CONNECTED URBAN DEVELOPMENT

White Paper

Connected and Sustainable Mobility

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About Connected Urban Development

Connected Urban Development (CUD) is a public-private partnership program focused on innovative use of information and communications technology (ICT) to make knowledge, people, traffic, and energy flow more efficiently. This increased efficiency enhances how people experience urban life, streamlines the management of cities, and decreases the urban environmental footprint.

The main success elements of the program are:

- Measuring CO2 emissions reduction resulting from operational implementation of CUD projects within cities.
- Demonstrating the positive impact of ICT and broadband connectivity on climate change.
- Developing relevant thought leadership and replicable methodologies allowing CUD partner cities to learn from each other and share their experiences and best practices with cities around the world.

The initial scope of the program includes five primary areas of focus:

- Connected and Sustainable Work
- Connected and Sustainable Mobility
- Connected and Sustainable Energy
- Connected and Sustainable Buildings
- Connected and Sustainable ICT Infrastructure

Context

Urban mobility problems are rapidly turning into an urban mobility crisis. As cities become larger, traffic congestion and accidents, energy consumption, carbon emissions, and other forms of pollution are increasing, imposing huge costs on local and global economies and impacting citizens' quality of life and the environment.

Although the effects on local communities are obvious and immediate, the long-term consequences of climate change will, indeed, be severe. A 2006 report on climate change, by Nicholas Stern, states, "Climate change threatens the basic elements of life for people around the world—access to water, food production, health, and use of land and the environment."[1] The report proposes that increased risk of floods, decreased crop yields, degraded biological ecosystems, and loss of land due to rising sea levels, among other things, would lead to a long-term decline in gross domestic product on the order of 5 percent to10 percent. Transportation and related congestion play an enormous role in this regard. According to data from the World Resources Institute, 14 percent of greenhouse gases are caused by transportation activities.

1. *The Stern Review Report on the Economics of Climate Change*, Cambridge University Press, 2006.

The Fourth Assessment Report of the Intergovernmental Panel on Climate Change[2] points to an alarming increase in disastrous weather conditions, including hurricanes, droughts, and heavy precipitation, as a result of changes in the climate attributable to human activities.

Recent analysis from the United Nations Department of Economic and Social Affairs shows that by 2030, 60 percent of the world's population will live in large urban centers.[3] Globalization and economic development accelerate these trends. Our societies and cities face unprecedented challenges.

ICT offers enormous capabilities, but most are vastly underutilized in urban transportation. This paradigm has not changed sufficiently enough to allow many cost-effective solutions to be applied. Many current transportation policies and practices still favor automobile travel over efficient alternatives such as taking public transportation, walking, or cycling. We lack a holistic view and an integrated approach to transportation and land-use planning that takes into account the full benefits of technological connectedness. Public- and private-sector organizations must partner in adopting a vision for the sustainable city of the future where transportation continues to play a key role in enabling mobility—yet is dramatically transformed by innovative ICT. Furthermore, these organizations must support smart urban mobility initiatives and develop technological roadmaps for implementing solutions; roadmaps must have an aggressive timeline aimed at delivering dramatic improvements in urban transportation system performance.

Key Principles

Connected and Sustainable Mobility—allowing people and goods to move freely and safely while respecting the environment—is one aspect of CUD that is crucial both for our economic vitality and for our quality of life. In today's knowledge-based society, people often require mobility to gather information or collaborate with others. In the CUD approach, moving information to people and conducting virtual collaboration are increasingly possible. Public policy and urban planning, however, lag dramatically in this area.

ICT offers tremendous potential for improving the efficiency of transportation systems. The London-based Forum for the Future stipulates in a 2006 paper[4] on transportation, "Despite barriers that exist, there are a growing number of opportunities to move ICT higher up the transport policy agenda. Governments must take the lead in committing to developing and using a sound evidence base and taking a more holistic approach to creating transportation policies that will result in a transport policy framework where ICT can be seen as a mode of transport, with all the social, economic, and environmental benefits that follow."

2. "Climate Change 2007," the Fourth Assessment Report. (AR4), Intergovernmental Panel on Climate Change (www.ipcc.ch/ipccreports).
3. Energy Statistics Yearbook, Department of Economic and Social Affairs, United Nations, 2005 (www.un.org/esa/desa/).
4. "ICT as a Mode of Transport," Forum for the Future, 2006.

There are many possible ways to use existing and evolving ICT to help solve urban transportation problems, but we need supportive policies, regulatory practices, and aggressive execution to take advantage of these opportunities.

Solutions

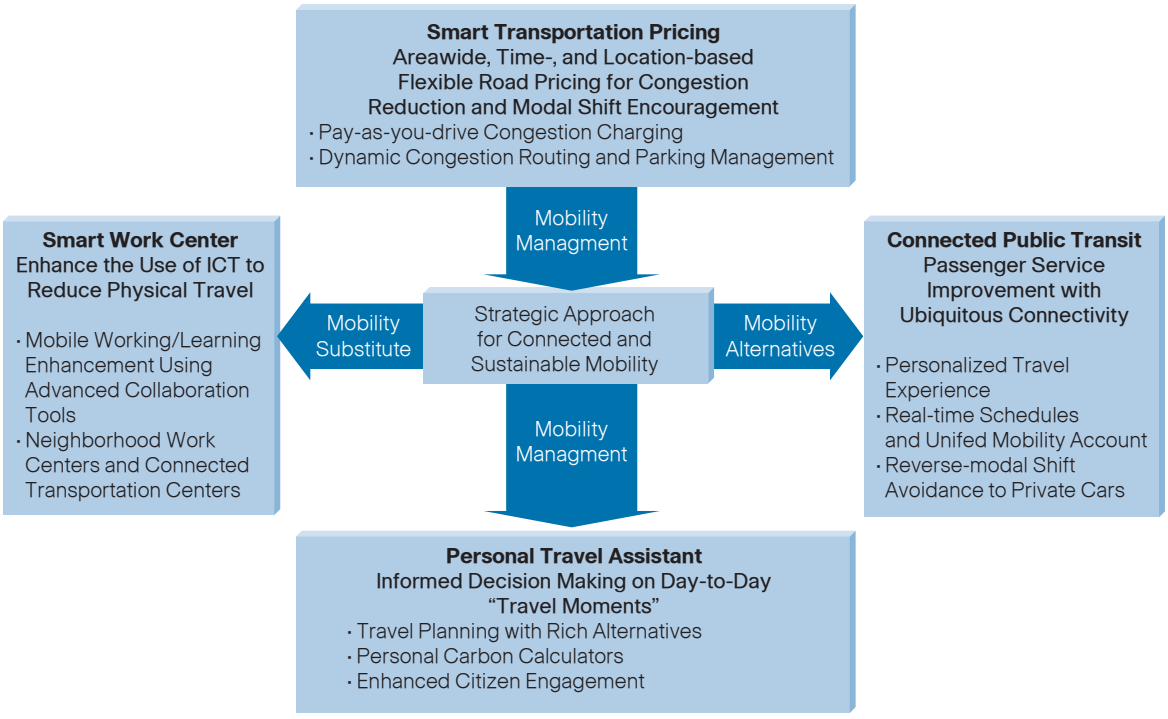
Strategic Approach

There are good examples of partial solutions that address specific local or modal issues. A strategic set of solutions takes into account all economic, social, and environmental impacts, including those that are indirect, not marketable, or long-term.

Integrated Solutions Approach

Although individual solutions may appear to impact urban mobility modestly, their combined benefits can be substantial. Therefore, an integrated approach is required to support a combination of mobility solutions systematically and make use of the dramatic changes that have occurred in the proliferation of ubiquitous connectivity. An example of this could be a particular program that includes improving public transit services and establishing pricing schemes for road use and parking fees, providing users more travel options and incentives. A strategic approach to a successful urban transportation system is shown in Figure 1.

Figure 1. Integrated Approach for Connected and Sustainable Mobility



Source: Cisco IBSG Connected Urban Development, 2008.

Integrating a comprehensive solutions portfolio around options, incentives, encouragement, enforcement, and compliance enables a city to put more power of choice into citizens' hands, as well as improve municipal human and asset capital management.

Smart Transportation Pricing

Smart transportation pricing provides cities with intelligence and flexible tools to manage transportation demand in urban areas. It enables cities to charge intelligent fees for road use and communicate transportation-related information in real time, taking advantage of global positing systems (GPS) and wireless communications technology.

Smart transportation pricing requires several key capabilities to be successful:

- Effective mobile communications infrastructure to exchange data in real time.
- GPS to locate commercial vehicles for obtaining accurate data about time, itinerary, and distance. City government can use the data to design or revise road-use pricing schemes.
- Wireless communications technology to enable commercial vehicles to exchange critical information associated with smart transportation with city operations centers in real time.
- Flexible road-use pricing schemes that combine a pricing tool with a standard electronic city map.
- Integrated transportation services payment systems for drivers. Knowing the total cost of transportation, including road tolls and parking, is important for drivers to make the right decision about their travel methods. Also, users can conveniently pay for transportation services through a universal mobility account, which is an integrated payment system.

Benefits

Problems related to traffic congestion typically represent 5 percent to 15 percent of total vehicle travel. Charging for road use, however, does little to solve this problem. Smart transportation pricing—which includes a pay-as-you-drive pricing model—applies to a larger portion of total vehicle travel. Not only does smart transportation pricing reduce traffic congestion by charging for road use, it also disperses and optimizes traffic flow, reducing traffic delays, accidents, energy consumption, and carbon emissions.

When integrated with other pricing reforms, parking, or public transit systems, smart transportation pricing can provide more benefits because it requires lower transaction costs and affects a greater share of total vehicle travel.

Smart Work Center

The smart work center is an intelligent neighborhood work center that facilitates "ubiquitous working" by:

- Enhancing the use of advanced ICT-based communication tools to reduce physical travel such as commuting and business trips.
- Improving the productivity of mobile and home workers by providing full business support, including conference rooms, shared office equipment, and various services such as bank, catering, child care, and legal.
- Changing mobility patterns by providing citizens with an accessible, secure, convenient, and shared mobile-working infrastructure.

A detailed discussion of smart work centers is beyond the scope of this paper and is explored in detail in the CUD white paper "Connected and Sustainable Work."

Personal Travel Assistant

Personal Travel Assistant, a service developed by Cisco with input from the Massachusetts Institute of Technology (MIT), improves the transit experience within urban environments. PTA enables cities to provide users with travel information in a convenient format through various service channels, including transit stations and vehicles, websites, and mobile devices such as PDAs. It can incorporate various smart travel assistant features that provide intelligent and dynamic guidance based on user profile and context (conditions of a particular travel corridor at a particular time) using real-time information.

Table 1 details potential features of PTA. To the degree that PTA increases the convenience of these travel options, mobility substitutes, or travel incentives, it can help reduce total motor vehicle travel, thereby increasing sustainability of urban mobility.

Table 1. Features of Personal Travel Assistant

Feature	Description
Route and schedule information	Provides public transportation (bus, train, ferry, etc.) route maps and schedule information using easy search features.
Automated reservations	Provides automated services for reserving public transportation, parking, and neighborhood workstations.
Current travel conditions, alerts, and avoidance	Offers real-time information on roadway, parking, and transit conditions; provides alerts when special problems develop on intended routes and recommends alternatives.
Travel optimization	Optimizes travel planning to minimize time and transportation/environmental costs based on user profile and context.
Transit vehicle arrival	Provides real-time information on when the next transit vehicle will arrive at a stop or station.
Mapping and guidance	Offers information about nearby parking (automobile and bicycle), public transportation stops/stations, and destinations.

Feature	Description
Real-time location information	Uses electronic maps to tell individuals where they are and the location of friends and colleagues (with their permission); provides a record of travel activity.
Meeting and travel coordination	Coordinates meeting and travel schedules among people.
Rideshare matching	Helps friends, colleagues, and strangers identify ride-share opportunities for personal and work travel.
Integrated payment systems	Integrates public transit, taxi, parking, road pricing, and related services; accommodates variable rates such as off-peak hours and frequent-user discounts.
Security features	Provides a "panic button" emergency alarm that makes a loud noise, automatically sending an alert to nearby security officers/police.
User travel analysis	Informs users of their travel activity in kilometers/miles, costs, and impacts (energy use, CO2 emissions).
System analysis	Provides information on when, where, and how people travel to facilitate transportation planning.

Source: Cisco IBSG Connected Urban Development and Victoria Transport Policy Institute, 2007.

Implementation

PTA implementation will require development of various information standards, coordinated planning among telecommunications providers (who will sell the devices and services), and support and input from various partners—such as transit agencies, parking facility managers, and vehicle manufacturers. It will also require marketing programs and incentives to maximize penetration of the technology.

Benefits

PTA represents a new way for citizens in urban areas to balance their work and personal lives. Citizens have more alternatives from which to make informed decisions about their daily travel, whether for commuting, attending offsite meetings, and/or engaging in personal endeavors. Beyond travel, PTA offers citizens and employers more flexibility in their daily work environment by providing smart working options throughout urban areas. By offering eco-friendly mobility solutions, PTA helps citizens reduce their carbon footprints.

Furthermore, PTA enables city leaders and agencies to predict, respond to, and administer the urban economy, environment, and transportation system using functions that help manage events during peak transportation times. Having a greater understanding of how citizens use transportation systems in their daily lives will enable cities to plan better and create city-to-citizen engagements.

Connected Public Transit

Connected Public Transit (CPT) is a set of information services that improves passengers' experience through ubiquitous connectivity. CPT is intended to make public transit convenient, comfortable, efficient, affordable, and reliable. It can incorporate various "smart traveler" features that provide dynamic (changeable) guidance based on user profiles and context using real-time information. Some CPT features will integrate with PTA services that use handheld devices and public monitors located at transit stops and on transit vehicles to provide information to users.

Table 2 describes CPT features; most provide information and services directly to passengers. A few (such as transit priority, improved utilization analysis, and vehicle performance monitoring) improve transit operations.

Table 2. Features of Connected Public Transit

Feature	Description
Current transit conditions, alerts, and avoidance	Provides real-time information on transit conditions (crowding and delays), creates alerts when problems develop on intended routes, and makes recommendations for avoiding such problems.
Trip optimization	Optimizes travel planning guidance to minimize time and transportation/environmental costs.
Transit vehicle arrival	Provides real-time information on when the next transit vehicle will arrive at a stop or station.
Park and ride	Provides information to motorists on the location and availability of park-and-ride facilities and details on traffic flow.
Mapping and guidance	Provides destination information at nearby public transportation stops/stations or from home via a web browser.
Integrated payment systems	Integrates payment for public transit (including multiple agencies), taxi, and related services; accommodates variable rates and special discounts.
On-board wireless	Allows passengers to access the Internet.
On-board work and entertainment stations and refreshments	Incorporates fold-down work tables, reading lights, electric plugs, entertainment systems, and refreshments similar to first-class airline services.
Interactive monitors	Provides computer monitors with interactive features strategically located at transit stops and in transit vehicles, allowing users to access value-added transit and location information.
Utilization analysis	Collects information on when, where, and how people travel; collects data on payment practices to facilitate transportation planning.
Transit priority	Prioritizes traffic signal controls.
Automatic vehicle performance monitoring	Collects information on bus performance such as driving profile, on-time reliability, and number of passengers.

Source: Cisco IBSG Connected Urban Development, 2007.

Low-income travelers tend to depend on public transportation and are relatively price-sensitive, while discretionary travelers (people who are able to choose between public transportation and driving their cars) tend to be more sensitive to quality of service factors such as convenience, comfort, and reliability.

Attracting discretionary travelers requires a CPT marketing approach that includes a careful analysis of consumer needs and preferences, and development of products and services that meet those requirements. Providing direct benefits to these travelers can increase transportation system efficiency overall and encourage use of public transportation, which increases revenue and reduces traffic and parking congestion, roadway accidents, and air pollution.

Urban traffic congestion tends to maintain "equilibrium"; it gets bad enough at times that people forego traveling during peak periods, travel at different times of the day, or choose a different destination or transportation method. There is theoretical and empirical evidence that transit service quality is an important factor in determining the level of congestion equilibrium. If service is poor, travelers will continue to drive even if congestion is severe. If service is relatively good, travelers will be more willing to shift from driving to taking public transportation. As a result, even motorists who never use public transit can benefit from improvements in service quality.

Implementation

CPT implementation will require coordinated planning among various partners, including transit agencies, local governments, and businesses. It will also require suitable marketing and incentives to maximize penetration of the technology.

Benefits

CPT increases use of mobility options and reduces traffic congestion, road and parking costs, accidents, and carbon emissions. If CPT services—such as The Connected Bus currently in operation in San Francisco—encourage efficient travel, consumer behavior will shift from driving automobiles to using different modes of transportation and mobility substitutes. The benefits of CPT and the positive impact it has on travel, however, depend on whether the concept contains a wide range of features for a particular system, and on whether the features are easy to use, reliable, comfortable, secure, and affordable.

Combining an integrated solutions approach with ICT will revolutionize urban mobility, making the flow of both information and physical transportation more sustainable. A packaged approach also will enable cities to maximize investment and continuously improve service quality to encourage the use of efficient transportation options, leading to a productive and livable urban environment.

The cost to implement an integrated solutions framework for Connected and Sustainable Mobility includes developing the systems, purchasing the necessary equipment, and accommodating additional transit passengers. Because such systems have high

fixed costs, unit costs will decline and cost efficiency will increase with expanded scope and use, including more features, service areas, and total users.

Impacts

Connected and Sustainable Mobility provides benefits for citizens, city governments, and enterprises. For citizens, it improves quality of life, enabling them to make informed decisions on day-to-day travel moments and eliminate unnecessary time spent on the road.

For city governments, Connected and Sustainable Mobility enhances citizen engagement, increases mindshare, improves the travel experience, reduces carbon emissions, decreases demand for road capacity, and improves efficiency of asset/capital management and use.

For both public- and private-sector organizations, Connected and Sustainable Mobility helps improve worker productivity and enables businesses to compete, as well as providing relevant public services such as parking, shopping, and dining.

Connected and Sustainable Mobility, combined with an urbanwide connectivity platform and broadband infrastructure, will revolutionize urban mobility, allowing cities to provide transportation systems that move people, goods, and information efficiently. An effective platform can:

- Ease transfers among different transportation modes, allowing people to choose the most efficient mobility option for each trip.
- Provide tools and services that let people work, study, and shop from home or other location.
- Offer efficient incentives and convenient payment methods for road and bridge tolls, parking fees, and transit fares.
- Provide real-time transit information and personalized passenger guidance.
- Help cities develop smart tools that provide people with the information they need to navigate through a city and make use of all their mobility options.

Implementation

Transportation professionals increasingly recognize the value of mobility management strategies that improve system efficiency in urban environments. These strategies are being applied in addition to, or instead of, supply-oriented solutions such as expanding roads and parking facilities.

Connected and Sustainable Mobility provides an integrated set of new tools and services to help cities deploy the best, new urban mobility ideas. Although most of these innovations have been implemented somewhere, no city has brought them all together into a functional network. Connected and Sustainable Mobility is helping cities build such networks, piece by piece.

Several critical factors are needed. The integrated solutions approach described earlier is one. Urban mobility business and IT architecture, a new operating model, and intelligent ICT infrastructure are three other essential ingredients.

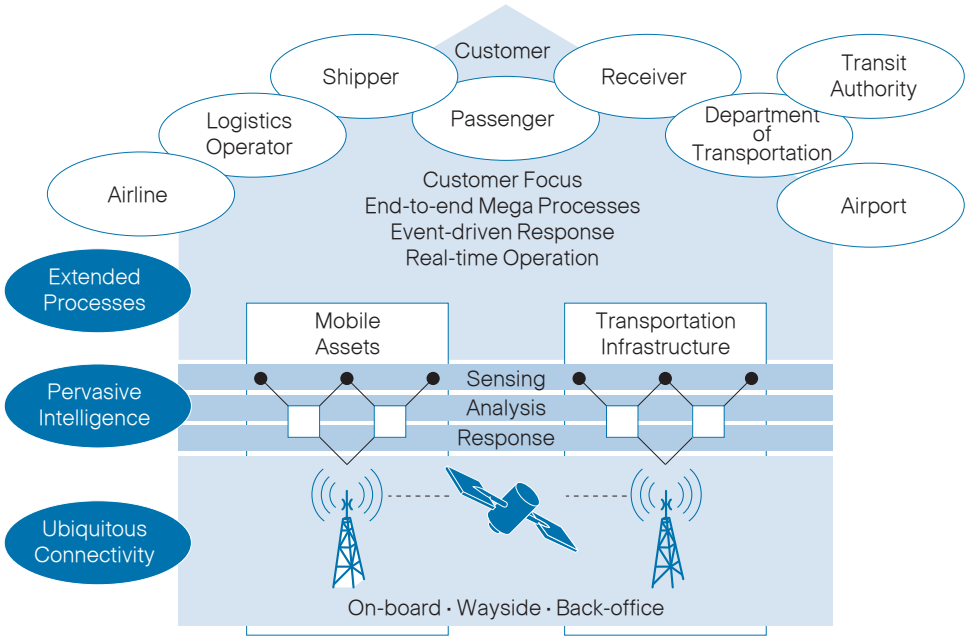
Urban Mobility Business and IT Architecture

Connected urban environments present cities with an opportunity to develop platforms for provisioning services to citizens, transportation agencies, and private-sector stakeholders. As cities grow and change quickly, requirements for efficient traffic flows and information services change just as rapidly. Globalization accelerates this trend. A sustainable transportation system must be capable of being reused and adapted for different requirements.

Connected and Sustainable Mobility uses a general-purpose, urbanwide platform based on a standard architecture and open interface to improve reusability of its components. This standard architecture will allow cities to manage the platform as it evolves and adapt to rapidly changing demands and technology opportunities.

Figure 2 represents an example of a Connected Urban Mobility platform built on a standard architecture.

Figure 2. Connected Urban Mobility Platform



Source: Cisco IBSG, 2008.

Extended processes integrate collaborative processes both inside and outside the enterprise. **Pervasive intelligence** represents an intrinsic capability to convert input into meaningful output. **Ubiquitous connectivity** is an innate capability for the exchange of data, voice, and video, and for controlling information nearly anytime, anywhere.

An urbanwide connectivity platform improves scalability, reusability, and maintainability throughout the system's lifecycle. A standard architecture also supports enhanced interconnectivity for Connected and Sustainable Mobility by removing variable interfaces and duplicate work, and by reducing inefficiency.

New Operating Model

Building an integrated solution usually involves interdisciplinary collaboration among several sectors. Many urban transportation systems are operated by multiple operations centers in the public and private sectors. Securing interoperability among these systems can be difficult and costly. In a complex operational environment, smart transportation must be supported by a new operating model that provides greater benefits with fewer costs.

Such a model requires a high level of intelligence through automation and event management. An intelligent operations model will fully, or partly, automate smart transportation processes—such as detecting when a car enters a charging zone, collecting fees, and managing customer services—resulting in the need for fewer operators. To accomplish this, most processes must be well-defined, simplified, and standardized before being automated. Information systems that enable process automation consist of an inference engine and knowledge base.

This operating model will also increase the productivity of operators by allowing them to react efficiently to event-management cases and customer services. For example, regulation infringement, illegal parking, and on-board system anomalies can be reported, investigated, and handled effectively by predefined rules. Operators can benefit from a rules-based engine for handling exceptions by categorizing the unexpected event easily and escalating it to the right expert or group. Call centers can deal with service calls, payments, and other issues associated with smart transportation by using accumulated information such as known errors in a knowledge base.

Event-management applications combined with a smart transportation knowledge base will help cities achieve predictable, reliable results that are generally regarded as basic attributes of public transportation operations. The intelligent operations model will provide results that can be used as evidentiary records against civil appeals.

Intelligent ICT Infrastructure

The urban transportation sector will benefit greatly from a citywide program that establishes a far-reaching broadband network and associated ecosystem to handle bandwidth-intensive transportation solutions.

A sustainable transportation system should provide a seamless travel experience that is efficient and predictable. Availability and accessibility of relevant, accurate, and timely information for transportation users and operators are essential for using various services effectively. Urban transportation information and services should be available via the Internet, as well as through a mobile web service as part of a transportation system. In this way, passengers and mobile devices become important parts of a connected environment based on an ICT infrastructure.

In addition, an intelligent ICT infrastructure should provide pervasive sensing technology, real-time visibility, the ability to monitor and control transportation facilities, and mobile assets to manage complex transportation challenges and to improve the security and safety of related systems. Intelligence and coordination are the foundation of Connected and Sustainable Mobility. Open IP networks can form the underlying ICT infrastructure that interconnects all technologies and mobile assets throughout urban transportation.

Conclusion

The future belongs to efficient and innovative policies and technologies that can change consumer behaviors significantly and automatically.

Certain policies and technologies can help cities balance their investments in transportation supply and demand management with clear vision, integrated planning, and better use of ICT and process reform. They also can encourage citizens and communities to get involved by providing feedback on their ideas, needs, and user experiences. Finally, policies and technologies can be developed that focus on the impact of changes and reforms on individuals and communities, finding better ways not only to connect people, but also to improve the quality of urban life and the environment.

Notes

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