

Investigating ITS Concepts for the Dulles Corridor Rapid Transit Project

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The objective of the Dulles Corridor Rapid Transit Project was to identify and define transit Intelligent Transportation System (ITS) technologies, or concepts, recommended for implementation in the Dulles Corridor. The Corridor is located in the Washington, D.C. region in northern Virginia. In the project, a comprehensive set of ITS concepts was prioritized and grouped into three categories for deployment—coordinate, implement, and monitor. The “coordinate” concepts are currently proposed or deployed in the Corridor or are primarily functions of a traffic agency or information service provider. The “implement” concepts are recommended for implementation as a part of the project and provide the greatest potential for payoff. The “monitor” concepts are immature technologies that can be implemented beyond the period of the project or may be implemented sooner if the technology matures rapidly. A technology implementation plan was then developed for the Corridor. The plan provides implementation phasing, and capital, operations, and maintenance cost estimates for each of the implementation concepts. The plan also provides qualitative benefits of the ITS concepts. The paper discusses the project background and process used in prioritizing and grouping the ITS concepts. It presents the ITS concepts with respect to the three categories (groupings), and discusses those recommended for implementation as a part of the project (the implement concepts). Key words: transit ITS, bus rapid transit (BRT), market packages, corridor, northern Virginia.

PURPOSE

The purpose of this paper is to present the process and results of the Dulles Corridor Rapid Transit Project. The project identified and prioritized a comprehensive set of Intelligent Transportation System (ITS) technologies, or concepts, applicable to the Dulles Corridor. The prioritized ITS concepts were reviewed further and grouped into three categories for implementation — coordinate, implement, and monitor. A discussion of the project background, process, and recommended ITS concepts is provided below. The implement concepts are discussed in greater detail because they are recommended for deployment specifically as a part of the Dulles Corridor Rapid Transit Project.

BACKGROUND

The Dulles Corridor is located in the Washington, D.C. region in northern Virginia. The corridor has become one of the most recognized places in the country for technology and internet-based

companies to locate. The corridor runs approximately 30 miles from West Falls Church to Leesburg, with major activity centers along the way including Tysons Corner, Reston/Herndon, Dulles International Airport, and eastern Loudoun County.

Growth along the Dulles Corridor has increased beyond the pace of transportation improvements, and in all likelihood, it will continue. With this in mind, transportation agencies in this region have embarked on a multimodal transit program. Providing oversight and direction to this effort is the Dulles Corridor Task Force. The Task Force is made up of executives from stakeholder transportation and planning agencies in the Dulles Corridor. The Task Force has subcommittees to recommend funding, service delivery, technology, and management of the project. The Technology Task Group is responsible for developing recommendations for the application of ITS technologies in the Dulles Corridor project. Representation in the group includes the following: Northern Virginia Transportation Commission, Virginia Department of Rail and Public Transportation, Virginia Department of Transportation, Washington Metropolitan Area Transit Authority, Washington Airports Task Force, Fairfax County, Loudoun County, Dulles Area Transportation Association, and Metropolitan Washington Airports Authority.

To provide rapid transit service in the Corridor, the Dulles Corridor Task Force developed an implementation program, which consists of the following four phases:

- Phase I: Express Bus – Starting in 1999, this phase provides express bus service and new bus routes within Fairfax County serving Herndon/Monroe and Wiehle Avenue to Tysons Corner and the West Falls Church Metro station.
- Phase II: Enhanced Express Bus – Starting in 2001, this phase provides additional bus routes and buses serving eastern Loudoun County and Fairfax County to Tysons Corner and the West Falls Church Metro station.
- Phase III: Bus Rapid Transit (BRT) – Starting in 2003, this phase provides new BRT routes and buses serving eastern Loudoun County, Dulles Airport, Reston/Herndon, Tysons Corner, and the West Falls Church Metro station.
- Phase IV: Rail – Starting in 2006, this phase provides rail from Metrorail’s orange line East Falls Church station through Tysons Corner. Starting in 2010, it extends rail from Tysons Corner to Reston/Herndon, Dulles Airport, and Routes 606 and 772 in Loudoun County.

PROCESS

A straightforward process was used to derive viable, comprehensive, and integrated ITS concepts for the Corridor. The process used a step-by-step approach to pare down concepts. Approved evalua-

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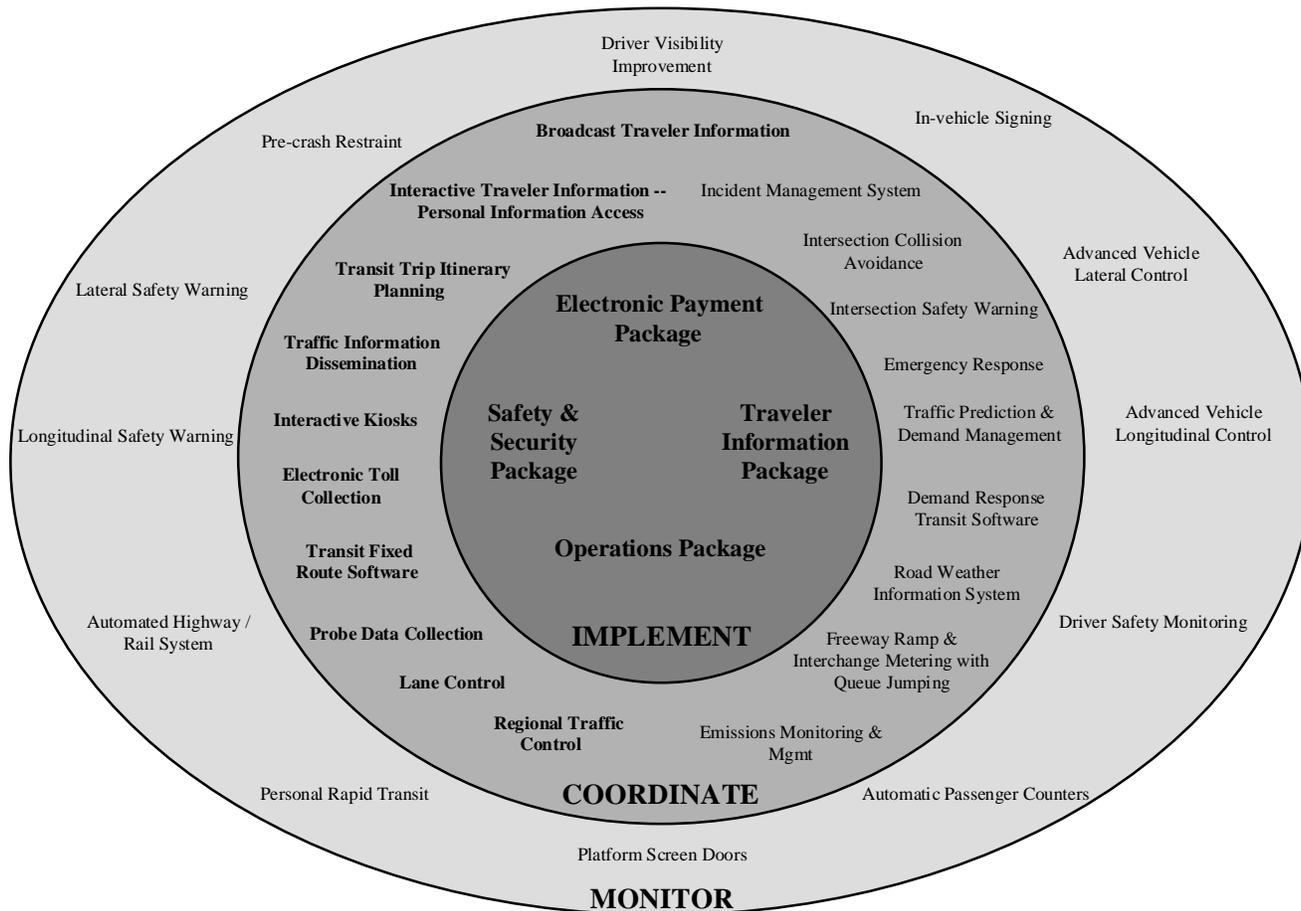


FIGURE 1 Dulles Corridor ITS concepts

tion criteria, costs, and other coordinated efforts were used to select concepts for implementation in the Corridor. The process was very effective in keeping the Technology Task Group informed and involved. The process was comprehensive and based upon the *U.S. DOT National ITS Architecture, Version 2.0 (1)*.

The *U.S. DOT National ITS Architecture* is a framework for the integration of ITS into the transportation system. A comprehensive list of ITS concepts, applicable to the Dulles Corridor, was developed from the National ITS Architecture market packages. Market packages provide an accessible, deployment oriented perspective defining specific technology application concepts. The market package approach helps to map ITS projects, developed from the recommended ITS concepts, to the various subsystems and components of the National ITS Architecture. The use of market packages also helps to identify recommended information flows between subsystems.

To gain a greater level of specificity for this project, some market packages were broken out in further detail or were tailored to this project. For example, the concepts of wayside/in-station traveler information (e.g., dynamic message signs at transit stops) and in-vehicle traveler information (automated next-stop announcement) were broken out in greater detail from the market package, Transit Traveler Information. Other concepts, such as transit vehicle tracking and broadcast traveler information, remained at the level of detail as defined in the National ITS Architecture market packages. Some of the concepts, such as plat-

form screen doors and precision docking, are unique and are not associated with a particular, existing market package.

Once the list of applicable ITS concepts was developed, each was evaluated against weighted criteria and ranked. The Technology Task Group developed the criteria, assigned weights to each, and performed the evaluation and ranking. The following criteria were used to evaluate and rank the ITS concepts: consistency with the Technology Task Group's application criteria and policy, technical feasibility, customer benefits, operator benefits, integration and compatibility with existing and planned systems, cost effectiveness (qualitative), and community and agency opportunity.

Benefits were assessed qualitatively because of the lack of available quantitative benefits information. The ITS concepts were then screened further using a logic and expert panel check. As a result of the prioritization and screening process, the list of concepts was broken into the following three categories:

- **Coordinate:** Those already proposed or implemented by candidate transit operators in the Corridor, or those that are primarily functions of a traffic agency or other agency.
- **Implement:** Those recommended for implementation as a part of the Dulles Corridor Rapid Transit Project with the greatest potential for payoff.
- **Monitor:** Those that could be implemented beyond the time period of the project or may be implemented sooner if the technology moves rapidly from an immature technology to a mature one.

After the concepts were grouped into the above three deployment categories, the implement concepts were organized into the following four functional areas: 1) electronic payment, 2) safety and security, 3) traveler information, and 4) operations.

Figure 1 presents the ITS concepts recommended for deployment in the Dulles Corridor. The concepts are grouped into the three deployment categories (coordinate, implement, monitor). The bold concepts in the coordinate ring are currently employed in the region.

A technology implementation plan was then developed for the Corridor and presented to the Dulles Corridor Task Force for adoption. The plan provides implementation phasing and capital, operations, and maintenance cost estimates for each of the implementation concepts.

The above process gave the study team a picture of the Dulles Corridor implementation recommendations in the context of regional efforts to implement ITS. A discussion of the three deployment categories is provided below. Implementation concepts are highlighted.

COORDINATION CONCEPTS

Some of the ITS concepts should be deployed in the Dulles Corridor by an agency or organization other than the Corridor's designated transit operator. These ITS concepts are often intermodal in nature and require coordination with the designated transit operator. In general, the coordination ITS concepts did not rate as high a priority as those recommended for implementation by this project. However, the concepts are applicable to the Corridor and provide many benefits.

The importance of the coordination concepts is that many of them are currently deployed in the region. Thus, an ITS infrastructure is already available to build upon and expand ITS in the Dulles Corridor. This provides a cost-efficient approach for ITS deployment in the Corridor. The coordination concepts are represented in the middle ring of Figure 1. Concepts in bold are currently employed in the region.

IMPLEMENTATION CONCEPTS

The ITS concepts recommended for implementation in the Dulles Corridor provide the greatest benefit to the Corridor's transit passengers and designated transit operator. These concepts ranked highest in the prioritization and screening process discussed earlier in the "Process" section. The implementation concepts are grouped into four packages: 1) traveler information, 2) electronic payment, 3) safety and security, and 4) operations. The concepts are represented in the center circle of Figure 1.

Traveler Information Concepts

The traveler information concepts provide real-time transit vehicle schedule information at transit stops and real-time occupancy information at parking facilities. It also provides next-stop location information to passengers onboard transit vehicles.

Transit vehicle tracking provides real-time location input to the transit information technologies. The traveler information concepts increase customer convenience, save passengers time, relieve uncertainty and anxiety, help travelers make smart decisions, and build customer loyalty and confidence. Each of the traveler information concepts is discussed below.

Transit Vehicle Tracking

Transit vehicle tracking, which includes automatic vehicle location (AVL) and computer-aided dispatching (CAD) functions, provides real-time location information for schedule adherence, dispatch, and traveler information. Often, other ITS applications interface or are integrated with the transit vehicle tracking system. These applications include a silent alarm for alerting dispatchers of emergencies, vehicle engine probes to alert drivers and dispatchers of potential engine problems, automatic passenger counters (APC), and in-vehicle traveler information systems (automated next-stop annunciation). For this project, however, the system provides vehicle location, schedule adherence, and dispatching.

Parking Facility Information

This concept provides real-time parking availability information and navigational guidance for parking lots and garages. Information is typically provided via dynamic message signs (DMS) in the vicinity of the parking facility and at the parking facility. Signage may specify the number of parking spaces or whether or not the facility is full. Signage may also direct drivers to the parking facility and to vacant sections of the facility. Signage may be located adjacent to arterials and freeways near the parking facility, at facility entrances, and inside the facility.

Wayside/In-Station Traveler Information

This concept provides real-time arrival/departure information at transit stops and station platforms. Information can be displayed on monitors or DMS signs. Information displayed on signs can also be announced simultaneously over integrated speakers or a station's public address system. Advertising and general public service announcements can also be provided over the system.

In-Vehicle Traveler Information

An in-vehicle traveler information system provides visual and audio announcements inside the transit vehicle automatically. Typically, announcements include next stop, major cross street, transfer point, and landmark information. Additional information, such as public service announcements and advertisements, may be provided at other times. An in-vehicle traveler information system meets Americans With Disabilities Act (ADA) requirements.

Electronic Payment Concepts

The electronic payment concepts recommended for implementation in the Corridor allow travelers to pay transit fares, parking fees, and tolls by electronic means (i.e., magnetic stripe card, smart card, and transponder). The concepts can be integrated into one universal system, and customers can be issued one account. The electronic payment concepts increase customer convenience (e.g., exact change not required, simplification through a single account), allow for cost savings to customers and transportation agencies, and save customers' time. Coordinated electronic toll collection, electronic fare payment, and parking facility electronic payment in the Corridor will provide the nation's first multimodal, integrated electronic payment system. The electronic payment concepts are discussed below.

Electronic Fare Payment (EFP)

This concept provides an electronic means of collecting and processing fares. Customers use a smart card or magnetic stripe card instead of tokens or cash to pay for transit rides. The electronic fare payment system may be linked to the transit vehicle tracking system for distance-based fare collection.

Parking Facility Electronic Payment

This concept collects parking fees electronically and detects and processes violators. Payment may be made using a credit/debit card, smart card, or vehicle-mounted transponder.

Safety & Security Concepts

The safety and security concepts provide surveillance in transit vehicles, in transit stations, at transit stops, and in parking facilities. Surveillance components consist of video, silent alarms, and two-way intercoms. The safety and security package deters vandalism and other criminal activities. This creates a safer environment for transit patrons and reduces maintenance costs due to vandalism. The safety and security concepts are discussed below.

Onboard Transit Security

Onboard transit security provides video monitoring of the passenger safety environment onboard the transit vehicle. Video images may be recorded and later reviewed, or they may be transmitted in real time over the bus's communications system to a central location. A silent alarm feature allows transit drivers to request assistance from dispatching in case of an emergency. Often there is a direct link of this feature to the authorities. The onboard transit security system is usually linked to the transit vehicle tracking system. Therefore, a vehicle can be quickly located during emergencies.

Transit Facility Security

Transit facility security provides remote, real-time video monitoring and recording of the passenger safety environment at transit stops and in stations. It allows passengers to request assistance via a two-way intercom system in case of an emergency. A direct link is often provided to the authorities.

Parking Facility Security

Parking facility security provides remote, real-time video monitoring and recording of the safety environment in parking lots and garages. It allows patrons to request assistance via a two-way intercom system in case of an emergency. A direct link may also be provided to the authorities.

Operations Concepts

The operations concepts improve the operations and maintenance functions of the transit system. They control access to and automate docking at BRT stations, monitor vehicle mechanics and manage maintenance, provide priority to buses at traffic signals, and assist in the dispatching of transit police. In short, the operation concepts improve transit travel times by reducing dwell times at stations and traffic signal delays, improve equipment reliability and reduce the number of delays due to equipment failure, and improve response time in emergencies. Each of the operations concepts is discussed below.

BRT Station Lane Access Control

This concept limits access at BRT stations to BRT buses. It prevents passenger vehicles and trucks from accidentally traveling on the entrance ramp to a BRT station. A gate, located at the front of the entrance ramp, is used to control BRT station access. The gate opens as a BRT bus, equipped with a transponder, passes a transponder reader upstream from the BRT station entrance ramp.

BRT Precision Docking System

A precision docking system assists drivers in correctly placing a transit vehicle at a stop or station. For example, the system would automatically position a bus, or assist a bus driver in positioning a bus, at a BRT station during a stop. The system designates where the bus must stop along the station platform.

Transit Vehicle Mechanical Safety Monitoring and Maintenance

This concept automatically monitors the condition of transit vehicle engine components, via engine sensors, and provides warnings if failures occur. The system may be linked to the transit vehicle track-

ing system to log the location and time of an incident, and to transmit real-time data to the transit management center or depot. This concept also provides vehicle diagnostics and manages the maintenance records of transit vehicles. It may simply consist of a computer spreadsheet to record and monitor maintenance activity or be a sophisticated computerized diagnostic system. Engine data, stored in the vehicle's processor, may be downloaded onto the central system for analysis.

Traffic Signal Priority (TSP) Study

Traffic signal priority holds a traffic signal green, or turns it green earlier than scheduled, to provide right-of-way to transit vehicles. Signal priority is typically granted to transit vehicles running behind schedule. The number of passengers onboard the transit vehicle may also be used as a criterion in determining whether or not to grant the transit vehicle priority. This system can be linked to the transit vehicle tracking system to determine if the vehicle is running behind schedule. It could also be linked to an APC system to determine the number of passengers onboard the vehicle.

Emergency Response

The emergency response concept provides automatic location of transit police vehicles and computerized dispatching to assist dispatchers in deploying appropriate resources to an emergency quickly and efficiently. This concept may be coordinated with transit vehicle tracking/onboard transit security, transit facility security, and parking facility security. The emergency response concept included here is for the designated transit operator. The emergency response concept included in the coordination concepts ties the emergency response systems of several agencies (e.g., VDOT, Virginia State Police, and local police, fire, and emergency management services) together for inter-agency coordination.

MONITOR CONCEPTS

Some ITS concepts are applicable to the Dulles Corridor but are technologically immature. However, these technologies are expected to become more reliable and proven over time. A few other concepts are technologically mature but ranked lower than the implementation concepts during the prioritization process (i.e., APCs and platform screen doors). However, their deployment would still be beneficial for the Corridor and their ranking may improve in the future, depending on needs. These concepts should be monitored over time and should be implemented if it is determined that they are reliable and address the needs and goals for the Corridor. The monitor concepts are shown in the outer ring of Figure 1.

Technology is developing at a rapid pace these days. For ITS, what may currently be the state of the art may be obsolete in five to ten years. Also, what is not reliable or proven today may be commonplace in the next decade. The market is a major driving force for this. A technology that can provide greater benefits at a reasonable price will tend to be more popular. Immature technologies tend to be costly. Research and development costs are recouped during the initial years of implementation. Over time, the cost tends to go down as the market for the technology increases and its use becomes widespread. In addition, cutting edge technologies may be more costly to operate and maintain than proven technologies.

Therefore, the above ITS concepts should be monitored during the life of the project and beyond. They have great potential and can provide significant benefits as costs eventually come down.

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REFERENCES

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