel nervous about using public transportation.

Travelers can use trip information before they travel, for trip planning purposes. For example, potential passengers can access a website or telephone to find the best routes to take to arrive at the desired destination, or to find out when the next arrival time is for a vehicle. On-board the vehicle, information updates can be provided about unexpected delays or estimated arrival time of connecting route vehicles.

The region already enjoys a telephone based trip planning service provided by RTA, as well as an official RTA online trip planner, supplemented by Google based travel information for CTA and Metra. The service boards currently have ways for passengers to sign up to receive service bulletins.

Supporting technologies

Implementation of transit traveler information requires:

- Field devices (automatic vehicle location equipment to track vehicles, transit stop based and vehicle based variable message signs, kiosks, personal communication devices, auto based in-vehicle services)
- Communications infrastructure (wireless messaging capabilities, communications with remote devices)
- Operations centers to house staff and software
- Websites

Application within the transportation model

The use of traveler information services for transit was addressed within the transportation model by decreasing the wait times for transit passengers. This reflects the lower wait times that are expected to result from passengers having accurate real-time information about vehicle arrivals.

It should be noted that this point that traveler information services for highway users is also an important strategy, but cannot be addressed very effectively within the transportation model. Real-time information for highway users is most effective at communicating incidents or unusual conditions that cause unpredictable congestion. The transportation model does not address congestion caused by incidents, so this strategy has limited impact within the modeling environment. This does not mean that it is an unimportant strategy; it means that the analytical tools that we have available do not effectively capture its benefits.

7. Use of roundabouts and other innovative intersection treatments

Roundabouts are a circular form of intersections that convert all movements to right turns. No stop signs are installed, and drivers approaching the roundabout must yield to traffic already in the roundabout. A paper on the design and benefits roundabouts is available online at: http://www.goto2040.org/WorkArea/DownloadAsset.aspx?id=13320

The use of roundabouts was approximated in the travel demand model by reducing congestion at intersections that were considered candidates for the installation of roundabouts. This determination was made based on the number of vehicles passing through the intersection.

8. Application of context sensitive solutions

Context sensitivity is a simple idea – taking the surroundings into consideration when making planning or infrastructure decisions. This represents a shift over traditional approaches which were all about "function" to an approach that balances the focused project purpose with community values and assets. Successful context sensitive processes both facilitate citizen participation throughout the process and allow greater design flexibility in the final product. A paper on context sensitivity is online at: http://www.goto2040.org/contextsensitivity.aspx.

Context sensitivity was not addressed within the travel model, as it provides primarily non-transportation benefits.

9. Advanced vehicle technology

Advanced vehicle technology is applied to both cars and trucks and provides a way for the vehicles we drive to help compensate for human shortcomings in physical capabilities and behaviors. Advanced vehicle technology also provides a way for our vehicles to track their own mechanical condition and notify us when maintenance is needed.

Advanced vehicle technology has a number of safety applications. Technology is available to provide intersection collision warning, obstacle detection, lane departure warning, rollover warning, road departure warning, forward collision warning, and rear impact warning. If desired, the capability to detect these adverse conditions can be further supplemented with automated vehicle responses. Properly functioning technology can detect conditions and react to them much faster than a human is capable of. If a collision does occur, collision notification technology can notify emergency responders immediately so the vehicle occupants receive speedy medical care and the wreckage can be cleared quickly. This service is already in use on some models of cars.

Advanced vehicle technology can also provide ways to make our driving easier, through driver assistance technologies. Navigation assistance is already a very commonly used technology, and parking assistance is available on a small number of models. Other services are not commonly in use yet, but technology is available to accomplish them. For example, vision enhancement technologies allow the driver to see better in the dark or in bad weather. Adaptive cruise control senses the forward vehicle and follows at a set distance and speed. Intelligent speed control receives information from equipped roadway infrastructure and maintains an appropriate speed for the facility. Lane change assistance senses surrounding vehicles and ensures collision free lane changes. Lane keeping technology can sense driving lanes and keep the car aligned. Lane keeping technology has been tested on commercial vehicles with proven success in reducing accidents and associated costs. Drowsy driver warning can monitor the driver for signs of falling asleep. Precision docking has been tested on public transit and commercial vehicles, and provides a way to automatically park a vehicle close to and at a desired angle with a docking area, be it a warehouse dock or a bus stop.

Finally, vehicle diagnostics monitor various vehicle systems for malfunction and communicate when repairs or adjustments are needed.

While the vehicle side investment is the responsibility of private industry, public investment is also required to complete the system.

Supporting technologies:

Regional implementation of advanced vehicle technology would require public investment in the following supporting technologies:

- Field devices (properly equipped traffic signals and other roadside equipment)
- Communication infrastructure (wired and wireless)

Private investment in supporting technologies is particularly important for the application of advanced vehicle technology, and could include:

- Vehicle on-board communication technology
- Vehicle-based sensors
- Vehicle-based software
- Operations centers to house staff and software

Expected benefits

This technology is expected to greatly reduce traffic incidents, which cause a large percent of daily roadway traffic congestion. This will also greatly reduce the costs in injury and property damage attributable to traffic accidents. The technology listed has the ability to address most of the major causes of traffic accidents.

In addition, the lane keeping, adaptive speed control, and anti collision technology will allow vehicles to safely drive closer together at higher speeds than is currently possible. This will increase roadway capacity without investing in additional lanes.

Decreased traffic congestion and smoother traffic will decrease the need for roadway expansion and reduce fuel consumption.

Application within the transportation model

The treatment of advanced vehicle technology within the transportation model is highly speculative. It was assumed that congestion would be decreased, as vehicles could safely operate at higher speeds or in closer proximity to each other; therefore congestion was reduced regionwide to account for this strategy.

10. Alternative fuels

Advanced fuels provide a way to maintain personal mobility while reducing the harmful effects of fossil fuel combustion. Some potential fuels have been tested or are currently available, including biodiesel, propane, natural gas, methanol, hydrogen, ethanol, electricity and compressed air. A report on alternative fuels is available online at: http://www.goto2040.org/WorkArea/DownloadAsset.aspx?id=15321

Definition and analysis of context sensitivity within a scenario context is still underway. It is expected that the use of alternative fuels will be applied to air quality and greenhouse gas emission calculations and will not greatly affect other transportation system characteristics.

11. Pedestrian improvements as part of new development

The treatment of pedestrian travel within the transportation model has already been described in detail in the modeling assumptions for the "preserve" scenario (http://www.goto2040.org/preserve_transportation.aspx) and will not be repeated here.

This scenario assumes that growth and land use change provides an opportunity to increase the pedestrian environment factor (PEF) through design that incorporates the needs of pedestrians and bicyclists. PEF was assumed to increase proportionally to new growth occurring in each area. This is assumed to be accomplished primarily through sidewalk construction and intersection improvements, including retiming for pedestrian access and physical redesign.

Results

The series of improvements made in the innovate scenario had substantial impacts on the operation of the regional transportation system. These results are described below.

Vehicle miles traveled and vehicle hours traveled (total and in congestion)

When compared to the reference scenario, the elements of the innovate scenario led to minimal change in total vehicle miles traveled (VMT) and vehicle hours traveled (VHT). However, VMT and VHT in congestion were reduced with substantial reductions to congested VMT in particular.

These improvements were overwhelmed by the overall increase in tripmaking that is expected to occur by 2040 due to forecast population and employment growth. Although VMT in congestion and VHT in congestion showed improvements from the reference scenario, they still increased by 25% and 37%, respectively, over current conditions. This indicates that other means are needed beyond the technology and pricing elements in this scenario to address our region's congestion.

To provide more detail on the effect of transportation system performance on freight movements, truck traffic is reported separately. The strategies in the innovate scenario are somewhat more effective at improving travel conditions for trucks than they are for passenger vehicles. Congestion VMT and VHT for trucks both declined substantially from the reference, but still exceeded current figures.

Vehicle miles traveled (VMT) and vehicle hours traveled (VHT)

Measure	Current	2040 reference	2040 innovate	Difference, innovate minus reference	Difference, innovate minus current
Total VMT	173,543,681	199,842,335	201,377,660	1,535,325 1%	27,833,979 16%
VMT in congestion	31,894,121	47,760,613	39,998,787	-7,761,826 -16%	8,104,666 25%
Total VHT	7,211,823	8,758,414	8,651,780	-106,634 -1%	1,439,957 20%
VHT in congestion	2,583,120	3,710,978	3,547,427	-163,551 -4%	964,307 37%
Truck VMT	31,689,032	39,605,484	39,632,354	26,870 0%	7,943,322 25%
Truck VMT in congestion	5,575,160	9,670,255	6,926,617	-2,743,638 -28%	1,351,457 24%
Truck VHT	1,168,719	1,573,918	1,526,479	-47,439 -3%	357,760 31%
Truck VHT in congestion	384,333	645,544	567,149	-78,395 -12%	182,816 48%

Mode share

The innovate scenario resulted in considerable increases in transit ridership, a small increase in non-motorized trips, and a small decrease in auto trips. When compared to current tripmaking, all modes increased; transit trips increased by the highest amount, 60%. Transit mode share increased from 10% in the reference scenario (as well as currently) to over 12% in the innovate scenario. Please note that these figures include all trips, not just work trips, and the total amount of trips made between the innovate and reference scenarios are approximately equal.

Trips by mode

Measure	Current	2040 reference	2040 innovate	Difference, innovate minus reference	Difference, innovate minus current
Auto trips	23,519,460	28,377,431	27,584,846	-792,585 -3%	4,065,386 17%
Transit trips	2,400,810	3,069,106	3,852,994	783,888 26%	1,452,184 60%
Non-motorized trips	355,706	492,444	507,266	14,822 3%	151,560 43%

Trip duration

The duration of trips fell between the reference and the innovate scenarios for transit trips, but increased for auto trips. This was caused primarily by the more dispersed land use pattern in the innovate scenario compared to the others, as well as increases in highway efficiency; this generally led to trips of greater distances. Please note that this figure includes all trips; work trips are generally longer in duration than others.

Trip duration (average minutes of travel)

Measure	Current	2040 reference	2040 innovate	Difference, innovate minus reference	Difference, innovate minus current
Auto trips	21.7	22.1	24.3	+2.2 +10%	+2.6 +12%
Transit trips	35.2	37.5	34.1	-3.5 -9%	-1.1 -3%

Additional analysis

Analysis of additional measures is available in the scenario pages of the *GO TO 2040* website, www.goto2040.org.