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Innovative Mobility Services & Technologies: A Pathway Towards Transit Flexibility, Convenience, and Choice

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ABSTRACT

The number of senior citizens is expected to double by the year 2020, representing 18% of the nation's population. After age 75, driving performance begins to decline due to changes in health and medication effects. Indeed, one quarter of seniors over 75 are expected to require alternative transportation services in the future. This chapter examines transit and innovative mobility options to better meet the needs of the growing older population in the near (2011) and more distant (2021) future.

Barriers to transit use among older adults include anxiety and confusion about using transit; inconvenience; cost and payment; safety; and physical discomfort. Emerging intelligent transportation systems (ITS) technologies can help to overcome these barriers and provide alternative mobility options, such as real-time information, simpler payment, demand-responsive door-to-door services, carsharing, and smart parking linked to transit. Other approaches include user training, smaller and more comfortable vehicles, and low-floor buses. While the scaling and cost reduction benefits of ITS are exciting, there are several obstacles to wide-scale deployment. One of the most significant is coordination among health and human service and transportation providers, particularly in suburban and rural locations. Some operators already struggle to provide services, and many staffers have limited experience with ITS technology. Thus, a

concerted effort is needed across many different types of transit agencies to share information and compatible technologies. In the future, coordination strategies and ITS technologies will play a critical role in providing more flexibility, convenience, and choice for older travelers.

INTRODUCTION

At present, there are nearly 35 million senior citizens, and this population is expected to more than double by the year 2020, when it will comprise 18% of the nation's population (*1*). By 2020, there will be more than 30 million bBaby bBoomers over the age of 65, many of whom will require alternative options for getting around because they no longer drive, or do not wish to drive. This next generation of older travelers will most likely live in the suburbs (52%) rather than in urban (27%) or rural (21%) areas (*2*). Many destinations are less accessible by transit in suburban and rural areas than urban ones because of differences in land use and density. Despite better transit access in urban areas, seniors currently travel most frequently by car (74% in urban areas and 91% in suburbs) and much less often by transit (8% in urban areas and less than 1% in the suburbs) (*3*).

As they age, adults begin to experience difficulty driving and yet their need for mobility, both for self-sufficiency and for good health, stays strong. In response, older travelers might be expected to turn to transit. However, many cannot because transit services are not available in their neighborhoods (*4*). Even where public transportation is readily available, seniors tend not to use it. At present, only 7.4% of public transportation users are 65 years of age or older (*5*). Those who do take transit often live by themselves and have health issues that affect their ability to drive a car or ride a bus. Instead of using public transportation, they are more likely to use taxis, specialized transit services, such as door-to-door paratransit, or ride as

passengers in cars with friends and family *(6).* Furthermore, there is evidence that a substantial number of older travelers would not use transit despite service improvements (*7*). For many older adults, using transit is an unfamiliar experience that presents numerous physical and cognitive challenges (*8*). Attracting seniors to public transportation often involves creating options that mimic automobile characteristics, such as employing smaller vehicles, increasing schedules, diversifying routes, and ensuring quick and safe entry (*9*).

Several factors will affect public transportation in the future. Adults will work months or years after the normal retirement age of 65 and will therefore have daily travel needs. These adults tend to live far from family members who would be able to assist with transportation. In fact, some of these adults will have no children or extended family at all. In addition, bBaby bBoomers tend to drive more miles annually than members of previous generations. They are more reliant on their cars and less familiar with transit. They are also more likely to have a wide range of interests and hobbies and will wish to remain active well past retirement. All these factors will put a strain on public transportation systems.

To prepare for these changes, public transportation officials will need to understand the nature of automobile reliance among older adults and the sudden isolation seniors suffer when they stop driving. They must also understand the current barriers to using public transportation and some strategies for overcoming them. The emerging technologies in intelligent

transportation systems (ITS) can help overcome these barriers and provide alternative transportation options for older adults. Although these technologies can help streamline community efforts to provide good alternative transportation for seniors, there are barriers for adopting some of them. Nevertheless, many of these can be addressed and overcome. In addition to ITS solutions, there are various strategies emerging for making public transportation more palatable to older adults, in part by making it seem more like private automobile travel, and in part by making public transportation less confusing and stressful for older users who may have some physical or cognitive impairments. By adopting some or all of these strategies, communities can prepare to keep the widest number of seniors active and mobile for as long as possible.

AUTO RELIANCE AND DRIVING CESSATION

Although auto use is lower in urban areas relative to suburban and rural ones, it is still the most commonly used travel mode of seniors. According to an analysis of the 1995 National Personal Transportation Survey (NPTS), driving a car was the preferred mode choice for 53% of all trips made by older adults in urban areas, 70% in suburban areas, and 66% in rural areas. The second most popular mode among seniors was as a passenger in a car: 21% in urban and suburban environments and 25% in rural areas. Overall, older individuals used autos for 74% of all trips in the city and 91% of total trips in the suburbs and countryside. Public transit constituted only

8.2% of all senior trips in urban areas and less than 1% in suburban and rural ones (*10*). In the future, seniors will likely rely more heavily on autos because so many of them live in suburban or rural areas, and this is how they currently prefer to travel (*11*).

Active seniors continue to use a car for nearly 90% of their trips until they reach age 85. Among adults aged 85 and older, private car travel decreases by approximately 10%, as these seniors begin to walk and use a taxi service for some trips. In addition, after age 65, there is an increasing shift from driving a private car to becoming a passenger (*12*). Older individuals often find many driving situations challenging. After age 75, driving performance begins to decline due to increased stimulus-reaction time, declines in visual cognitive performance, and medication effects (*13*). Auto crash statistics indicate that the fatality rate of seniors increases between the ages of 55 and 70. In fact, this increase spikes sharply after the age of 65 (*14*). McKnight (*15*) identifies specific mental processes that are exceptionally difficult for senior citizens while driving: attention sharing, judging gaps in traffic, conducting visual searches, navigation, and motor control. For example, when a driver makes a left turn at an intersection with no signal, he or she must monitor multiple events at once. This is called attention sharing, and it becomes more difficult as drivers age. Older drivers make mistakes such as hitting the accelerator at the wrong time or taking unnecessarily wide swings around corners.

As a result of physical, cognitive, and financial challenges, every senior will have to give up driving if he or she lives long enough. Some are forced to stop because of a discrete event, such as a crash or an illness. The rest engage in a process of gradual cessation. Focus groups conducted in Florida, Maine, and Maryland suggest that older drivers begin to limit driving by reducing the types of trips they take and by increasing the number of stops per trip (*16*). Recreational trips are generally the first to be eliminated, which are also those that older adults value the most (*17*). Gradually, these drivers become passengers in cars driven by a family member or friend. Not surprisingly, many non-driving seniors living in rural areas rely entirely upon other drivers for mobility *(18)*. While these seniors report that their first alternative transportation mode of choice is riding in someone else's car, many dislike feeling dependent on others for getting around (*19*, *20*).

Although older adults know that they must eventually stop driving, it is easy to understand why they wish to retain control over their own mobility for as long as possible.

According to Marottoli *et al.* (*21*) driving cessation is associated with a subsequent decrease in out-of-home activities. Staying at home is linked to inactivity, which increases the risk of heart disease, stroke, and fractures. Furthermore, when seniors stay at home, they socialize less, have fewer decisions to make, and fewer things for look forward to. This has been linked to a decline in cognitive abilities. Inactive seniors begin to feel a loss of

freedom. They consider themselves to be too old, and they lose optimism. Some fall into depression (*22*).

Given the health and mental health benefits of retaining mobility, and the increasing difficulty that seniors face while driving, it is critical to understand and address many of the barriers to public transportation use among older adults.

TRANSIT BARRIERS AND RECOMMENDED STRATEGIES

A number of studies in recent years have attempted to explore the reasons why older travelers do not take transit, even if it is available to them (*23*). In general, the results of these studies suggest a number of concerns:

- Lack of direct service to local and essential destinations;
- Limited transit service hours during off-peak periods and on weekends;
- Necessity to make multiple transfers;
- Transit service that is not prompt or reliable;
- Physical discomfort, anxiety, or both related to climbing stairs, paying fares, walking to and standing at stops, and standing on buses;
- Rapid pedestrian walking cycles, lack of convenient crosswalks, poor sign legibility, and high speed limits on streets used by older pedestrians;
- Fear of crime on buses, at bus stops, and in park-and-ride lots after dark;
- Transit costs; and

- Difficulties understanding how to use transit.

Many studies have also recommended strategies to encourage transit use among older adults. While all transit users tend to respond favorably to service improvements, seniors may place more value on enhancements that directly impact their physical and psychological comfort, safety, and access to local destinations (*24*). Older travelers are less familiar with public transportation. In addition, many have physical and cognitive challenges that limit their ability to negotiate crowds, read signs, handle small coins or tokens, and climb stairs. As a result, they need a higher level of information and assistance in using public transportation. Burkhardt *et al.* (2002) recommend "developing mobility planning and training programs to help older persons make a transition from driving to public modes of travel" (*25*). In addition, transportation choices need to become more accessible. For example, communities could improve services by employing comfortable vehicles and facilities *(26)*. Friendly and patient transit drivers may also make the experiences of older riders more pleasant and comfortable (*27*).

Public transportation will likely have to turn to technology to help alleviate travel barriers such as unreliable service and long transfer times and inconvenient routes. ~~Intelligent transportation systems (ITS)~~ ITS can facilitate system management and help to address customer concerns by improving scheduling, dispatching, and maintenance tracking of public transportation vehicles (*28*, *29*). They can also be used to provide real-time

information to travelers while they wait and make paying for services simpler. In rural and suburban areas, transit services enhanced by technology can provide demand-responsive, door-to-door services (*30*).

While new technologies have the potential to greatly improve transit services, the demand for and ability of seniors to use these innovative systems is still uncertain, particularly in the near future (*31*).

Public Transportation Options and Technology Enhancements

Older travelers need immediate, reliable transit information. At present, seniors can call 211 to get information about health and human service transportation. The 211 service includes telephone access—and in some cases e-mail access—to a live operator who provides information and referrals using printed and electronic databases. Although these operators can connect callers to transportation options in their community, the information they provide is often limited to the names and numbers of transportation providers. For example, if a caller needs to know how to get to a particular destination, the operator will likely connect the caller to a taxi or bus service. Few operators can provide information about routes or destinations. Thus, the 211 service is best suited for callers who need general information: “Can someone pick me up?” This service is less suited for people who need information about a particular bus route or destination:

“Which bus stops at the grocery store?” Seniors who are less familiar with technology or have a disability that makes it challenging to use a menu-based system also benefit from this system.

A new approach toward providing this information via telephone, mobile phone, or Internet is the 511 service. Seniors who call 511 on a mobile phone can get instant information on traffic and road conditions, information on individual bus routes, the numbers of taxi services, and other health and human services travel information. The 511 service can handle a large volume of phone calls.

In addition to 511, there are many assistive technologies that aid older and disabled travelers by providing additional safety and security. The technologies incorporated into transportation infrastructure include:

Intelligent pedestrian signals. These detect the presence of pedestrians at crosswalks and activate walking signals, requiring no action from the pedestrian.

Talking signs and bus stops. These communicate information via infrared signals, which are then read by passengers through mobile phone or PDA. The information can also be transmitted audibly for riders who are visually impaired.

Other technologies are available to users who purchase devices that can offer them information. These include:

Personal aids. Riders with cognitive disabilities can receive additional information in the form of maps or directions through a PDA.

Personal location devices. These provide global positioning system (GPS)-based monitoring for riders with special needs, such as Alzheimer's, so they can be helped in an emergency.

There are many other barriers to using transit for older drivers, and technological solutions can help with many of them. ~~To address safety concerns held by many seniors regarding public transportation use, there are several enhanced safety and security solutions available.~~ To deal with the concern held by many seniors that they will not be safe while using public transportation, there are several solutions available (Table 7.1):

TABLE 7.1 **Enhanced Safety and Security Systems**	
In-Vehicle Surveillance	Audio and/or video recording systems provide on-board monitoring. Driver-triggered alarms (or mayday systems) are also an option. Coupled with automatic vehicle location, surveillance can provide operators with real-time incident management in the event of an emergency *(32)*.
Transit Station or Stop Surveillance	Includes in-vehicle surveillance systems and emergency intercoms *(33)*.
Boarding Assistance	Vehicle features that aid passengers with special needs (e.g., physical limitations) to get on and off transit vehicles, including low-floor buses, ramps, and lifts *(34)*.
Wayfinding	Could include signs in Braille, route color coding, and the use of 511 and/or 211 traveler information services *(35)*.

To enhance overall mobility, there are solutions that can improve bus services for seniors, aid them in using door-to-door services, offer innovative carpooling and vehicle sharing options, and assist them in finding and paying for parking remotely. See the table below for descriptions of a range of such mobility services (Table 7.2)~~.~~

TABLE 7.2 **Mobility Services**	
Bus Rapid Transit (BRT)	Options include reducing travel time and providing enhanced rider information, using ITS technologies, such as automatic vehicle location, signal control and priority, collision avoidance, precision docking, smart card fare collection, and real-time bus status information *(36)*.
Demand-Responsive Paratransit	More than 5,000 agencies provide door-to-door transit services on demand. It is the most widely accessible form of public transportation in the U.S. The service varies from agency to agency and may include small buses (often less than 30 feet), vans, or passenger cars (e.g., taxis). Typically, passengers request a ride (reservation), and a vehicle is dispatched to transport the traveler to and from their destination. ITS technologies can enhance paratransit services, providing users with more flexibility, reliability, and convenience *(37)*.
Dynamic Ridesharing	Dynamic ridesharing offers an innovative solution to carpooling. It employs Internet- and telephone-based systems, which enable users to identify shared ride partners on a “real-time” (or non-recurrent) basis. Dynamic ridesharing differs from traditional ridesharing that requires more formal, fixed arrangements made well in advance of the traveler’s departure time.
Car sharing ~~(Short-Term Vehicle Access)~~	The principle of car sharing is simple: individuals gain the benefits of private vehicle use without the costs and responsibilities of ownership. Car sharing is most common in major urban areas where transportation alternatives are easily accessible. Individuals generally access vehicles by joining an organization that maintains a fleet of cars and light trucks in a network of locations. Vehicles are most frequently deployed from lots located in neighborhoods, at transit stations, or businesses. Car sharing members typically pay for use through hourly rates and subscription-access plans. The majority of car sharing operators manage their services with advanced technologies, which can include automated reservations, smart card vehicle access, and real-time vehicle tracking *(38)*.
Smart Parking Management, Linked to Transit	Smart parking can be defined broadly as the use of ITS technologies (e.g., sensors, variable message sign (~~changeable message signs (CMSs),~~VMSs), and wireless communication) to help motorists locate, reserve, and pay for parking at transit stations. These systems can provide advanced (e.g., reservations) and real-time parking information via ~~CMS~~VMS, Internet, or PDA regarding available parking spaces at transit park-and-ride lots, the departure time of next trains, and downstream roadway traffic conditions *(39)*.

Some of these programs are still in pilot testing. Nevertheless, more of these services will be available to travelers in the ~~U.S~~United States~~.~~, particularly in urban areas, over the next five years.

OPPORTUNITIES AND OBSTACLES FOR ITS DEPLOYMENT

~~While~~ Although there are many potential benefits associated with the application of ITS technologies to transit and alternative mobility, there is a range of issues limiting ITS deployment in public transportation. These include coordination and communication between agencies, limited funding, limited fleet size, and reluctance among some transportation staffers to learn about technology. To deal with this, communities should phase in ITS technologies incrementally, so they can resolve the problems with each technology before adding another layer of complexity (*40)*. In addition, they should conduct staff training to develop ITS expertise (*41*).

Finally, emerging technologies must be designed to work together so that users can move from one solution to another seamlessly. For example, some vendors have begun to provide smart cards and readers that incorporate multiple card interfaces ~~(e.g., more than one transit operator fare payment on a single smart card)~~ (*42*). When making future purchasing decisions, operators should consider requiring open technology, meaning those that do not restrict communication among devices and software (*43*).

People who need specialized transportation services, such as demand-responsive paratransit provided by federal, state, and local agencies, ~~often~~

~~report~~complain that requesting these services ~~can be~~is frequently inconvenient because travelers must make trip reservations ~~well~~ in advance. In addition, pick-up times can be unreliable, and users find it challenging to obtain traveler information. A primary obstacle to providing high-quality specialized transportation services is coordination.

Coordination

Coordination involves communication and planning among health and human service and transportation providers. Poor coordination among agencies can lead to fragmented services and coverage gaps. Without proper coordination, agencies can duplicate each other's efforts, spend money unnecessarily, and confuse users (*44*). In contrast, well-coordinated services result in better quality services for more riders, better routes, greater coverage area, and cost savings (*45*).

Some agencies have streamlined communication by developing a coordinating committee. In these cases, agencies have formed a brokerage agreement, which appoints one agency as the primary point of contact for all specialized human service transportation. At its most proactive level, coordination allows agencies to share resources, such as vehicles and staff, purchase or procure vehicles jointly, consolidate services, and harmonize the standards of various programs. ~~Such an approach can lead to a~~This approach provides seamless service for the widest number of users (*46*).

This kind of coordination can play a critical role in rural areas, which need to maximize existing resources. At present, only 40% of rural residents have access to public transportation. Another 20% have minimal access, while the remaining 40% have none (*47*). Improved coordination will play an important role in providing transit and critical mobility services to a significant number of seniors in the future (*48*). While ITS can facilitate customer and inter-operator/agency coordination, few agencies employ it (*49*). To help address a range of communication concerns in providing transit and specialized transportation services, two national programs recently have been adopted: United We Ride (UWR) and Mobility Services for All Americans (MSAA). These programs could greatly improve transit services for seniors through improved communication and ITS technologies.

National Strategies to Enhance Transit and Mobility Solutions

In 2004, the federal government created the Interagency Transportation Coordinating Council on Access and Mobility. This council coordinates the 62 federal programs, spread throughout eight different departments, which focus on specialized transportation services (*50*). The council launched a five-part federal interagency initiative, ~~called United We Ride (~~UWR~~)~~, which aims to aid states in coordinating specialized transportation services. UWR objectives include: 1) lowering agency barriers, 2) promoting coordination, 3) improving productivity, 4) attaining economies of scale from transportation sharing, and 5) lowering service duplication. Its

primary goal is to create a bridge among transportation, ITS, and human services to create new transportation solutions (*51*).

As part of UWR, the U.S. Department of Transportation launched a ~~multi~~four-year effort, called Mobility Services for All Americans (MSAA), with a ~~four-year~~ budget of $8 million (*52*). This program employs advanced technologies to improve the quality and accessibility of specialized transportation services (*53*). MSAA's main goal is to employ emerging technologies to streamline the billing, scheduling, reservations, dispatching, and reporting of these services. Other goals are increasing mobility and accessibility for the transportation disadvantaged and the general public (*54*) (*55*).

Software programs have helped transportation and social service agencies to coordinate billing and cost sharing. This software enables various agencies to more easily calculate shared costs and automate billing and reporting activities. The software systems frequently have been enhanced with several ITS technologies including: Geographic Information Systems (GIS), Mobile Data Terminals (MDT), and Automatic Vehicle Location (AVL). Other cost-effective technologies include Computer Aided Dispatch (CAD), smart fare cards, and advanced traveler information systems. ~~These technologies are defined in the table below.~~

Transit Technologies	
~~Geographic Information System (GIS)~~	~~GIS is a computer application/database management system that stores, displays, and analyzes geographic information (e.g., vehicle location) for planning purposes, including optimizing routes and schedules *(56)*.~~

Mobile Data Terminals (MDTs)	MDTs are located in vehicles and serve as a wireless communication device between drivers and agency/traffic management centers. MDTs can record data (e.g., schedule adherence) and provide travelers with en-route information (e.g., stop announcements) *(57)*.
Automatic Vehicle Location (AVL)	Computer-based tracking of real-time vehicle positioning via GPS, radio frequency communications, or both. AVL may be coupled with next-vehicle arrival information, linked with computer aided dispatch (CAD), to provide vehicles with updated schedule/routing information and improve schedule adherence *(58)*.
Computer Aided Dispatch (CAD)	Often used with AVL and MDTs, CAD software manages and enhances communication between drivers and dispatchers (i.e., optimizing schedules) and vehicles and passengers (e.g., automated announcements as vehicle nears arrival) *(59)*.
Advanced Traveler Information Systems	This includes web sites, changeable message signs, automated telephone systems, e-mail, PDAs, in-vehicle navigation systems, 511 and 211 telephone systems, and kiosks to provide a wide range of information (e.g., next vehicle arrival and transfer information). Information can also be received on mobile phones via the Internet *(60)*.
Smart Fare Cards	A fare payment card with an embedded microchip, which stores information from balances to relevant passenger information (e.g., disability needs and fare subsidies). Smart fare cards benefit passengers because they do not have to carry cash and agencies since it makes coordination easier. It also provides fraud protection and can be used for other applications (e.g., parking) *(61)*.

To improve customer service, MSAA is creating scalable Travel Management Coordination Centers (TMCC) that provide high-quality mobility information. These centers will ultimately provide “one-stop” mobility information. They will help customers make trips by networking with all the relevant agencies and operators in a community. TMCC customer services include: 1) monthly transit passes; 2) shared rides between passengers from different programs; 3) lower fares for travelers that group themselves in advance; 4) fare reduction for off-peak travel; 5) seamless multi-modal services; 6) discounts for certain modes and times of use; 7) accessible

vehicles (e.g., low-floor buses); 8) understandable signs, schedules, and maps; and 8) multi-lingual information, formats, and media. Not surprisingly, many of these services will be made possible with ITS technologies (*62*).

Barriers to achieving TMCCs include institutional obstacles. Many agencies are resistant to sharing costs, sharing vehicles and user information, coordinating billing and reporting, or simply using shared technology. In addition, ITS deployment is limited in many rural areas. Memoranda of Understanding among government, community, and nonprofit organizations may help address these challenges in the future (*63*).

While TMCC demonstration projects may be complete by 2011, their impact on existing transit and mobility service providers—particularly specialized transportation services in rural areas—may be limited.

Other Mobility Solutions

Despite technological advances and a national program designed to improve inter-agency coordination, seniors will still need specialized transportation services. Four key approaches to providing these services include: demand-responsive paratransit (including taxis) and community, volunteer, and supplemental transportation options.

Demand-Responsive Paratransit

Paratransit is a curb-to-curb transportation service, also known as dial-a-ride. This service varies widely among the more than 5,000 agencies

providing it. It includes a range of vehicles—small buses, passenger vans, and cars/taxis. Some services are complementary, meaning they usually mimic an area's fixed route service. Some are known as general services, meaning that the providing agency has authority to determine eligibility for service. With user subsidy services, the transit agency may hire a private provider, such as a taxi, and then pay part of the fee for the user. Demand-responsive paratransit may provide service to one senior at a time; it may pick up many seniors along a route to deliver them all to a single destination; or it may serve as a neighborhood bus that picks up and drops off individuals along a fixed or flexible route (*64*).

Taxis are the most common form of demand-responsive service. In fact, it is the only form of available transportation in many areas. Health and human service agencies frequently provide discount taxi vouchers to seniors in urban and suburban areas. Travelers with similar destinations or origins can also share the cost of a ride or taxi trip. This is called a shared ride taxi (*65*). As agencies begin to use more ITS technologies, they can make cost-effective enhancements to demand-responsive services in ways that help seniors remain mobile.

Community Transportation

Community transportation services provide a convenient alternative to the private vehicle through a network of public and community-based agencies. These services include a wide range of vehicles from rail and fixed-

route buses to demand-responsive paratransit. The types of services provided typically reflect the infrastructure, resources available, and the needs of residents (*66*).

Volunteer Transportation

Because older adults often prefer to ride with friends and family, they respond very well to riding with volunteers who drive them to doctor's appointments, shopping centers, etc. In addition, volunteers frequently offer to escort frail travelers right into the waiting room of a doctor's office or into their living rooms (*67*).

Supplemental Transportation

Some independent travel organizations maintain relationships with existing transportation, health, and social service agencies. These organizations provide demand-responsive paratransit services and frequently cater to the specialized needs of older travelers, including the frail elderly who may require escort services (*68*).

More of these services, enhanced with ITS technologies, are expected to emerge over the next five years.

A promising and growing provider of supplemental services is the Independent Transportation Network*America*® (or ITN), which is a national non-profit mobility provider. ITN started in 1995 as part of a pilot project in Portland, Maine. ITN provides services ~~to individuals over age 65 and those~~

~~with impaired vision~~ 20 hours a day, 365 days a year to individuals over age 65 and those with impaired vision.

Approximately 1,000 individuals currently use the service in Maine. Communities in five states (California, Florida, New Jersey, Florida, and South Carolina) plan to launch ITN's model and software in the near future.

ITN operates a sustainable business model through fares and voluntary support. Annual membership fees are $35, and members make reservations to schedule trips. The system is cashless; members get a monthly statement. Customers can request door-to-door or escort services, as well as assistance with packages and seat belts, and other assistance. The ITN software, ITN*Rides*™, employs GIS and a database, which comprehensively manages volunteers, outreach, commercial transactions and expenses, membership, scheduling, and logistics (*69*).

More advances in transit and mobility services for older travelers will appear in the longer term and are explored in the next section, focusing on the period from 2011 to 2021.

FACTORS AFFECTING PUBLIC TRANSPORTATION IN 2021

Many factors are likely to affect the transit industry between 2011 and 2021. In this context, it is important to consider key variables that are likely to affect the demand and supply for public transportation services in 2021. For example, b~~B~~aby ~~B~~boomers are likely to be more active and to work many more years than past generations. Because ~~the majority of~~ this generation

intends to ~~will~~ age in place, which for many of them is in a suburban area ~~s~~far from family assistance, they will need specialized mobility options. Also, technology will be available to coordinate transportation programs among agencies. As technological enhancements become pervasive, their costs decrease.

Transit Industry Developments

In 2021, the transit industry will continue to face budgetary constraints, coordination challenges, and competition from the private auto for modal share. In light of these obstacles, public transportation services will have to be more streamlined, efficient, customer friendly, and flexible. Only by improving transportation and human service agency coordination—using more widespread and integrated technology, offering a greater array of innovative services, and recruiting many more volunteers—can the industry meet these needs. Bus rapid transit (~~or~~ BRT) and specialized services, for instance, will need to more closely mimic personal vehicles by providing higher quality public transportation access/service to the growing senior population living predominantly in the suburbs, as well as urban and rural areas.

These services will deploy multi-purpose and smaller ~~-~~size vehicles more frequently in 2021, providing operational efficiencies and comfort and convenience for users. These will likely include school buses, small buses, and taxis. Cross agreements among agencies and brokerage services will

allow communities to use transportation fleets more efficiently. For example, an agreement between the school system and public transit system might allow school buses to transport seniors when school is not in session. These brokerage services might also provide taxi vouchers. In addition, public transit will likely use fuel-efficient vehicles~~,~~ offering up to three times the efficiency of typical internal combustion engine vehicles (*70*).

When agencies use technology to coordinate services and to provide service information to users, seniors will be able to make better connections between ~~transportation~~ modes of transportation. They will also be able to use smart cards to pay for any public transportation fees without fumbling for change. They will be able to easily communicate their transportation needs to demand-responsive providers or they will be able to effortlessly determine which services operate in their neighborhood and on what schedule. They will ~~also~~ certainly have the opportunity to share rides and participate in other innovative solutions to keep them mobile, such as travel management centers, carsharing, and smart parking management, linked to transit. In any case, they will have ready sources of information for choices they can make on how to get around.

~~While~~ Although many institutional barriers to coordination will have been addressed by 2021, the transit industry will continue to face challenges. This will require an ongoing commitment among transit agencies and operators, both private and non-profit, to attract riders, manage

operational costs, and provide higher quality services where older travelers are living and working.

Rural and suburban locations will need a higher degree of flexibility and choice in providing mobility services to seniors. Such changes are likely to be implemented incrementally and at different rates across the U.S. Some regions will be rather advanced in providing a range of innovative services by 2021, and others will still be planned or under development at this time. Not surprisingly, funding will continue to present an obstacle for public transportation, particularly in small communities. In many cases, this will require innovative financing strategies, such as volunteer recruitment and vehicle sharing agreements. Still, many seniors will expect a higher quality of service, and the transit industry will need to respond by providing a greater level of convenience and choice. Nevertheless, many improvements will still be needed beyond 2021.

Changing Infrastructure

Mixed-use developments constructed at or near transit stations, often called transit villages, can provide an unprecedented level of car-free mobility for residents. Still, it is unlikely that a large proportion of seniors will have moved to such locations by 2021. Most seniors show a clear preference for remaining in their own homes, which will continue to require high auto dependency among a group of people with limited exposure to public transportation. Because these seniors will not be living near fixed-route

transit, public transportation alternatives will need to mimic the private car. Infrastructure developments, which greatly aid older travelers, may ~~attract~~ tempt some seniors to walk or use public transit where it is available. These will include improved pedestrian walkways with intelligent signals and talking signs, along with comfortable seating and good lighting at bus stops.

The Role of Transit Technology

By 2021 there should be more widespread deployment of transit technologies to aid communities in keeping track of fleets, service demand, and costs. These technologies will help public transit users to construct trips among relevant agencies and operators and provide information about paying for public transportation and requesting special services. In addition, technology will enhance safety. Popular assistive technologies will include intelligent pedestrian signals and talking signs. In-vehicle surveillance, transit station/stop surveillance, and boarding assistance will also be more common in the future. These technologies, ~~—~~particularly when combined~~—~~, can give travelers information en route, facilitate connections, and improve access, making public transportation easier to use even for those who are frail or cognitively impaired. Coordination among transit operators can facilitate fare payment, real-time traveler information, and improved planning, scheduling, dispatching, and billing.

Specialized and Innovative Transportation Services

In the future, seniors will expect more mobility choice and higher quality transit, particularly as economic projections forecast a sharp decline among lower-income seniors. Those seniors who can no longer drive will need solutions that reach far beyond public transportation.

Key mobility solutions will include: bus rapid transit (or BRT), demand-responsive services provided by inter-agency travel centers, dynamic ridesharing, carsharing, and smart parking, linked to transit.

Advanced ~~Bus Rapid Transit (~~BRT~~)~~

By 2021, advanced BRT systems will be deployed in major metropolitan areas. These services will rely heavily on numerous technologies, including automatic vehicle location, collision avoidance, precision docking, smart fare card collection, and real-time bus status information. By providing information to riders, drivers, and dispatchers, BRT will be more convenient and reliable and reduce wait times. It will integrate well into existing infrastructure, promote efficient land use, and will be cost effective. BRT will also use precision docking, low-floor buses, and smart fare payment to make it more accessible to seniors (*71*).

Travel Centers

By 2021, ~~Travel Management Coordination Centers (~~TMCC~~)~~s will have become mobility management hubs focused on providing one-stop mobility information for seniors who need specialized travel services. These travel centers can construct trips by networking among relevant agencies and operators in a community. Although these centers will be operating in both urban and suburban areas, centers in many rural and remote areas may still be planned or under development at this time. These centers will play a key role in providing streamlined specialized transportation services in the future.

Demand-Responsive Services

Services that provide on-demand travel will evolve substantially by 2021, primarily because so many seniors will need quality, cost-effective transportation alternatives. In suburban and rural areas, the need will be acute. Because these services will more closely mimic the private car, they will have eliminated many of the concerns seniors have about using public transportation, such as inflexible routes and inconvenient departure times. Various providers can use travel centers and ITS technology to coordinate their efforts to provide on demand rides to seniors. This coordination will bring together transit agencies, paratransit and taxi operators, community-based organizations, supplemental transportation operators, and volunteers

into a loose network of providers available to offer transportation to an active senior population.

Both supplemental and volunteer providers, who often cater to the specialized needs of frail seniors through escort services, will become increasingly popular. In addition, paratransit operators will continue to use a range of smaller and more comfortable vehicles—small buses, passenger vans, and cars/taxis.

Dynamic ridesharing services—an innovative approach to carpooling—will also be available through numerous paratransit and taxi providers in 2021. With this service, users call or email their travel requests to a central clearinghouse that matches them with an available driver going to the same location. Dynamic ridesharing differs from more traditional carpooling approaches because advanced reservations are not required. Rather, the system relies on a database of authorized users in a region and wireless technology for collecting requests. Not surprisingly, this approach can be more successful in regions with a high number of subscribers.

Car sSharing

Car sharing, or short-term vehicle access, will be increasingly popular among older adults in 2021, particularly in urban areas, retirement communities, and some suburban environments. Through car sharing, a group of individuals joins a club or organization that owns a small fleet of vehicles to which they have shared access. These individuals gain the

benefits of private vehicle use without the costs and responsibilities of ownership. Most people use car sharing as a supplement to other transit options (*72*). Car sharing applications for seniors have already been tested on a limited basis, and several operators and automakers have expressed interest in this market segment in the future. Given the price sensitivity of many seniors, who are living on fixed budgets, car sharing can offer a flexible alternative to auto ownership for older travelers.

The majority of car sharing operators will manage their services with advanced technologies, including automated reservations, smart card vehicle access, and real-time vehicle tracking. Not surprisingly, car sharing vehicles for older drivers will also be equipped with driver collision, navigation, and parking assist technologies, all of which will make it easier for seniors to drive and park safely.

Smart Parking, Linked to Transit

In 2021, many seniors—particularly those living in the suburbs—will use smart parking services to locate, reserve, and pay for parking at park-and-ride lots and transit stations throughout the U.S. These systems will provide older travelers with advanced reservations and real-time parking information via ~~changeable message signs (or CMS),~~message signs, in-vehicle navigation, the Internet, and PDAs. With these technologies, seniors can get information about available parking spaces at transit park-and-ride lots, along with the departure time of connecting trains and buses or

downstream roadway traffic conditions. Smart parking services will enable travelers greater choice and flexibility in their trip making by facilitating transit connections with their personal vehicles (*98*).

CONCLUSION

One quarter of seniors over the age of 75 are expected to require alternative transportation services in the future. Yet, older travelers express numerous concerns about using public transportation. They bristle against the inconvenience, the cost, and the poor service of public transit options. They dislike the physical discomfort they associate with crowded platforms and buses, limited seating, and steep stairs. They fear the anxiety and confusion that results from inadequate signage, multiple transfers, and frequent, inexplicable delays. Thus, it is important to consider opportunities to enhance public transportation options in the future, emphasizing those that mimic the private automobile. Numerous approaches to improving transit have been identified, such as user training, smaller and more comfortable vehicles, low-floor buses, and coordination strategies to provide greater flexibility, comfort, convenience, and choice for older travelers.

The most sweeping improvements to public transportation may be possible because of ~~intelligent transit technologies~~ITS. These can help providers improve scheduling and dispatching, as well as tracking the

whereabouts of the vehicles in their fleets. They can help users of public transit by providing information on service providers and schedules. This ~~includes~~ would include real-time information about the location of buses and trains. These technologies can help users and providers communicate with each other to schedule on-demand transit rides. They can even help seniors work together in small groups to arrange carsharing or ride-sharing services of their own or to talk to volunteers who might be able to assist them. When ~~deployed~~ used on a large scale, these technologies simultaneously expand service of public transit ~~services~~ while cutting its costs.

~~While~~ Although these benefits are exciting, there are several obstacles to widescale ITS deployment. ~~Such an effort~~This deployment would require a concerted focus across many different types of transit agencies to share information and technology. Not surprisingly, some agencies already struggle to provide the services they do, so asking them to undertake an additional, costly, time-intensive project may not be feasible. In addition, many staffers in public transportation have limited experience with this type of technology and may harbor an unwillingness to learn about it. ~~Furthermore, not all emerging technologies are compatible with each other.~~ Providing interoperability among competing technologies will be important in the near term. Although today's older adults may have limited understanding of how technology can provide them with real-time information about transit options, seniors coming of age a decade or more from now will likely be

much more technologically savvy. In fact, they may have grown to expect technological solutions to many of their concerns.

One of the most significant barriers to providing enhanced public transportation services is coordination among health and human service and transportation providers, particularly in suburban and rural locations. To help address these concerns and to enhance public transportation services, two national programs were launched recently: ~~United We Ride~~UWR and M~~obility Services for All Americans~~SAA. Both focus on improving the quality and accessibility of specialized transportation services through advanced technologies and improved coordination. One goal is to create ~~Travel Management Coordination Centers (or~~ TMCCs~~)~~ to provide a model for disseminating “one-stop” mobility information in the future. While TMCC demonstration projects may be complete in 2011, they may have a limited impact on mobility services at that time.

Between 2011 and 2021, the transit industry will continue to evolve, reflecting ongoing changes in ~~B~~baby ~~B~~boomer demographics, economics, land use, travel patterns, technology use, and fuel costs. During these years, coordination and ITS technologies will play a critical role in providing more flexibility, convenience, and choice for older travelers in 2021. Key transit and mobility service innovations will include advanced BRT~~,~~, travel centers~~,~~, demand-responsive services, including dynamic ridesharing~~,~~, carsharing~~,~~ and smart parking, linked to transit.

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