

MONTGOMERY COUNTY, MARYLAND'S AERIAL SURVEILLANCE PROGRAM

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Background

Montgomery County, Maryland forms the northwestern border of Washington, D.C. covering an area of approximately 500 square miles. Montgomery County has a population of 750,000 with 65 percent of the population working within the county. There is over 2000 miles of roads in Montgomery County with three of the heaviest traveled interstates (I-270, I-370, and I-495) in Maryland. Because of an excellent job base thousands of people come into the county each day to work, attend to business, or shop. Typical average weekday traffic on certain sections of the interstate system can reach 130,000 vehicles, and on typical major arterials can reach 70,000 vehicles.

Montgomery County operates Bide-On a 250 bus transit system which connects to the Washington D.C. area bus and metro-rail systems.

Management of this substantial and growing transportation system has been a priority in Montgomery County. Montgomery County's Department of Transportation is responsible for managing and operating the transportation system. The Department of Transportation has been aggressive in implementing the latest technologies to help manage the transportation system.

Advanced Transportation Management System

In 1980, Montgomery County's Department of Transportation started the construction of a computerized signal system. The real time computerized signal system has grown from controlling 10 intersections to the present system that controls over 600 traffic signals.

The computerized signal system has been enhanced several times over the past 13 years to provide improved incident and traffic management features. In 1990, Montgomery County's Department of Transportation, Division of Traffic Engineering began the design of an enhancement to the computerized signal system of a system to provide

a system that would support the management of the transportation system into the 21st century. The system would be known as the Advanced Transportation Management System (ATMS). The ATMS would be composed of multiple sub-systems controlled and monitored from common transportation workstations. The ATMS would be open architecture to allow for growth and integration of systems from multiple vendors. May, 1992, Montgomery County entered into a contract with Automatic Signal/Eagle Signal to develop and implement the ATMS. As of the date of this article the ATMS was being installed in Montgomery County's Transportation Management Center (TMC) with acceptance testing to start in February, 1994. The ATMS will include:

- Advanced traffic responsive traffic signal control.
- Automated sign control system.
- 200 camera video surveillance system.
- Sophisticated electronic transportation monitoring systems.
- Time critical geographic information system (GIS)
- Automated transportation information system.
- Integrated transit and traffic operations.
- GPS and other technologies based vehicle tracking system.
- Automated incident management system.
- Aerial surveillance operations.
- Automated integration with police/fire computer aided dispatch systems.

Montgomery County has been divided into six areas for implementation of ATMS related field equipment. The first area was started in 1992 with anticipated completion by early 1995. The remaining five areas will be implemented on a two year schedule per area depending on funding. Implementation of the field hardware will be done in conjunction with the construction of a 300 mile fiber optic based communication system. The fiber optic system will enhance the Department of Transportation's existing 300 plus mile twisted pair copper network.

Transportation Incident Management Program

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Montgomery County has a transportation management program. This program combines the capabilities of the ATMS and the coordination of activities between police, fire and rescue, and transportation agencies within Montgomery County and Maryland. Montgomery County has formed a Transportation Incident Management team (TIM) composed of representatives from the Department of Police, Department of Fire and Rescue, Department of Environmental Protection, and the Department of Transportation. TIM meets on a regular basis to discuss and implement improvements to the county's incident management program.

Transportation Management Center

Montgomery County's Transportation Management Center (TMC) houses and operates the ATMS and has direct connections to police and fire and rescue dispatch facilities. Ride-On transit dispatch is located adjacent to the existing TMC, Montgomery County is in the initial design stage of a new TMC which is planned to house within one facility traffic operations, transit operations, highway maintenance operations, and police and fire support personnel.

The existing TMC is staffed from 6:00 AM to 11:00 PM 365 days a year. As staffing allows the TMC is planned to be staffed on a 24 hour basis.

Aerial Surveillance Program

As part of Montgomery County's transportation management program an aerial surveillance program was started in 1989. The aerial surveillance program was the result of a continuing effort by the Montgomery County Department of Police and the Department of Transportation to improve transportation management in the county. A test of using an aircraft to monitor AM and PM rush hour traffic was funded by the Department of Transportation. Initially a traffic engineer would fly in a contracted airplane with a contracted pilot each morning and evening rush hour and would use a portable radio to radio problems to the Transportation Management Center. Within a few months of the start of the project the Department of Transportation entered into a contract to lease an airplane on a 24 hour basis and the Department of Police assigned two Sergeants with existing commercial pilot licences to fly the airplane. A radio pack was designed and constructed by county personnel to provide multiple communication

frequencies that allow the observer to contact most police, fire, and transportation agencies in the Washington DC. area including state highway and police agencies.

In 1992, because of budgetary reasons the Montgomery County Department of Police had to withdraw the two pilots from the project. The Department of Transportation contracted pilot services with the company supplying the aircraft. The project has been solely operated by the Department of Transportation since 1992.

Montgomery County uses a single engine high-winged airplane. The airplane was chosen over a helicopter because of operating costs. The airplane can be operated for approximately \$80 per hour versus \$300 per hour for a helicopter with similar performance capabilities. It was decided that for 99 percent of the missions that would be flown to manage traffic did not require the hovering and landing capabilities of a helicopter. Five years of experience has proven this to be true.

Over the past five years the airplane used by Montgomery County has changed to meet the requirements of the county. Initially the county leased a Cessna 172, a small four passenger airplane with limited room for personnel, equipment, and passengers. In 1990, the county contracted for a Cessna 182. The Cessna 182 is a larger four place airplane with sufficient room for personnel, limited equipment, and passengers. The Cessna 182 was replaced in the late 1993 with a Cessna 206. The Cessna 206 is a six place airplane with excellent load carrying capabilities. The Cessna 206 was required to be able to carry the additional equipment associated with **on** board live video broadcasts.

The aerial surveillance project has been a critical part of the Department of Transportation's transportation management program. On a typical flight the airplane either finds or quickly responds to incidents which impact the transportation system. The observer contacts the appropriate authority to respond to the problem, notifies the TMC to adjust traffic signals, etc. in the area of the incident, and directly notifies the airborne radio **traffic** reporters of the problem. The airplane is known as MC-IO. MC-10 performs on a regular basis traffic management functions, police surveillance, environmental protection activities, assists fire and rescue in locating

fires in rural and other hard to access areas. MC-10 is used for still and video photography. MC-10 is manufactured by NSI.

Live Aerial Video Project

Montgomery County determined that the aerial surveillance project could be further enhanced if live video could be sent from the airplane to the Transportation Management Center and other agencies. Providing a live video picture of what was happening to the TMC would help managers on the ground make appropriate decisions as they would have the “big picture” which can not be readily described over the radio or by land line. Multiple ground units would have to describe a situation and their description is usually controlled by what they can actually see which is very limited on the ground.

In July, 1991, after several meetings the State of Maryland, Montgomery County, the State of Virginia, and Fairfax County, Virginia delivered a proposed demonstration project for live aerial video to the Federal Highway Administration (FHWA). The demonstration project would be divided into stages, the first would be to test live video from a helicopter and from a fixed wing airplane. Other stages were proposed enhancements to the information gathered by the aircraft. Fairfax County, Virginia would install a video camera system on one of its police helicopters and Montgomery County, Maryland would implement live video capabilities in its fixed wing airplane.

After FHWA approved a .50/50 funded demonstration project for stage one Montgomery County Department of Transportation prepared specifications and advertised through the normal bid process for a contractor to supply and implement the specified video system. The normal bid process in Montgomery County takes six months. Because of limited knowledge by the county’s procurement office of the type of company that would be qualified and improper advertisement of the bid the county received no bids. The Department of Transportation was then authorized by the county’s Chief Administrative Officer to contact capable vendors directly and obtain bids. Four companies submitted bids and the Department of Transportation negotiated a contract with the qualified lowest bidder. A contract was signed in April, 1993 with N-Systems Incorporated (NSI) located in Columbia, Maryland.

Some equipment was ordered and other components of the system were designed and

During the Summer and Fall of 1993 installation and testing of the system began. Testing had to be stopped when the county upgraded the airplane from the Cessna 182 to the Cessna 206. As part of the contract for the Cessna 206 a new console was to be constructed by the airplane contractor and installed in the airplane. This console would contain the multiple radios, video monitor, S-VHS recorder, GPS receiver, and microwave transmitter. The console was completed at the end of December, 1993. As of the date of this article, the console is temporarily installed in the aircraft with permanent installation scheduled by the end of January, 1994.

Montgomery County’s aerial surveillance system is composed of:

Airplane

- 0 Microwave transmitter
- 0 GPS receiver
- 0 Color video camera
- 0 Color video monitor
- 0 S-VHS player/recorder
- 0 Microwave antenna

Transportation Management Center

- 0 Microwave receiver
- 0 Automated tracking antenna
- 0 Antenna control system
- 0 Color video monitors
- 0 S-VHS editing system

Portable Ground Transmit and Receive System

Transmit

- 0 Microwave transmitter
- 0 Microwave antenna
- 0 Color video camera
- 0 Tripods
- 0 Batteries

Receive (3 sets)

- 0 Microwave receiver
- 0 Microwave antenna
- 0 Color monitor
- 0 S-VHS player/recorder
- 0 tripod

o batteries

The video system provides the capability to automatically **track** the airplane by sending the actual location of the airplane, as determined by the global positioning system (GPS) receiver in the airplane, to the receive and control equipment located in the Transportation Management Center. The control equipment in the TMC automatically points the tracking antenna located on the roof of Montgomery County Government's Executive Office Building (EOB) a 15 story high-rise located in Rockville, Maryland. The TMC is located on the 11th floor of the EOB. The EOB is located near the geographic center of Montgomery County. The microwave system used in this project requires the tracking antenna to track within 14 degrees of the airplane to maintain a usable picture and to be able to receive the GPS data. Should the automatic tracking fail the antenna on the roof of the EOB can be positioned manually from the TMC through a touch screen control unit. Audio can be sent over the microwave system from the airplane to the TMC.

In the airplane an industrial grade color video camera is mounted so as to aim out of the side window behind the observers seat. The observer can monitor the video system and record what the camera is viewing. An additional monitor is mounted so the pilot can also see what the camera is viewing and adjust the track of the airplane accordingly.

The portable transmitter system provides the county the capability to transmit live video from the scene of an incident or other activity directly back to the TMC. The portable system uses the same type of any microwave transmitter as is installed in the airplane. A directional microwave antenna is mounted on a tripod and is aimed in the direction of the tracking antenna on the roof of the EOB. Since the portable unit is using the same antenna as the airplane both systems can not be operational at the same time. When the ground unit is in use the staff in the TMC moves the roof mount antenna until an acceptable microwave signal is received.

The ground based portable receivers can receive transmissions from the airplane or from the ground based transmitter. The portable receiver antenna can be used as a directional antenna to receive the signal from the airplane when the airplane is in the distance or can be pointed straight-up and will receive transmissions from the airplane as it circles overhead.

The portable units will be used by the Maryland State Highway Administration, Montgomery County Department of Transportation, and one unit will be installed in Montgomery County's Police/Fire and Rescue Command Bus. The Command Bus is sent to major incidents to serve as an on-scene command and communication center.

As part of Montgomery County's automated transportation information system the video and audio received from the airplane or ground unit can be sent over the government network to other agencies. The video and audio can also be sent from the TMC over the subscriber cable television system into homes and businesses. The on-air television broadcast stations are presently connecting to the TMC's system and will be able to receive the same video and audio and then re-transmit as part of their news broadcasts. The airborne and portable video can be combined with video from fixed video surveillance system.

Preliminary testing indicates the airborne system performs exceptionally well as long as a good signal can be received. Initial tests indicates that the video signal can be received from the airplane while it is over any point in Montgomery County as the airplane flies at its normal altitude of 1000 feet above the ground. There are certain areas of the county where other microwave signals are interfering with the signal from the airplane. This may be addressed by going to another frequency. Tests of the portable receivers have been very successful. The directional mode allows personnel on the ground to track the aircraft manually in the distance. The distance the airplane can be received is dependent on the altitude it is flying and if solid objects or terrain block the microwave signal.

The portable ground transmitter works well as long as terrain or solid objects do not block the microwave signal. Testing has been successful from distances up to 3 to 4 miles even though the antenna is mounted on a tripod sitting on the ground. Extended distances and increased areas of coverage could be possible with a 40 foot telescoping mast for the antenna. As part of Montgomery County's transportation management program an incident management and transportation analysis van is planned This van will be specified with a telescoping antenna and other equipment to integrate with the airborne and ground based video system.

Presently, the camera mounted in the airplane is not stabilized so image steadiness is dependent on

how **turbulence** impacts the airplane. When the camera is zoomed in close then an movement is exaggerated. The first stage of the demonstration project was to demonstrate the use of live video and how well a microwave signal can be sent from an airplane to a traffic management center. Improvements to the video image can be greatly enhanced by installing a gyro-stabilized camera mount.

Montgomery County has been reviewing and testing a stabilized video system which can be readily adapted to the existing microwave system and could be mounted on the Cessna 206 as it was recently certified and tested on a Cessna 172. The stabilized system is manufactured by Wescam, a major supplier of stabilized film and vi&o equipment used by the motion picture and television industry. The system mounted on the Cessna 172 has been tested by Montgomery County personnel. The Wescam system has been used to track individual vehicles from the Cessna 172 and will readily allow the operator to fix the camera on an incident or intersection. The stabilization maintains a steady image **even** in severe turbulence.

Summary

Montgomery County's aerial surveillance program is critical to the county's transportation management program. The airborne video system greatly enhances the aerial surveillance program. The airborne video system provides ground personnel ,including decision makers, the ability to make educated decisions on what actions should be taken because they see the total impact of an incident or event on the transportation system. The vi&o images can be shared with other agencies and the media This sharing of the "big picture"* helps other agencies respond to situations and allows Montgomery County Government and the media to disseminate improved information to the public.

Montgomery County has just started testing the airborne and ground based system. Initial findings indicate the system can be enhanced by installing a gyro-stabilized camera. Low light capabilities could be added for night time operation. Fixed remote receiver sites would improve reception in those areas with interfering signals.

Even the initial tests have proven that "live" broadcast quality video from an airplane can be done. The "live" vi&o can be a valuable tool to help manage traffic on a daily basis and during incidents or special

events.

Montgomery County plans to complete its evaluation of the airborne system during the first quarter of 1994 with results forwarded to the Federal Highway Administration soon after. Montgomery County hopes to work with the State of Maryland and the Federal Highway Adminisuation to further enhance the aerial video project.

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