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Dulles Corridor Technology Task Group Policy Statement

C:dctftech

Dulles Corridor Task Force

Technology Application Criteria and Policy

Technologies derived from the aerospace industry can be used to make transit systems more attractive for the user, increase their on-time performance, improve their efficiency and build towards a whole new 21st century urban transportation environment. Some of these technologies are commonplace in other cities while others are developmental or evolutionary. *These technologies are generically referred to as Intelligent Transportation Systems (ITS) enhancements to conventional highway and transit systems, Personal Rapid Transit (PRT) of which the first is running in prototype form, and longer term Automatic Highway Systems (AHS) which were first demonstrated in 1997.*

The DCIIS plan, for which the Dulles Corridor federal appropriation was obtained, is a phased multi-modal concept, which envisioned the extensive use of appropriate new technologies to attract a high level of transit use from a relatively wealthy suburban area.

The near term technologies are summarized in attachment 1, the far term concepts in attachment 2 and the technology section of the DCIIS plan is attachment 3. The technology choice is broad. The purpose of this note is to define in lay terms the criteria which should be applied to the application of technology in the Dulles Corridor. The Corridor is defined as the actual transportation corridor plus its "trafficshed".

1. ***The overall goal is the creation of a whole new 21st Century transportion environment in the Dulles Corridor by the year 2010. A building-block approach should be adopted for the application of current and evolving technologies.***
   Background:
   - The National Capital Region faces a 70% increase in highway demand and a 20% increase in highway capacity based on conventional systems. The Dulles Corridor trafficshed is projected to gain *about 25% of the new jobs and households projected for the entire region by 2020.*
   - Effective transportation will not be achieved simply by extrapolating the conventional highway and transit systems that have resulted in the region's current congested system.
   - New ideas and technologies are evolving and their application involves various degrees of risk.
   - The DCTF should not be deterred by long term evolution requirements if the potential gain to the traveler and taxpayer is substantial.

2. ***Technology should be applied where there is a pay-off for the customer or the operator.***
   - Examples include technologies which:
     a) heighten the system's appeal to users
     b) reduces trip time and increase on-time performance

c) increase system productivity.

3. ***Risk should be held commensurate with the time scale and potential pay-off.***
Governments for good reason traditionally are not risk-takers.

- The risks should be well understood for each application.
- The promise should not be oversold to the public.
- For higher risk applications the basic system should be able to function at some level if the application falls behind schedule or fails to meet its full promise.
- Phase 2 can accept less risk than later phases due to its short time scale.
- Visible short-term success is desirable.

4. ***Dulles Corridor Systems should have a high degree of compatibility and integration with all modes of connecting systems.***
   - A high degree of seamless use is important if commuters are to be attracted to use the Dulles Corridor system.
   - Compatibility extends to the provision of real time information for the user and to the coordination of scheduling, operation and control between connecting elements.
   - "Seamless use" should be extended when practical, from transit fare cards to include a single electronic card to pay fares, parking at transit stations and highway tolls.
   - "Compatibility" should be considered with respect to coordination and control of all transportation features in the Dulles Corridor and its trafficshed including toll roads, future "Hot Lanes", traffic management systems and other future road based or fixed guideway systems.
   - However, application to the Dulles Corridor project should not be unreasonably delayed by compatibility considerations.

5. ***The objective and time scale for each technological application should be clearly defined and linked to a system of "payment by results," with contractors.***
   - Technology advances rapidly. The perfect can be the enemy of the good. Proposals to add the latest advance should be measured against the objective and time scale.
   - Whenever practical the design concept or "system architecture", should have the flexibility to accept up grades.

6. ***It should be recognized that even "proven" technologies would require some development to adapt them to the specifics of the Dulles Corridor system.***
   - If the technology already is working well in Metro or another connecting system, extension of that technology to the Dulles Corridor would be the lowest risk option providing it does not involve future technological or other limitations.
   - **Definitions**:
     Level 1: If the technology is in use elsewhere it's available "off the shelf" which implies no risk. But while proven units may be available those units

will have to be integrated into an operating system specific to the Dulles Corridor project.
Level 2: If the technology is available but not supported by user experience, the development and integration required for the Dulles Corridor will require more time and risk.
Level 3: If the technology has been demonstrated but has yet to be engineered for production, the time scale performance and probably cost, will be uncertain.

7. ***The DCTF should not be deterred by long term evolution requirements if the potential gain to the traveler and taxpayer is substantial.***
   - In Phase 2, the first phase to be technologically enhanced, the time scale is short and applications should be limited to level 1 risk.
   - Phase 3, the BRT, has a longer lead time with which to accept risk.
   - For Phase 4 the DCTF should consider the potential identified in the DCIIS, of the new concepts under development that offer a whole new level of transportation capability.

Recommendation: The DCTF as the current managing entity, should appoint a technology manager now and use a subcontractor to *create* its "system architecture" *before the end of June.*

Dulles Corridor Rapid Transit Technology Concepts Description

Dulles Corridor Rapid Transit ITS Concepts -- REVISED 8/16/99

Preliminary Candidate Technologies	Description / Functional Performance	Technology/ Technique	Technology Status	Prerequisite System	Current Regional Applications	Benefits	Issues	Dulles Phase
Public Transportation Systems								
1. Transit Vehicle Tracking (AVL)	Provides real-time location information for schedule adherence, dispatch, and traveler information. Optional features include silent alarm for alerting dispatchers of emergencies, and vehicle engine probes to alert dispatchers of potential engine problems	- GPS (GPS receiver) - Dead Reckoning (odometer, compass) - Signpost and Odometer (radio beacons, reader, odometer) - Ground-based Radio	Existing	None	- PRTC - Montgomery County - VDOT Snow Plow Pilot - WMATA Columbia Pike	- Security, safety - Enhanced operations - Better customer information	Prerequisite for many other technologies	Phase 2 +
2. Transit Fixed-Route Software	Computer software that assists transit properties in planning and operating transit fixed-route services. Performs automatic driver assignment, vehicle monitoring, and routing and scheduling	hardware, software	Existing	May use schedule performance data from transit vehicle tracking system for route and schedule planning	- PRTC (FlexRoute) - Montgomery County	- Improves operating efficiency - Better customer satisfaction		Phase 2 +
3. Demand Response Transit Software (ParaTransit)	Computer software that assists dispatchers in allocating transit fleet resources to demand response service requests. Performs driver assignment, vehicle monitoring, and routing and scheduling of transit vehicles. Provides data processing and information display to assist dispatchers in making optimal use of the transit fleet. Area of application includes Tyson's Corner.	hardware, software	Existing	May use real-time transit vehicle tracking data for dynamic routing and scheduling of transit fleet	- PRTC (FlexRoute)	- Improves operating efficiency - Enhanced trip scheduling - Better customer satisfaction		Phase 2 +
4. Automatic Passenger Counters (APC)	Automatically counts the number of people boarding and alighting a transit vehicle to determine passenger loading. Data are used for planning and analysis purposes, in determining real-time loads (to dispatch additional vehicles during periods of heavy ridership), and sometimes in determining traffic signal priority requests. Data may be downloaded to the control center manually or automatically (via vehicle communications system)	- Treadle Mats - Infrared Beams - Video Imaging - EFP systems are sometimes used as a means of automatically counting passengers, for rail systems	Existing	APCs are often coupled with the transit vehicle tracking system	- None	- Improves planning and route scheduling/dispatching - Enhances operations		Phase 2 +
5. Electronic Fare Payment (EFP)	Provides an electronic means of collecting and processing fares. Customers use a smart card instead of tokens or cash to pay for transit rides.	- Magnetic Stripe Card - Credit Card - Contact Smart Card - Proximity Smart Card	Existing	May be coupled with transit vehicle tracking system for flex fare system (distance-based fare collection); can use the same payment media and systems as parking facility electronic payment and electronic toll collection systems	- WMATA SmarTrip - ITS Task Force Electronic Payment Study	- Improves operating efficiency - Reduces lost transactions - Better customer satisfaction	Compatibility with electronic toll collection (Smart Tag) and other systems	Phase 3 +
6. Parking Facility Electronic Payment	Collects parking fees electronically, determines parking space availability, and detects and processes violators.	- Vehicle/Roadside Short Range Communications (tag, reader) - Electronic Card	Existing	Can use the same payment media and systems as transit electronic fare payment and electronic toll collection systems	- WMATA SmarTrip (Metrorail) - DC Parking Meter Payments - Arlington Parking Meter Payments	- Provides customer service - Enhances operations	Compatibility with electronic toll collection (Smart Tag) and other systems.	Phase 3 +
7. On-board Transit Security	Provides remote visual monitoring/recording of the passenger safety environment on board the transit vehicle. Allows drivers and passengers to request assistance in case of an emergency. Direct link to authorities.	Surveillance, communications, systems	Existing	Transit Vehicle Tracking	- Montgomery County	- Enhances safety - Better customer satisfaction	privacy, monitoring	Phase 2 +
8. Transit Facility Security	Provides remote visual monitoring/recording of the passenger safety environment in stations, parking lots, and at transit stops. Allows passenger to request assistance in case of an emergency. Direct link to authorities.	- Surveillance, communications, systems - Solar-powered bus stops	Existing	None	- Metrorail Stations and Parking Lots	- Enhances safety - Better customer satisfaction	privacy, monitoring	Phase 3 +
9. Parking Facility Security	Provides remote visual monitoring/recording of the safety environment for persons in parking lots. Allows person to request assistance in case of an emergency.	Surveillance, communications systems	Existing	None	- VDOT I-95 Park & Ride Lots Security and Surveillance (planned)	- Improves safety - Provides customer service - Enhances operations	privacy, monitoring	Phase 2 +
10. Transit Vehicle Mechanical Safety Monitoring and Maintenance	Automatically monitors the condition of transit vehicle engine components and provides warnings if failures occur. Manages the maintenance records of transit vehicles.	Sensors, systems	Existing	May be coupled with transit vehicle tracking system for real-time engine component monitoring at transit management center	- WMATA Columbia Pike and Falls Church electric bus	- Improves operations - Improves vehicle maintenance		Phase 2 +

Preliminary Candidate Technologies	Description / Functional Performance	Technology/ Technique	Technology Status	Prerequisite System	Current Regional Applications	Benefits	Issues	Dulles Phase
11. Multi-modal Coordination	Establishes two-way communications between multiple transit and traffic agencies, or transit mode operators, to improve operations and service coordination. Includes timed transfers of transit vehicles.	hardware, software	Existing	Transit Vehicle Tracking	- Metrobus/Metrorail - SmarTraveler Agency Server - IEN	- Improves Regional Communication and Coordination - Improves Operations		Phase 2 +
12. On-board Electronic Destination Signs	The external display of bus route / rail line information on transit vehicles. Information includes route/line destination and/or bus route number / rail line, indicating the bus route / rail line and direction the vehicle is traveling. Electronic displays are typically mounted on the front and side(s) of the transit vehicle	- Dot Matrix Sign - LED Sign - LCD Sign	Existing	May be coupled with transit vehicle tracking system to change displayed information automatically at end of route/line	- Metrobus/Metrorail - Montgomery County	- Better customer service -Enhanced operations	Information must be very accurate	Phase 2 +
13. In-vehicle Traveler Information	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.	- AVL-triggered Announcements - Beacon-triggered Announcements - LED Dynamic Message Sign - LCD Dynamic Message Sign - Dot Matrix Dynamic Message Sign	Developing	Transit vehicle tracking for AVL-triggered announcements	- None	- Better customer service -Enhanced operations	Information must be very accurate; technology status	Phase 3 +
14. Automated Public Address System	Automatically routes messages to designated stations. Messages may be pre-recorded or voice synthesized. System may be operated manually (live voice messages). May be coupled with visual in-station traveler information system.	hardware, software	Existing	PA Infrastructure	- VRE Trip	- Better customer service -Enhanced operations	ADA - visual signs also needed	Phase 3 +
15. Wayside/In-station Traveler Information	Provides real-time arrival/departure information at bus stops and terminals, and train stations and platforms.	- LED Dynamic Message Sign - LCD Dynamic Message Sign - Dot Matrix Dynamic Message Sign - CRT Display Monitor - Solar-powered bus stops	Existing	Transit Vehicle Tracking	- VRE Trip	- Better customer service -Enhanced operations	Technology status; information must be very accurate; ADA; vandalism; maintenance	Phase 3 +
16. Parking Facility Information	Dynamic messages signs that provide parking availability information and parking lot navigational guidance.	Hardware, software	Developing	Parking Facility Electronic Payment	- VDOT I-95 Park & Ride Lots Parking Guidance Info	- Provides customer service - Enhances operations	Technology status information must be very accurate	Phase 4 +
Traveler Information Systems								
17. Broadcast Traveler Information	Non-interactive traveler information, such as travel advisories/reports, general transit information, video footage, and public service announcements, provided over the telephone, television, and radio.	- Telephone - Television - Radio - Internet	Existing	Transit vehicle tracking and traffic network surveillance for real-time information	- SmarTraveler - VDOT - WMATA	- Better customer service -Enhanced operations	Need to coordinate with SmarTraveler. Information must be accurate	Phase 2 +
18. Interactive Kiosks	Provides tailored static information, via agency/company-owned kiosks, in response to a traveler request. Information provided includes travel advisories, traffic conditions, transit services, traveler services, ride share/match, parking information, and fare/pricing information. Kiosks may link to an Internet web site or centrally-controlled traveler information database as a means of accessing traveler information.	hardware, software, communications	Existing	Transit vehicle tracking and traffic network surveillance for real-time information	- Fairfax County Kiosk Program - Arlington County Kiosk Program - MWCOG Kiosk Program	- Better customer service -Enhanced operations	vandalism, maintenance	Phase 2 +
19. Transit Trip Itinerary Planning	Software that generates a transit trip itinerary (route, schedule, and fare information) based on user-specified trip parameters such as trip origin/destination and travel time, and criteria such as fastest route, lowest fare, least number of transfers, and least walking distance. Integration of multiple transit systems is an option. Delivery mechanisms include the Internet and traveler information telephone systems.	hardware, software	Existing	None	- WMATA's ARTS System	- Better customer service -Enhanced operations	Information must be very accurate	Phase 2 +
20. Interactive Traveler Information -- Personal Information Access	Provides tailored information, via personal devices, in response to a traveler request. Includes interactive request/response systems and information systems that "push" a tailored stream of information to the traveler based on the traveler's submitted profile. Information provided includes travel advisories, traffic conditions, transit services, traveler services, ride share/match, parking information, and fare/pricing information.	- Telephone - PC (Internet Web Site) - Pager / Personal Data Devices - Fax -E-mail	Developing	Transit vehicle tracking and traffic network surveillance for real-time information	- SmarTraveler - VRE Trip - VRE Express Link - Fairfax City TDM Info	- Better customer service -Enhanced operations	Information must be very accurate	Phase 2 +

Preliminary Candidate Technologies	Description / Functional Performance	Technology/ Technique	Technology Status	Prerequisite System	Current Regional Applications	Benefits	Issues	Dulles Phase
Traffic Management Systems								
21. Traffic Network Data Collection	Collect traffic data, such as vehicle speeds, occupancy, and volumes, via a number of devices for incident detection, roadway system management, and planning	- CCTV - Loop Detectors - Radar	Existing	Traffic Operations/Management Centers	- VDOT Smart Traffic Center - Smart Traffic Center - VDOT VA Beltway Detection - Alexandria Red Light Cameras - MdSHA TOC - Montgomery Co. ATMS - Montgomery County TOC - Chesapeake HA Routing Traffic	- Improves operations - Enhances safety - Improves Regional Mobility - Meets regional goals	Information must be very accurate; maintenance	Phase 2 & 3
22. Probe Data Collection	Uses vehicles as a means of collecting traffic data. This approach is an alternative to Traffic Network Data Collection. Most systems use electronic toll collection technology to collect traffic data. Another method uses wide-area wireless communications between vehicles and an information service provider (ISP).	- Vehicle/Roadside Short Range Communication (tag, reader) - Vehicle/ISP Wide-area Wireless Communications	Existing	Electronic Toll Collection, cellular coverage	- SmarTraveler	- Enhances traffic information - Provides data to other transportation technology systems	Information must be very accurate; maintenance	Phase 2 +
23. Traffic Signal Priority	Holds traffic signal green, or turns it green earlier than scheduled, to provide right-of-way to transit vehicle. Signal priority is typically granted to transit vehicles running behind schedule. The number of passengers on board the transit vehicle may also be used as a criterion in determining whether or not to grant the transit vehicle priority.	- DGPS - RF - Spread Spectrum Radio - Video - Infrared - Optical	Developing	Transit Vehicle Tracking, Multi-modal Coordination (optional)	- ITS Task Force Signal Priority Treatment Study - NOVA Signal Coordination (Preemption only) - WMATA Columbia Pike - Montgomery County - MD 210/Rt 5 - DC Georgia Avenue (planned)	- Improves schedule adherence - Enhances transit attractiveness	Highly political. No adopted standards for the region	Phase 2 +
24. Computerized Traffic Signal Control	Central control and monitoring of surface street traffic signals	hardware, software, communications	Existing	None	- VDOT Smart Signal System - Montgomery County - DC DPW - Arlington County - City of Alexandria - City of Fairfax	- Provides BRT line crossing control - Enhances operations	Highly political. No adopted standards for the region	Phase 2 & 3
25. Lane Control	Controls use of surface street and freeway lanes via electronic signage. Examples include dynamic lane closure and HOV signs.	hardware, software, communications	Existing	None	- VDOT	- Enhances operations	Limited information on signs	Phase 2 & 3
26. Freeway Ramp and Interchange Metering with Queue Jumping	Controls the number and timing of vehicles entering a freeway. Helps to reduce or eliminate a surge of vehicles entering the freeway system. High-occupancy vehicles (including transit vehicles) are allowed to bypass the metered queue of vehicles.	hardware, software, communications	Existing	None	- VDOT	- Enhances operations	Capacity for preemption/queue jumping lots	Phase 2 +
27. Lane Access Control and Reversible Lane Management	Controls the access to and direction of traffic flow in reversible lanes. Control is typically accomplished via dynamic message signs, and physical means such as ramp gates and moveable barriers. May also detect vehicles traveling the wrong way via sensory and surveillance devices. May provide control for BRT lane entry.	- Dynamic Message Sign (dot matrix) - Dynamic Physical Barriers (moveable Jersey barrier, ramp gate) - Vehicle/roadside Short Range Communications (tag, reader) - Surveillance (CCTV, loop detectors)	Existing	None	- VDOT	- Enhances operations	Safety	Phase 3 +
28. Regional Traffic Control	Provides electronic communication among traffic agencies to allow coordinated, interjurisdictional control of traffic signals.	hardware, software	Developing	Computerized Traffic Signal Control	- None	- Enhances operations	Highly political	Phase 3 +
29. Incident Management System	Detects, verifies, and implements response to incidents. Provides electronic communication among transit agencies, traffic agencies, and emergency management service providers for coordinated response and management of incidents.	hardware, software, communications	Existing	Traffic Network Data Collection	- Montgomery County ATMS - VDOT Smart Traffic Center	- Improves safety - Provides customer service - Enhances operations	Co-location (Montgomery County)	Phase 2 +
30. Traffic Prediction and Demand Management	The collection, storage, and processing of transportation data for historical evaluation, real-time assessment, and forecast of the roadway network performance.	hardware, software	Developing	transportation data collection systems	- VDOT Data Warehouse - COG Data Warehouse (planned)	- Better resource management - Enhances data organization	Technology status	Phase 3 +

Preliminary Candidate Technologies	Description / Functional Performance	Technology/ Technique	Technology Status	Prerequisite System	Current Regional Applications	Benefits	Issues	Dulles Phase
31. Electronic Toll Collection	Collect tolls electronically, and detect and process violators	- Vehicle/Roadside Short Range Communications (tag, reader)	Existing	Can use the same payment media and systems as transit electronic fare payment and parking facility electronic payment systems	- VDOT Smart Tag - MWAA AVI Study	- Provides customer service - Enhances operations	Compatibility with electronic fare collection (Smart Trip) and other systems	Phase 2 +
32. Traffic Information Dissemination	Disseminate traffic information (congestion, incidents, etc.) to motorists using roadway equipment such as dynamic message signs (a k.a. VMS) and highway advisory radio (HAR).	- Dot Matrix Dynamic Message Signs - HAR	Existing	None	- VDOT VMS - VDOT HAR - DC VMS - DC HAR - MdSHA VMS - MdSHA HAR	- Provides safety and delay information to travelers - Improves operations	Information must be very accurate	Phase 2 +
33. Road Weather Information System	Collects and analyzes road and weather conditions on or near the roadway. Collected road weather information is monitored to detect and forecast weather related hazards such as icy road/bridge conditions, dense fog, and approaching severe weather fronts. Information is used to deploy road maintenance resources, and issue location specific warnings and general travel advisories.	Sensors, communications, systems	Developing	None		- Provides customer service - Enhances operations	Technology status. Information must be very accurate.	Phase 3 +
Vehicle Safety Systems								
34. Driver Safety Monitoring	Determines a driver's condition and performance, and warns the driver of potential dangers	- Lane Tracker - Infrared Camera	Immature	None	- None	- Improves safety	Technology status	Phase 4 +
35. Longitudinal Safety Warning	Warns driver of a potential rear-end collision. Uses collision sensors on the front and rear of the vehicle to detect impending longitudinal collisions.	- Radar	Developing	None	- None	- Improves safety	Technology status	Phase 3 +
36. Lateral Safety Warning	Warns driver of a potential side collision. Uses collision sensors on the sides of the vehicle to detect impending lateral collisions.	- Radar	Developing	None	- None	- Improves safety	Technology status	Phase 3 +
37. Advanced Vehicle Longitudinal Control	Automates speed and headway control functions using collision sensors and vehicle dynamics processing to control the throttle and brakes.	- Radar	Developing	Longitudinal Safety Warning System	- None	- Improves safety	Technology status	Phase 3 +
38. Advanced Vehicle Lateral Control	Automates the steering control function using collision sensors, vehicle dynamics, and other sensors to measure the lane position and lateral deviations, and to control steering.	- Roadway Magnets (disks, tape) - Video Imaging	Immature	Lateral Safety Warning System	- None	- Improves safety	Technology status	Phase 4 +
39. Intersection Safety Warning	Provides the vehicle operator with a warning of potential hazards at an intersection.		Immature		- None	-Improves Safety	Technology status	Phase 3 +
40. Intersection Collision Avoidance	Determines probability of collision and provides warnings to vehicles.		Immature		- None	-Improves Safety	Technology status	Phase 3 +
41. Driver Visibility Improvement	Enhances driver visibility using an enhanced vision system.	- Infrared cameras	Immature	None	- None	- Improves safety	Technology status	Phase 4 +
42. In-vehicle Signing	Provides travel advisory, warning/regulatory, and other driver information through in-vehicle devices. The information helps transit drivers operate transit vehicles safely and efficiently.	- Vehicle/Roadside Short Range Communications	Immature	None	- None	- Improves operations - Enhances safety	Technology status Information must be very accurate	Phase 4 +
43. Pre-crash Restraint	Determines the probability of a collision and, if determined that a collision is within a certain degree of certainty, deploys a pre-crash restraint mechanism to protect the driver and passengers against the collision. A vehicle air bag system is a somewhat similar concept.	Sensors, systems	Immature	Longitudinal and Lateral Safety Warning Systems	- None	- Improves safety	Technology status	Phase 4 +
44. Emergency Response	Provides automatic location of transit police vehicles and computerized dispatching to assist dispatchers in deploying appropriate resources to an emergency quickly and efficiently.	- GPS	Existing	None		- Improves safety - Better incident control and response	Technology status	Phase 2 +
45. Precision Docking Systems	Assists driver in correctly placing the transit vehicle at a stop.	Proximity sensors	Developing	None	- None	- Improves loading operation - Better customer satisfaction - Reduces damage	Technology status	Phase 3 +

Preliminary Candidate Technologies	Description / Functional Performance	Technology/ Technique	Technology Status	Prerequisite System	Current Regional Applications	Benefits	Issues	Dulles Phase
46. Automated Highway/Rail System	Automates driving functions -- enables "hands-off" operation of a vehicle	Sensors, systems, communications	Immature	Advanced Vehicle Longitudinal and Lateral Control Systems		- Improves safety - Increased capacity	Technology status	Phase 4 +
47. Emissions Monitoring and Management	Monitors individual vehicle emissions and general air quality within a corridor or area. Information is used to manage emissions and to implement environmentally sensitive TDM programs, policies, and regulations.	Sensors, Communications	Developing	None	- None	- Supports regional goals	Technology status	Phase 4 +
ITS Planning								
48. ITS Planning	ITS data collected from ITS systems used for policy making, funding allocation, and planning.	hardware, software, communications	Existing	ITS data collection systems	- ITS Task Force (preemption/priority study and electronic payment study) - WMATA Electronic Payment Study - VDOT -- Northern Virginia EDP - VDOT -- NOVA ITS Framework - DC DPW -- Washington DC EDP - I-95 Corridor Coalition - ITS Task Force Umbrella Study - ITS Task Force ITS Training - VDOT Woodrow Wilson ITS Design (planned)	- Supports regional goals - Provides for better systems/projects - Reduces technology takeover	Highly political. Coordination with multiple jurisdictions	Phase 2 +
Personal Rapid Transit								
49. Personal Rapid Transit (PRT)	Provide direct origin to destination transportation service, on demand, via a fixed-guideway network. Vehicles, that travel on the fixed guideway, are fully automated and accommodate a small group of people (typically one to six passengers).	- Hanging Suspension - Air Suspension - Linear Induction Motor	Developing	None	- None	- Reduces pollution - Increases customer comfort and convenience (e.g., privacy, minimal weight time, no transfers, etc.) - Increases service performance - Reduces operating costs - Can be implemented incrementally	Technology status	Phase 4 +
Miscellaneous								
50. Platform Screen Doors	Provides a safety barrier between the platform edge and the transitway -- prevents passengers from falling from the platform onto the transitway. The system is integrated with a precision docking system. When the transit vehicle arrives at a stop, the transit vehicle doors line up with the platform screen doors, through which passengers board and alight the transit vehicle.	- Structure and Transparent Barrier - Actuated Screen Doors - Vehicle Detectors	Existing	Precision Docking System	- None	- Security, safety - Energy savings (from reduction in heating / air conditioning for enclosed stations)	Requires reconfiguration for change in vehicle types (alignment issues)	Phase 3 +

Dulles Corridor Rapid Transit Technology Concepts Evaluation Matrix

Dulles Corridor Rapid Transit Project ITS Concept Evaluation Matrix (Prioritized) -- REVISED 8/16/99

ITS Concepts	Evaluation Criteria							Total Score
	Consistency with the Tech. Task Group's Application Criteria and Policy	Technical Feasibility	Customer Benefits	Operator Benefits	Integration and Compatibility with Existing and Planned Systems	Cost Effectiveness	Community and Agency Opportunity	
Weights	5	4	5	5	2	4	3	
1. Transit Vehicle Tracking (AVL)	10	8	8	10	7	9	8	246
5. Electronic Fare Payment (EFP)	10	8	9	9	5	7	9	237
2. Transit Fixed-Route Software	8	9	8	9	8	9	7	234
7. On-board Transit Security	9	8	8	8	7	7	10	229
16. Parking Facility Information	10	7	9	8	7	7	8	229
8. Transit Facility Security	9	9	8	7	7	7	10	228
9. Parking Facility Security	9	9	8	7	7	7	10	228
11. Multi-modal Coordination	10	8	8	8	6	6	9	225
6. Parking Facility Electronic Payment	10	7	8	8	6	6	7	215
3. Demand Response Transit Software (ParaTransit)	4	8	9	9	8	9	6	212
44. Emergency Response	7	8	7	9	6	7	8	211
29. Incident Management System	5	9	7	8	8	8	8	208
31. Electronic Toll Collection	5	9	8	8	7	7	8	207
15. Wayside/In-station Traveler Information	10	7	9	5	5	6	8	206
19. Transit Trip Itinerary Planning	8	6	8	8	6	6	8	204
13. In-vehicle Traveler Information	10	5	10	5	6	6	7	202
14. Automated Public Address System	8	9	8	5	7	6	7	200
32. Traffic Information Dissemination	5	8	8	7	8	7	8	200
24. Computerized Traffic Signal Control	6	9	5	9	8	8	5	199

ITS Concepts	Evaluation Criteria							Total Score
	Consistency with the Tech. Task Group's Application Criteria and Policy	Technical Feasibility	Customer Benefits	Operator Benefits	Integration and Compatibility with Existing and Planned Systems	Cost Effectiveness	Community and Agency Opportunity	
Weights	5	4	5	5	2	4	3	
49. Personal Rapid Transit (PRT)	8	6	8	7	6	6	8	199
20. Interactive Traveler Information -- Personal Information Access	6	8	8	5	7	8	8	197
26. Freeway Ramp and Interchange Metering with Queue Jumping	6	8	7	7	6	8	6	194
50. Platform Screen Doors	6	7	8	7	6	6	7	190
27. Lane Access Control and Reversible Lane Management	6	9	5	8	7	7	5	188
45. Precision Docking Systems	7	6	8	8	6	5	5	186
23. Traffic Signal Priority	7	7	7	7	6	6	5	184
17. Broadcast Traveler Information	5	8	7	6	6	7	7	183
48. ITS Planning	6	7	5	7	6	7	8	182
10. Transit Vehicle Mechanical Safety Monitoring and Maintenance	6	7	6	8	5	6	6	180
12. On-board Electronic Destination Signs	6	7	7	7	7	5	5	177
4. Automatic Passenger Counters (APC)	5	6	4	8	7	7	5	166
35. Longitudinal Safety Warning	6	6	5	7	5	6	6	166
36. Lateral Safety Warning	6	5	5	7	5	6	6	162
21. Traffic Network Data Collection	2	7	5	6	6	8	8	161
25. Lane Control	1	9	5	5	8	8	6	157
30. Traffic Prediction and Demand Management	5	5	5	5	5	7	6	151
47. Emissions Monitoring and Management	3	5	5	6	6	6	8	150

ITS Concepts	Evaluation Criteria							Total Score
	Consistency with the Tech. Task Group's Application Criteria and Policy	Technical Feasibility	Customer Benefits	Operator Benefits	Integration and Compatibility with Existing and Planned Systems	Cost Effectiveness	Community and Agency Opportunity	
Weights	5	4	5	5	2	4	3	
18. Interactive Kiosks	5	8	5	3	5	5	7	148
37. Advanced Vehicle Longitudinal Control	4	5	5	6	6	6	5	146
38. Advanced Vehicle Lateral Control	4	5	5	6	6	6	5	146
28. Regional Traffic Control	3	6	5	5	5	7	6	145
34. Driver Safety Monitoring	6	3	5	7	4	4	5	141
33. Road Weather Information System	1	8	5	5	5	6	6	139
39. Intersection Safety Warning	3	4	6	6	5	5	6	139
22. Probe Data Collection	5	5	3	5	7	5	5	134
40. Intersection Collision Avoidance	3	3	6	6	4	5	6	133
43. Pre-crash Restraint	2	4	5	5	5	6	6	128
41. Driver Visibility Improvement	2	3	6	6	5	5	5	127
46. Automated Highway/Rail System	8	2	5	5	2	2	5	125
42. In-vehicle Signing	2	4	3	5	5	4	4	104

Note: ITS concepts are rated on a scale of 0 to 10 on how they meet each of the evaluation criteria (0 = meets criterion negatively, 1 = does not meet criterion, 5 = meets criterion, 10 = completely meets criterion).

Dulles Corridor Rapid Transit Technology Implementation Concepts Phasing

Dulles Corridor Rapid Transit Project ITS Concept Phasing – REVISED 8/31/99

A list of ITS concepts applicable to the Dulles Corridor was compiled and analyzed. The most beneficial ITS concepts, with respect to the Dulles Corridor Rapid Transit project, were identified and are recommended for deployment. The phase in which these ITS concepts should become operational is provided below. Operational means that the system is fully deployed, has passed acceptance testing, and is operating on a full-time basis. The list on the left (see below) contains ITS concepts that should be implemented by the Corridor's designated transit operator as a part of the Dulles Corridor Rapid Transit project. The number of concepts in this list is limited due to fiscal constraints. The list on the right (see below) contains ITS concetps that should be implemented in the Corridor, but by an agency/organization other than the Corridor's designated transit operator. These ITS concepts deal with functions typically provided by VDOT or some other non-transit entity. ITS concepts that have already been deployed in the Dulles Corridor, or ITS concepts that are not recommended for deployment in the Dulles Corridor, are not listed. A glossary of ITS concepts with deployment examples is provided at the end of this document.

Phase I – Express Bus 1999 - 2001

Dulles Corridor Transit Agency

Other Transportation Agencies

- Interactive Traveler Information – Personal information Access (SmarTraveler)
- Broadcast Traveler Information (SmarTraveler)

Phase II – Enhanced Express Bus 2001 - 2003

Dulles Corridor Transit Agency

- Parking Facility Information
- ITS Planning

Other Transportation Agencies

- Traffic Information Dissemination (VDOT)
- Interactive Kiosks (WashCOG)

Phase III – Bus Rapid Transit 2003 - 2010

Dulles Corridor Transit Agency

- Transit Vehicle Tracking
- Electronic Fare Payment
- On-Board Transit Security
- Transit Facility Security
- Parking Facility Security
- Multi-modal coordination

Other Transportation Agencies

- Intersection Safety Warning (DAAR operator)

- Parking Facility Electronic Payment
- Wayside/In-station Traveler Information
- In-vehicle Traveler Information
- Lane Access Control
- Precision Docking Systems
- Transit Vehicle Mechanical Safety Monitoring and Maintenance

Phase IV – Rail Tysons 2006 / Beyond 2010

Dulles Corridor Transit Agency	Other Transportation Agencies
• Emergency Response	• Traffic Prediction and Demand Management (VDOT, NVTC, WashCOG)
• Platform Screen Doors	• Emissions Monitoring and Management (NVTC, WashCOG)

Beyond Phase IV or As Needed

Dulles Corridor Transit Agency	Other Transportation Agencies
• Personal Rapid Transit (PRT)	• Freeway Ramp and Interchange Metering with Queue Jumping (VDOT)
• Traffic Signal Priority	• Traffic Signal Priority (appropriate traffic agency)
• Automatic Passenger Counters (APC)	
• Longitudinal Safety Warning	
• Lateral Safety Warning	
• Advanced Vehicle Longitudinal Control	
• Advanced Vehicle Lateral Control	
• Automated Highway/Rail System	• Automated Highway/Rail System (VDOT, DAAR operator)

Dulles Corridor Rapid Transit Project ITS Concept Phasing -- REVISED 8/31/99

The table below contains ITS concepts that are applicable to the Dulles Corridor. The number preceding each concept is the same as the number assigned to each concept in Technical Memorandum 1 (*Dulles Corridor Rapid Transit ITS Concepts*). The order in which the concepts appear below represent the order in which the concepts were ranked, from highest to lowest, in the evaluation exercise (the concepts were rated on how well they met certain evaluation criteria). Implementation phasing is provided below for the ITS concepts that are to be deployed by the Corridor's designated transit operator. Phasing steps include "planning," "pilot," and "operational." "Planning" is defined as the design, procurement, and installation of the ITS concept. "Pilot" is defined as the period during acceptance testing. "Operational" is defined as the ITS application being fully functional for revenue service. Implementation phasing is not provided below for ITS concepts that:

- are already implemented
- are primarily provided by a non-transit operator or other organization
- would be deployed on a specific or as-needed basis, or beyond phase 4
- are not recommended for implementation as a part of this project

Only the ITS concepts that contain phasing information in the table will be considered and recommended for implementation as a part of the Dulles Corridor Rapid Transit project. Due to fiscal constraints, the project is limited to recommending the deployment of the most applicable and beneficial ITS concepts in the Corridor. Further refinement in the selection of the recommended ITS concepts will commence with the identification of costs and relative benefits. ITS concepts not "making the cut" may be implemented by other agencies and projects, after completion of phase 4, or when funding becomes available. Refer to the "comments" column in the table for the justification and reasoning in selecting the ITS concepts recommended for implementation in this project.

ITS Concepts	Phase 1	Phase 2	Phase 3	Phase 4A	Phase 4B	Comments
1. Transit Vehicle Tracking (AVL)	Planning	Pilot	Operational	Operational	Operational	May be an enhancement/expansion of an operator's planned/existing system. Identify operator(s) in Phase 1.
5. Electronic Fare Payment (EFP)		Planning / Pilot	Operational	Operational	Operational	Coordinate with the WashCOG and WMATA electronic payment studies. Coordinate with concepts 6 and 31. Prerequisite: legacy EFP systems
2. Transit Fixed-Route Software						For bus service only. Transit agencies in the region currently have this system. Enhance/expand operator's existing system in Phase 3.
7. On-board Transit Security		Planning	Pilot / Operational	Operational	Operational	For bus service only. Application of this concept is tied to the procurement of transit vehicles; the level of functionality will be determined at the time of procurement.
16. Parking Facility Information	Planning / Pilot	Operational	Operational	Operational	Operational	Need to coordinate with VDOT for display of parking information on VDOT VMSs.
8. Transit Facility Security		Planning	Pilot / Operational	Operational	Operational	Install when BRT stations are built.
9. Parking Facility Security		Planning	Pilot / Operational	Operational	Operational	Operation of system is an issue (e.g., What agency will monitor the cameras?).
11. Multi-modal Coordination		Planning	Pilot / Operational	Operational	Operational	Need to establish coordination agreements among participating operators.

ITS Concepts	Phase 1	Phase 2	Phase 3	Phase 4A	Phase 4B	Comments
6. Parking Facility Electronic Payment		Planning / Pilot	Operational	Operational	Operational	Coordinate with concepts 5 and 31.
3. Demand Response Transit Software (ParaTransit)						Transit agencies in the region currently have this system.
44. Emergency Response		Planning	Pilot	Operational	Operational	Coordinate with concepts 7, 8, and 9.
29. Incident Management System						Is primarily a VDOT function -- coordinate with VDOT. Coordinate with concept 44.
31. Electronic Toll Collection						Is a VDOT function. Coordinate with concepts 5 and 6.
15. Wayside/In-station Traveler Information		Planning	Pilot / Operational	Operational	Operational	Provide static information initially, then provide real-time information. May want to coordinate information with concept 16. Prerequisite: AVL system for real-time information
19. Transit Trip Itinerary Planning						Expand WMATA's existing project.
13. In-vehicle Traveler Information		Planning	Pilot / Operational	Operational	Operational	Need mechanism to trigger announcements at specific locations. May use GPS receivers on board vehicle or beacons along transitway, or may integrate with AVL system.
14. Automated Public Address System						Provide function as a part of concept 15.
32. Traffic Information Dissemination						Is a VDOT function. Coordinate with and provide information to VDOT for transit-related announcements.
24. Computerized Traffic Signal Control						Is a VDOT function. A synchronized traffic signal system would improve bus service.
49. Personal Rapid Transit (PRT)						Progression of technology should be monitored. Concept may be applied in the future.
20. Interactive Traveler Information -- Personal Information Access						Information should be provided to travelers by SmarTraveler. Provide transit data to SmarTraveler.
26. Freeway Ramp and Interchange Metering with Queue Jumping						Is a VDOT function. Queue jumping would improve bus service.
50. Platform Screen Doors			Planning	Pilot / Operational	Operational	Deploy at underground airport station. Prerequisite: Precision Docking System
27. Lane Access Control and Reversible Lane Management		Planning / Pilot	Operational	Operational	Operational	Used for controlled access to BRT stations from the Dulles Airport Access Road. Need to establish what agency is responsible for deployment.
45. Precision Docking Systems		Planning / Pilot	Operational	Operational	Operational	
23. Traffic Signal Priority						May be applied on a site-specific basis (e.g., at station parking lots) if/when a need for deployment is determined.
17. Broadcast Traveler Information						Information should be provided to travelers by SmarTraveler. Provide transit data to SmarTraveler.

ITS Concepts	Phase 1	Phase 2	Phase 3	Phase 4A	Phase 4B	Comments
48. ITS Planning		Operational	Operational	Operational	Operational	Initial application of this concept may involve minimal use of technology and transportation data collected via ITS. Additional transportation data will be used over time as data collection increases.
10. Transit Vehicle Mechanical Safety Monitoring and Maintenance		Planning	Pilot / Operational	Operational	Operational	Application of this concept is tied to the procurement of transit vehicles; the level of functionality will be determined at the time of procurement. May be coupled with AVL system.
12. On-board Electronic Destination Signs						Is standard on transit vehicles.
4. Automatic Passenger Counters (APC)						Progression of technology should be monitored. Concept may be applied in the future. As an alternative, ridership data may be collected manually.
35. Longitudinal Safety Warning						Progression of technology should be monitored. Concept may be applied in the future.
36. Lateral Safety Warning						Progression of technology should be monitored. Concept may be applied in the future.
21. Traffic Network Data Collection						Is a VDOT function.
25. Lane Control						Is a VDOT function.
30. Traffic Prediction and Demand Management						Is a VDOT and MPO function -- coordinate with VDOT and MPO.
47. Emissions Monitoring and Management						Is a MPO function -- coordinate with MPO.
18. Interactive Kiosks						Coordinate with WashCOG's kiosk program.
37. Advanced Vehicle Longitudinal Control						Progression of technology should be monitored. Concept may be applied in the future.
38. Advanced Vehicle Lateral Control						Progression of technology should be monitored. Concept may be applied in the future.
28. Regional Traffic Control						Is a VDOT function.
34. Driver Safety Monitoring						Not recommended for implementation. There is not a perceived need to apply this concept for this project.
33. Road Weather Information System						Is a VDOT function.
39. Intersection Safety Warning						Coordinate with VDOT or appropriate roadway operator. Consider implementation for island platform / right door bus, median cross-over design of BRT stations.
22. Probe Data Collection						Buses will not be traveling on Dulles Toll Road.
40. Intersection Collision Avoidance						Not recommended for implementation. Sufficient functionality is provided by concept 39.
43. Pre-crash Restraint						Not recommended for implementation. The concept is difficult to implement for multi-passenger service, such as transit.

ITS Concepts	Phase 1	Phase 2	Phase 3	Phase 4A	Phase 4B	Comments
41. Driver Visibility Improvement						Not recommended for implementation. There is not a perceived need to apply this concept in the Dulles Corridor.
46. Automated Highway/Rail System						Progression of technology should be monitored. Concept may be applied in the future.
42. In-vehicle Signing						Not recommended for implementation. There is not a perceived need to apply this concept for this project.

NOTE: Planning = the design, procurement, and installation of an ITS concept; Pilot = the period during acceptance testing; Operational = the ITS application is fully functional for revenue service

Dulles Corridor Rapid Transit Technology Implementation Concepts Costs

			Phase II (2001-2003)					Phase III (2003-2005,2010)					Phase IV (2006+)					
				Costs ($)					Costs ($)					Costs ($)				
ITS Concept	Component	Unit Cost ($)	Quantity	Capital	Capital Installation / Integration [1]	Total Capital	Annual O&M [2]	Quantity	Capital	Capital Installation / Integration [1]	Total Capital	Annual O&M [2]	Quantity	Capital	Capital Installation / Integration [1]	Total Capital	Annual O&M [2]	Total Capital Cost ($)
Parking Facility Information	Parking Dynamic Message Sign (DMS)	15,000	6	90,000				6	90,000									
	Highway DMS	120,000	6	720,000				6	720,000									
	Vehicle Detector	2,000	6	12,000				6	12,000									
	DMS Controller	10,000	6	60,000				6	60,000									
	System Server	65,000	1	65,000	236,750	1,183,750	473,500	continued		176,400	1,058,400	914,500	continued				914,500	3,242,150
Phase II: 3 facilities including Wiehle, Herndon and 606. Phase III: 3 additional facilities including West Park, Reston, and 772 Includes two parking DMS, two highway DMS, and two detectors per site.																		
Transit Vehicle Tracking	AVL Vehicle Equipment (GPS receiver, on-board computer, mobile data terminal)	9,000	114	1,026,000				25	225,000									
	Monitoring & Dispatching System (central hardware & software)	2,500,000	1	2,500,000				continued										
	ITS Planning Computer Hardware & Software	35,000	1	35,000				continued										
	Multi-modal Coordination Computer Hardware & Software)	113,000	0	0	0	3,561,000	1,780,500	1	113,000	0	338,000	1,949,500					1,949,500	3,899,000
Phase II: 114 total buses. Phase III: 25 additional buses (139 total buses) System cost includes integration. Deployed on entire bus fleet.																		
Wayside/In station Traveler Information	DMS or Display Monitor	15,000						16	240,000				2	30,000				
	System Server	65,000						1	65,000				continued					
	Central Software	20,000						1	20,000	81,250	406,250	162,500	continued		6,000	36,000	177,500	442,250
Phase III: 8 facilities including West Falls Church, West Park, Wiehle, Reston, Herndon, Dulles, 606 and 772. Phase IV: Additional facility at Tysons Includes two DMS per facility.																		
In-vehicle Traveler Information	DMS	1,500						162	243,000				196	294,000				
	Annunciator	5,000						139	695,000				98	490,000				
	Announcement Data	20,000						1	20,000				continued					
	Central Recording Station	15,000						1	15,000	243,250	1,216,250	486,500	continued		156,800	940,800	678,500	2,157,050
Phase III: One DMS on each of the 116 standard buses and two DMS on each of the 23 articulated buses. One annunciator on each of the 116 standard buses and 23 articulated buses. Deployed on entire bus fleet. Phase IV: Two DMS on each of the rail cars and one annunciator on each of the rail cars. Note: Announcements of major stops and transfer points are a requirement of the Americans with Disabilities Act (ADA).																		

GRAND TOTAL 8,740,450

[1] Initial installation/integration is 25% of capital costs; additional installations/integration is 20% of capital costs

[2] Operations and maintenance is 50% of capital costs; the value is the maximum annual cost of operating and maintaining the ITS application during the phase

ELECTRONIC PAYMENT PACKAGE

			Phase II (2001-2003)						Phase III (2003-2006,2010)						Phase IV (2006-)					
				Costs ($)						Costs ($)						Costs ($)				
ITS Concept	Component	Unit Cost ($)	Quantity	Capital	Capital Installation / Integration [1]	Total Capital	Annual O&M [2]		Quantity	Capital	Capital Installation / Integration [1]	Total Capital	Annual O&M [2]		Quantity	Capital	Capital Installation / Integration [1]	Total Capital	Annual O&M [2]	Total Capital Cost ($)
Electronic Fare Payment	Bus Farebox & Card Reader	15,000							139	2,085,000					0	0				
	Turnstile w/Card Reader	10,000							30	300,000					18	180,000				
	Ticket Vending Machine with Card Reader	30,000							15	450,000					9	270,000				
	Central Hardware	5,000							1	5,000					continued					
	Central Software & Database	3,000,000							1	3,000,000					continued					
	Clearinghouse	1,000,000							1	1,000,000	0	5,840,000	3,920,000		continued		0	450,000	4,145,000	7,290,000
Phase III: 139 total buses, farebox / card reader deployed on entire bus fleet; 5 BRT stations at West Park, Wiehle, Reston, Herndon, and 606; three vending machines per station and 6 turnstiles per station. Phase IV: 8 rail stations at West Park, Tysons, Wiehle, Reston, Herndon, Dulles, 606 and 772 (3 additional stations from Phase III); 6 turnstiles per station and three vending machines per station. System cost includes integration. Annual O&M cost for the clearinghouse function is $1,000,000. Central costs (hardware, software, clearinghouse) should not be duplicated for an integrated electronic fare payment / parking facility payment system.																			
Parking Facility Electronic Payment	Transponder Reader Assembly	8,000							12	96,000										
	Card Reader	3,000							12	36,000										
	Camera (violation enforcement)	5,000							6	30,000										
	Central Hardware	5,000							1	5,000										
	Central Software & Database	3,000,000							1	3,000,000										
	Clearinghouse	1,000,000							1	1,000,000	0	4,167,000	2,583,500						2,583,500	4,167,000
Phase III: 8 parking facilities including West Park, Wiehle, Reston, Herndon, 606, and 772. Two transponder readers and two card readers per facility, and one camera per site. System cost includes integration. Annual O&M cost for the clearinghouse function is $1,000,000. Central costs (hardware, software, clearinghouse) should not be duplicated for an integrated electronic fare payment / parking facility payment system.																				

GRAND TOTAL 11,457,000

[1] Initial installation/integration is 25% of capital costs; additional installations/integration is 20% of capital costs

[2] Operations and maintenance is 50% of capital costs; the value is the maximum annual cost of operating and maintaining the ITS application during the phase

SECURITY/SAFETY PACKAGE

			Phase II (2001-2003)					Phase III (2003-2006, 2010)					Phase IV (2006-)					
				Costs ($)					Costs ($)					Costs ($)				
ITS Concept	Component	Unit Cost ($)	Quantity	Capital	Capital Installation / Integration [1]	Total Capital	Annual O&M [2]	Quantity	Capital	Capital Installation / Integration [1]	Total Capital	Annual O&M [2]	Quantity	Capital	Capital Installation / Integration [1]	Total Capital	Annual O&M [2]	Total Capital Cost ($)
On-board Transit Security	CCTV Camera	2,500						278	695,000									
	Microphone & Silent Alarm	300						139	41,700	184,175	920,875	368,350					368,350	920,875
Phase III: 139 total buses. Two cameras per bus. Deployed on the entire bus fleet.																		
Transit Facility Security	CCTV Camera	5,000						36	180,000				0	0				
	Video Monitor	3,500						6	21,000				1	3,500				
	Central Video Switcher & Controller	20,000						1	20,000	55,250	276,250	110,500	continued		700	4,200	112,250	280,450
Phase III: 6 facilities including West Park, Wiehle, Reston, Herndon, 606, and 772; 6 cameras at each facility. One monitor per facility.													Phase IV: 1 additional facility at Tysons; camera costs are included in rail station construction cost.					
Parking Facility Security	CCTV Camera	5,000						59	295,000									
	Video Monitor	3,500						2	7,000									
	Central Video Switcher & Controller	20,000						1	20,000	80,500	406,500	163,000					163,000	406,500
	Two-way Intercom	2,000						2	4,000									
Phase III: 5 parking facilities including West Park, Wiehle, Reston, 606, and 772. Estimated 4,700 spaces (assumed 1 camera per 80 spaces). 1 monitor per 35 cameras. Intercom cost is included in the facility construction cost. The Herndon facility needs to be retrofitted with Two-way intercom (2 intercoms for facility).																		
GRAND TOTAL																		1,607,825

[1] Initial installation/integration is 25% of capital costs; additional installations/integration is 20% of capital costs.

[2] Operations and maintenance is 50% of capital costs; the value is the maximum annual cost of operating and maintaining the ITS application during the phase.

OPERATIONS PACKAGE

ITS Concept	Component	Unit Cost ($)	Phase II (2001-2003) Quantity	Phase II Costs ($) Capital	Capital Installation / Integration [1]	Total Capital	Annual O&M [2]	Phase III (2003-2006,2010) Quantity	Phase III Costs ($) Capital	Capital Installation / Integration [1]	Total Capital	Annual O&M [2]	Phase IV (2006-) Quantity	Phase IV Costs ($) Capital	Capital Installation / Integration [1]	Total Capital	Annual O&M [2]	Total Capital Cost ($)
BRT Station Lane Access Control	Vehicle Transponder	50						68	3,400									
	Transponder Reader Assembly	8,000						8	64,000									
	Gate Assembly	100,000						8	800,000	216,850	1,084,250	433,700					N/A	1,084,250
Phase III: 68 BRT buses; deployed on BRT buses only. Four readers with gates eastbound and four readers with gates westbound. System is used to restrict BRT station access to BRT buses only.																		
Precision Docking System	Per Bus	20,000						68	1,360,000									
	Per Station	5,000						4	20,000	345,000	1,725,000	690,000					N/A	1,725,000
Phase III: Deployed on BRT buses only. Based on four stations at West Park, Wiehle, Reston and Herndon																		
Transit Vehicle Mechanical Safety Monitoring and Maintenance	Engine Sensors & On-board Processor	600						139	83,400									
	Driver Warning Interface	1,000						139	139,000									
	Computer Hardware and Maintenance Scheduling Software	120,000						1	120,000	85,600	426,000	171,200					171,200	426,000
Phase III: 139 total buses. Deployed on entire bus fleet																		
Traffic Signal Priority Study	Traffic Signal Priority Equipment (intersection)	8,500	9	76,500														
	Transit Vehicle Priority Equipment (bus)	1,500	12	18,000														
	Report (pre-study and evaluation)	100,000	1	100,000	23,625	218,125	47,250					N/A					N/A	218,125
Phase III: Deployed at 9 intersection and on 12 buses.																		
Emergency Response	AVL Vehicle Equipment (GPS receiver, radio & mobile data terminal) Non-Bus/Rail Vehicles	7,000						25	175,000									
	Monitoring & Dispatching System (central hardware & software)	1,000,000						1	1,000,000	0	1,175,000	587,500					587,500	1,175,000
Part of the VDOT ALERT initiative. Assumes 25 non-bus/rail vehicles. System cost includes integration.																		
GRAND TOTAL																		4,630,375

[1] Initial installation/integration is 25% of capital costs; additional installations/integration is 20% of capital costs
[2] Operations and maintenance is 50% of capital costs; the value is the maximum annual cost of operating and maintaining the ITS application during the phase
N/A = Not applicable