Use of Unmanned Aerial Vehicles in Traffic Surveillance and Traffic Management

Technical Memorandum

Prepared for:

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ITS SECTION
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1. Background

Florida's rapid population growth, high profile as a vacation destination, expansion of defense and other high technology corporations, and gateway status for worldwide commerce, all together requires a transportation network that is knowledgeably and expertly managed. Improvements in transportation management through use of Intelligent Transportation Systems (ITS) are being deployed throughout the State of Florida. Management techniques and processes are being improved to provide more reliable data links to nodes (generally traffic management or control centers) of the transportation network.

2. Need for Information on Traffic Situations

Providing timely information on highway or other transportation modes on traffic flow and incidents, and the transmission of this information to the appropriate decision maker, are key requirements for improving traffic and incident management. The use of Unmanned Aerial Vehicles (UAVs), equipped with video cameras and/or other sensors, is a technically viable method of providing timely information to support decisions regarding major traffic incidents and natural disasters, and also in providing an improved security and safety for the public.

Time-sensitive information is also used in providing Advanced Traveler Information Systems (ATIS) and recently 5-1-1 systems. This information can provide a responsive node in this quickly growing service to support the traveling public with options to avoid congestion and non-recurring incidents.

It is not unlikely that the following scenarios could be envisioned by employment of UAVs in our future surveillance, data collection, and management of our scarce transportation and other public assets.

- Micro-UAVs depart their replenishment bases to cover pre-programmed sectors of a metropolitan urban area to collect data to aid in management of peak-period traffic.
- Forest Management Rangers launch UAVs to detect fires, precisely report smoke and fire locations, and track fires.
- Coast Guard managers launch UAVs capable of surveillance, identification, and neutralization of watercraft incursions, and to provide homeland security in maritime areas.
- Law enforcement and immigration department teams provide remote surveillance of borders, particularly in remote areas.
- Emergency and traffic managers request UAV surveillance support for hurricane and other natural disaster evacuations, post-disaster assessments, and to provide real-time traffic surveillance for decision makers.

- Law enforcement officials request that UAVs with special tracking equipment be deployed to provide surveillance intelligence for support of law enforcement initiatives.
- Utility and other infrastructure agencies use UAVs to provide remote sensing views of transmission lines, pipelines, retransmission stations, and the like.
- Weather central sends UAVs into the eye of approaching hurricanes for meteorological data measurements.

The Florida Department of Transportation (FDOT), ITS Section of the Office of Traffic Engineering and Operations (OTEO), is a leader in promoting use of UAVs for traffic, incident, and emergency management initiatives.

3. Current UAV Efforts within the Florida Department of Transportation

FDOT has funded a research project to investigate and design a "system" as a pilot baseline. Named the *Airborne Traffic Surveillance Systems (ATSS) Proof of Concept Study*, this initiative reflects the integration of remote sensing techniques with ITS concepts to provide a baseline study for future ITS deployment of UAV or similar vehicles. Applications and integration of the technology and methodology used in the ATSS Study can be utilized in both rural and urban environments. The application of the lessons learned and the model deployment of ATSS is of strategic importance to be used to enhance the deployment of rural ITS initiatives in the next 5-10 years. Use of UAVs in remote data collection can provide the Department with a cost-effective methodology to collect, analyze, and provide selected data for a variety of tasks and missions.

4. UAV Traffic Surveillance Concept Development

In 2000, FDOT staff initiated discussions on the use of UAVs to collect video data and transmit the live video data to communications sites along the route of flight. The data would then be sent to an appropriate Traffic Management Center (TMC) and/or Emergency Operations Center (EOC) where the information would be used by management to support traffic and emergency management decisions.

The University of Florida formed a research team of faculty and graduate students from the Departments of Electrical and Computer Engineering and Civil and Coastal Engineering. This research team developed a scope of services and has funding for development of the concept. The main objective of the research project was to develop the design and integration of a system that could provide data obtained from an airborne platform to a TMC and/or EOC.

During development of the concept and the lead time to gain approval and funding for the ATSS project, FDOT had been proactive in promoting the use of UAVs to provide data collection. A UAV flight demonstration was approved by the Federal Aviation Administration (FAA) as part of the ITS America Annual Meeting in Miami Beach, Florida. On June 3 and 4, 2001, a *Sentry* UAV was flown from Opa-Locka West Airport, north of Miami, on a 35-40 mile route along US-27, I-75, and the Florida Turnpike, this area of Florida being all sparsely populated. Live video images were successfully linked to a ground station at the Opa-Locka West Airport and this test provided a first live-fly demonstration of the concept in Florida. (Other UAV missions for transportation purposes had been flown elsewhere.)

5. Study Objectives

The ATSS study team was composed of a group that collectively brought powerful credentials and interactions to the table. The University of Florida provided the principal research team. The FDOT ITS Section provided management, communications, microwave towers, and flight operations experience. The University of North Florida (UNF) provided weather support and folded in results of a study on roadway weather conditions. The Tallahassee Commercial Airport was to provide a facility for flight operations while the State Emergency Operations Center (SEOC) was to provide facilities for data viewing, storage, and dissemination. SRA International was to provide the UAV flight and ground integrator and Aerosonde was the supplier of the UAV.

The concept for use of UAVs in traffic management included:

- Investigate the integration of ATSS into existing or future ITS operations,
- Use UAVs for video data surveillance and data collection,
- Use the current FDOT microwave tower system for video transmissions,
- Link video data from the microwave system to SEOC and appropriate TMCs,
- Use the proven process and results for future remote sensing initiatives, and
- Support FAA rule development for future UAV flight operations.

The Aerosonde UAV was chosen for this proof of concept demonstration. It was developed in 1995 in Australia and has been used extensively as a meteorological platform and in military applications. It was the first UAV to make a transatlantic flight, flying from Nova Scotia to Scotland (2044 mi, or 3270 km) on August 20 and 21, 1998. It flew for 26 hours and 45 minutes. This particular UAV, the “Laima,” is on permanent display in the Seattle Air and Space Museum. The Aerosonde UAV has a 9.5 ft wingspan, is 6.2 ft in length, and weighs 30 lbs fully loaded. It has a range and endurance of over 1600 mi and over 30 hours flight duration.

Figure 1 on the following page is a picture of the Aerosonde UAV that was to be used in the flight operations.

Figure 1. The Aerosonde UAV in Flight

6. Data Integration and Communications Tests

A data integration and communications test of the concept has been conducted, with video data being provided at each of the two microwave tower downlink sites, SR-136 and Lake City. The data were successfully received and recorded at the SEOC in Tallahassee.

Thus, the concept of ATSS was validated through this ground data integration and communication test. The only link that remained to be accomplished was the airborne data collection by the UAV and downloading of the video data to the FDOT microwave tower system.

7. Concept of Operations/Flight Profile

The concept of operations for the flight operations and data distribution is shown below. Specifics of the UAV flight profile were:

- UAV launches at Tallahassee Commercial Airport (TCA) and climbs to 1000 feet,
- Fly the I-10 corridor eastward to the I-10/I-75 interchange area near Lake City,
- Avoid obstructions and populated areas along route,
- Orbit I-10/I-75 interchange, primarily north on I-75 to the SR-136 tower,
- Provide video sensor data to SR-136 and Lake City microwave towers,
- Transmit data along the microwave tower system to Tallahassee SEOC, and
- Return to TCA along I-10 westward from sensor area, lands at TCA.

The mission would be replicated with flight duration ranging from several hours to over 10 hours. The test flight scenario is illustrated in Figure 2 on the following page.

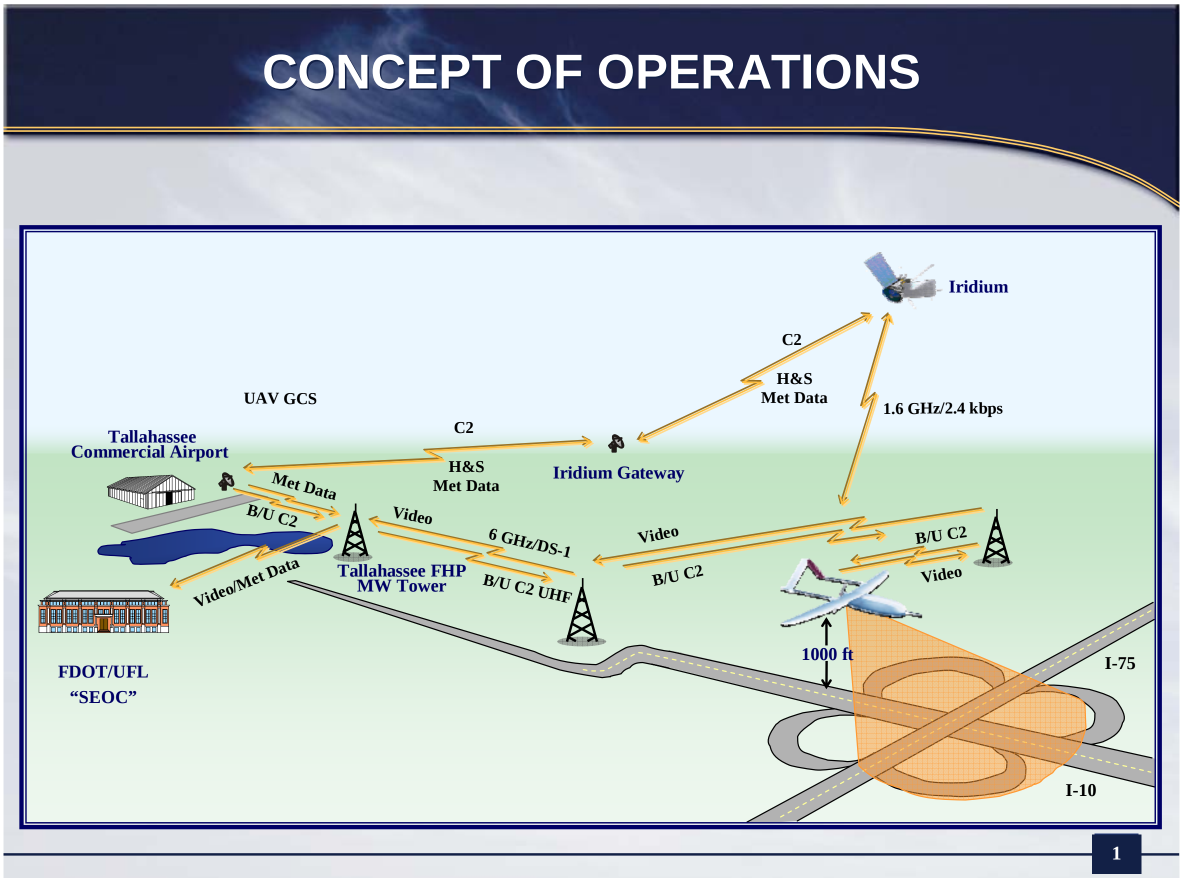

Figure 2. Graphic View of UAV Test Scenario

8. Requirements for Permission to Fly in National Airspace

The process for approval to fly in National Airspace (NAS) is to submit a Certificate of Authorization (COA) to FAA for permission to fly the proposed route. The COA contains a narrative of what route the applicant desires to fly, the reasons for the request, safety considerations—especially the command and control considerations—and a summary of the proposed vehicle's capabilities. At the time of submission, May 2003, the FAA had no formal rules on operation of UAVs in the National Airspace. This is still the case today.

The FAA advised the FDOT that the original COA request was disapproved, "…in that the applicant has not demonstrated an equivalent level of safety with respect to see-and-avoid procedures for avoiding other aircraft" (FAA letter, November 22, 2004). The FDOT considered a revised COA that would reflect several options for providing a different approach to seek approval from FAA on see-and-avoid concerns. However, FDOT concluded that FAA would not approve any COA that did not include use of a chase plane or other overly restrictive measures. This restriction is too severe a restraint to make use of the UAV an effective tool for transportation management.

Accordingly, FDOT halted the research effort and terminated the research contract with the University of Florida on April 15, 2005.

9. Conclusion

The ATSS study somewhat demonstrated an innovative approach to apply ITS technology through surveillance, data collection, and data transmission. Use of UAVs in data collection and other tasks can be expected to dramatically improve traffic management and incident management, forest fire surveillance, and law enforcement initiatives. Lessons learned can be utilized by a variety of agencies as they expend resources to manage transportation, emergency management, disasters (both man-made and natural) incident management, and other transportation-related initiatives.

The concept of airborne data collection and dissemination for real-time use through use of UAV assets works—this has been proven, despite the fact that actual flight operations were not conducted. It is hoped that within the near future, the regulatory agencies will develop rules and standards that will allow the use of UAVs in multiple-role scenarios, from data collection to payload delivery, in rural and urban areas. Military applications of UAVs for selected missions are increasing and the associated technology spin-off is applicable for use in the civilian sector.

Transportation managers should be knowledgeable with the current and emerging technology associated with the use of remote sensors, whether they are airborne, seaborne, or on the land. There is a need for further development of the process and procedures for use of airborne assets in data collection and their associated use in transportation management. Eventually these changes will help save lives, time, and resources.