UTILIZATION OF FLORIDA'S EXISTING AND FUTURE INTELLIGENT TRANSPORTATION SYSTEMS FOR ENHANCING STATEWIDE TRANSPORTATION SYSTEM MANAGEMENT DURING AND AFTER HURRICANE EVACUATIONS

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Abstract

Coastal areas in many parts of the world are vulnerable to impact by hurricanes and tropical storms. The transportation systems of those areas can be taxed heavily by storm related evacuations, and the after effects can last for days, weeks and even months. Coastal urbanized areas that have Intelligent Transportation System equipment deployed for management of the transportation facilities recognize the power of ITS technologies and strategies to handle both recurring and non-recurring transportation congestion. The primary purpose of this paper is to evaluate the potential real-time use of Intelligent Transportation Systems (ITS) technologies to improve safety and efficiency during hurricane evacuations. A secondary use of ITS for post evacuation evaluation and preparedness planning is also addressed. The highway system in Florida serves as the backdrop for this evaluation. Hurricane evacuation is a serious business, and the government and private sector decision makers who bear responsible charge for public safety have a solemn task. The technologies of ITS cannot create a system that will completely eliminate traffic congestion during evacuations, but they can provide managers and operators with the best tools to get the job done quickly and safely. Of the immediately available technologies, those that have the greatest potential are motorist information devices, closed circuit video cameras for monitoring, robust communications systems for sharing of information, and traffic data collection devices that aid in the decision making activities both during the event, and after the event in planning for future storms. Transportation management centers in nearby locals that are safe haven zones for evacuees also may utilize ITS to manage the evacuating traffic, provide information to those seeking shelter, and even remotely operate devices in areas that are undergoing an evacuation.

1.1 General Requirements for Hurricane Evacuation

The requirements associated with providing a safe and efficient evacuation in advance of an approaching hurricane can be separated into three general areas of focus:

1. Tracking, predictive modeling, decision support, and issuance of watches, warnings and evacuation orders.

2. Transportation of the evacuating public to safe areas, and return to their homes and businesses when the orders are lifted.

3. Provision of adequate public shelters including logistical support (security, medical care, food and water).

In order for an evacuation to be successful, all three of the above requirements must be met by the responsible public agencies. Provision of the above requirements is temporally sequential, with the exception that transportation again becomes an issue when the evacuation order is lifted. Information sharing between the responsible agencies and the use of technology to support each focus area are generally accepted to be important factors in improving evacuation safety and lessening the overall economic cost of an evacuation.

Although the three focus areas of tracking, transportation and shelter are of equal importance, the transportation system is expected to adapt dynamically to any inadequacies in tracking or the provision of shelter. If warnings are late, inaccurate, or poorly coordinated between jurisdictions, the impact on the transportation system is dramatic. If the transportation system capacity is degraded, shelter provisions can be impacted, as travelers may be forced to seek refuge before arriving at their intended destination.

1.2 The Highway Transportation System in Evacuation

The provision of transportation for evacuees on Florida highways is difficult to plan due to the number of variables that will impact the timing and quantity of demand on the highway system. The highway demand is highly dynamic for the following reasons:

1. Although evacuations orders can be mandatory, the decision regarding the evacuation destination, route and travel departure time is left to the individual. The Florida Emergency Preparedness association website (http://www.fepa.org/) advises:

   > "If possible, make arrangements to stay with the friend or relative who resides closest to your home and who will not have to evacuate…If you are unable to stay with friends or family and no hotels/motels rooms are available, then as a last resort go to a shelter."

   The present approach in the State of Florida which requires individuals to plan their own evacuation route and determine their own time of departure is not likely to change to a

more structured approach in the immediate future. Although the impact of this individual decision making on the transportation system is not entirely unpredictable (traffic counts are available from previous evacuations), the precise time and place of demand and resulting congestion is highly dynamic and dependant upon the characteristics of the approaching storm.

2. In spite of the advanced technologies deployed to track storms, early prediction of the precise time and location of landfall is not an exact science. The Governor at the State level, and local officials primarily at the County level must therefore exercise judgement regarding the issuance of evacuation orders, and are understandably likely to "err on the side of caution". The actual utilization of major controlled access facilities such as the interstate highways during an evacuation will reflect the sequence and times at which major populations centers are issued evacuation orders. Although it might be assumed for planning purposes that extreme coastal areas will always be evacuated first, there is a real possibility that some inland communities (e.g. trailer parks) in the storm surge might also receive early evacuation orders.

3. Although congestion due to evacuation tends to slow traffic and reduce the potential for personal injury vehicular accidents, the resources by which incident management is conducted during an evacuation will be highly strained. A compounding effect due to a fuel spill, breakdown or simple "run out of gas" scenario is likely to cause extensive delays, particularly when incident responders at police agencies are already actively engaged in regional traffic control and detour management activities. Implementation of reverse lane travel scenarios also increases the burden on enforcement and safety providers, and the potential for motorist confusion leading to a more serious incident is heightened. Property, personal injury and fatal accidents during an evacuation will require a high degree of flexibility in the transportation system to avoid gridlock conditions.

4. Traffic statistics and anecdotal data from past evacuations show that travel related to evacuations passes through several critical stages. If the evacuation order is issued during a school day, the first stage of travel is likely to include travel to the home from the workplace by commuters, and to the home from schools by bus for schoolchildren. The second stage involves local trips for supplies and fuel, and either return to the home or departure on the evacuation trip. The fourth stage involves actual evacuation departure, and the final involves eventual return to the home. In the evacuation of a region where orders are staggered by county, a good deal of multi-directional travel will occur on the controlled access facilities prior to the full scale "inland" exodus late in the stages before landfall.

The highly dynamic nature of providing highway transportation capacity and services during an evacuation leads to consideration of the capabilities of Intelligent Transportation Systems (ITS) technologies to better manage the transportation facility during and after evacuations. ITS technologies are primarily designed to provide real-time monitoring and management capability, and secondarily offer the capability to record relevant performance data for review of the transportation system performance.

The goal of utilization of ITS for hurricane evacuations are as follows:

1. Reduce the evacuation travel times. In the case of Hurricane Bertha in July of 1996 the measured duration of substantial evacuating traffic in hours for Nassau, Duval, St.

Johns, Flagler, Volusia and Brevard was ten hours and fifteen minutes (10.25 hours).[1] This statistic could serve as a base case for pre-ITS instrumentation transportation system performance. Implementation of ITS measures and active management of facilities can improve facility throughput, quicken incident response and clearance, and provide for more balanced utilization of the full capacity that the highway system offers.

2. Improve Safety. Extracting peak performance form the highways during the evacuation will reduce the potential for the Hurricane Opal scenario where cars are gridlocked on the highway, exposing travelers to the possibility of weathering the impact of landfall and storm surge while in their vehicles on the highway.

3. Improve communication to motorists en-route. The ability to communicate directly with motorists already enroute is an essential element of ITS. This communication can take place via variable message signs, radio transmissions and to a limited (but growing) number of in-vehicle devices including cell phones, pagers, and displays.

4. Improve hurricane preparedness through better data collection. A useful by-product of ITS instrumentation is the collection of real time data associated with motorist behavior and travel characteristics.

2 Intelligent Transportation Systems (ITS) for Emergency Management of the Highway System

The Florida Department of Transportation has established a formal system of evacuation routes and has addressed basic considerable evacuation planning for each district. Having established in this report that utilization of the highway system during an evacuation by the travelling public is dynamic based upon several uncontrollable variables, real time traffic management through ITS should be evaluated. The following excerpt from Hurricane Evacuation Traffic Analysis and Operational Measures Final Report[2] by the Center for Urban Transportation Research captures the sentiment of many experts in the field:

"Real time traffic information can be life saving. Evacuees must be warned of serious traffic problems that, if they were to try to use the congested evacuation route, could potentially leave them stuck behind in gridlock when the hurricane strikes. It is extremely dangerous to be in an automobile when the hurricane strikes. This situation occurred during Hurricane Opal."

It is not likely that ITS can completely prevent congestion during evacuations, especially considering that much of the urban and suburban highway infrastructure in Florida is already congested during normal operations. Although ITS technologies intuitively have value in providing safer and more efficient evacuations, a more deterministic look at how the

[1] Center for Urban Transportation Research, Hurricane Evacuation Traffic Analysis and Operational Measures Final Report, prepared for the Florida Department of Transportation, March 1998, Statistic derived from Table 1-9 on p. 24.
[2] Center for Urban Transportation Research, Hurricane Evacuation Traffic Analysis and Operational Measures Final Report, prepared for the Florida Department of Transportation, March 1998, p. 26.

technologies would actually be used and what the real operational benefits would be compared to other management alternatives needs to be conducted.

ITS is a very broad family of technologies that have been organized into a well defined "architecture" that allows for an orderly evaluation of those technologies which appear promising in addressing an operational need. To evaluate the application of ITS to emergency management for evacuations, the basic elements of the high level ITS architecture can serve as a guide. At the highest level in the ITS National Architecture[3] , the physical elements of ITS can be defined to consist of centers, roadside equipment, traveler, vehicle and communications elements. To evaluate the utilization of ITS for hurricane evacuation management, each of these sub-areas will be addressed.

2.1 ITS Centers Subsystems

The National Architecture for ITS defines centers as subsystems that provide management, administrative, and support functions for the transportation system. In Florida at the State level, ITS "Traffic Management Centers (TMC)" exist or are planned for at least four major urban areas (alphabetical order):

- Jacksonville (Interim center operational, system under construction)
- Miami (interim center built and partly operational, new center in design)
- Orlando (built and fully operational)
- Tampa (planned)

Other management centers exist or are being developed for major suburban areas such as Dade, Broward, Palm Beach, Seminole, Hillsborough and Volusia counties. Many Florida cities and counties also have TMC's for the operation of their traffic signal systems in urban and suburban population centers. Although many functions are planned for these centers related to all aspects of transportation management, we will focus solely on highway operations for the purposes of this report.

The utility of existing TMC's in hurricane evacuation transportation management is presently limited to management within the immediate jurisdiction of only the regional roadways already instrumented with ITS equipment. Hurricane evacuations are by their very definition multi-jurisdictional, therefore the current regional and corridor only operations will be limited to simply reacting to the traffic situation once it arrives. Although center to center communication could be established to facilitate inter-jurisdictional travel management strategies, the nature of current institutional framework is somewhat parochial. The Florida Turnpike transverses multiple districts, thereby having more amenable institutional characteristics to facilitate evacuation strategies, however current electronic instrumentation of Turnpike facilities with ITS is focused on Electronic Toll Collection (SUNPASS).

[3] Federal Highway Administration, National ITS Architecture Documentation, www.odetics.com/itsarch/, Updated 3/24/2000

The utility of the developing FDOT TMC's in dealing with Hurricane evacuations prior to landfall includes performing the following operational functions:

- Live, manned operation of the transportation facility before, during, and potentially after the evacuation.

- Provide decision makers with real-time data and images to confirm actual field conditions, implement and fine tune inter-jurisdictional strategies during the evacuation.

- Control of Dynamic (Variable) Message Signs to provide evacuation information, warnings of delays, and information regarding alternate routes.

- Utilization and sharing of video camera images for the purpose of congestion and incident management.

- Remote monitoring and management of reversible lane operations should they be deployed on instrumented facilities.

- Dissemination of travel information and advisories and information to various out-sources including Highway Advisory Radio, TiRN, the internet, and public agencies. This needs to be coordinated at the state wide level.

- Assistance with incident detection, response and clearance.

- Recording of data on travel patterns, speeds and accidents over time during and after the evacuation.

2.1.1 **De-centralized versus Centralized Approach.** The use of TMC's for the safe and efficient management of the highway transportation network for hurricane evacuations could be approached in one of the two following ways:

- De-centralized. The involvement of the TMC's in hurricane evacuations could be managed in de-centralized manner, utilizing the sharing of data and images to promote inter-regional traffic management strategies. This approach would have the strength of letting the center closest to landfall be in a lead role during the early stages of an evacuation, although they might have to eventually abandon the center. This approach might bring more total manpower to the overall problem, keeping local TMC operators working on their regional roadways as long as possible.

- Centralized. The involvement of the TMC's in hurricane evacuations could be managed in centralized manner utilizing a common hardware, software and communications platform for a statewide, integrated operation. In this scenario, inter-regional traffic management strategies could be deployed from one center under the guidance of managers responsible for the evacuation at the state-wide level.

Given the current status of TMC development in Florida (the Orlando Regional Traffic Management Center (RTMC) is fully operational), and the centralized location of Orlando equidistant from the coastal regions, it has been proposed by some that Orlando should be the

lead TMC in the implementation of a de-centralized approach, or the Central TMC in implementing the centralized approach. Since the centralized approach tends to fit the evacuation scenario better, it could be concluded that the Orlando RTMC should be designated and retrofitted as required to serve as the statewide ITS coordination center for multi-jurisdictional hurricane evacuations.

2.2 ITS Roadside Equipment

Although TMC's provide a useful function as centers for coordination and communication even without direct control of field devices, the nature of the field infrastructure that supports the TMC's makes ITS a highly useful tool in assisting with the management of evacuation activities. ITS field, or roadside, equipment has the distinct advantage of being in place and operational prior to the approach of the hurricane, rather than being deployed during the event. Video cameras on roadside poles and dynamic message signs mounted on roadside cantilever structures are examples. In Orlando, these devices are connected utilizing a state-owned fiber optic communications system built primarily for the ITS.

Table 1 presents a subjective evaluation (by the author) of each type of ITS roadside device based system for its utility in addressing hurricane evacuation needs. ITS is normally deployed in a series of "market packages" which consist of a subsystem of roadside device normally monitored and controlled from a central location, usually a TMC. The devices listed in Table 1 can be easily integrated into a single system through the use of a hardware and software "platform" designed for ITS operations. Integrating software is readily available to connect any complement of roadside devices that are desired for specific operational purposes into an overall system. The existing system at the Orlando TMC is an example of an integrated package, in the case of Orlando primarily designed to handle recurring (everyday commuter) congestion as well as non-recurring congestion (incidents and special events). The ITS integrating software is capable of expansion to add more of the existing types of roadside devices as well as the incorporation of new devices. Table 1 provides a comparison of ITS roadside device types and how each type rates against criteria important to hurricane evacuation operations. The following considerations are reflected in this analysis:

- Traveler Information: How well does the roadside subsystem support the need to communicate in real time with motorists?

- Reversible Lane Support: Does the ITS roadside subsystem have the potential for increasing the safe operation of reversible laning scenarios?

- Monitoring: Is this the type of system that provides real time information back to the operator that is useful for performance monitoring and decision support?

- Traffic Control: Does the ITS roadside subsystem have the potential to implement regulatory (meaning legally enforceable) traffic control?

- Evaluation: Do the roadside devices involved collect data that would be useful in evaluating performance and enhancing future preparedness activities?

Table 1 Subjective Assessment of Comparative Utility of ITS Devices for Evacuation Management.

ITS Roadside Device Based System	Potential Use for Evacuations	Traveller Information	Reversible Lane Support	Monitoring	Traffic Control	Evaluation	Overall Assessment of Utility*
Video Cameras	Real time monitoring of highway conditions, incident management, landfall confirmation.	**1**	**9**	**9**	**4**	**6**	**8**
Dynamic Message Signs (Permanent)	Communication with motorists enroute, safety messages, alternate route usage, shelter information, regulatory advisories.	**9**	**7**	**1**	**7**	**4**	**6**
Dynamic Message Signs (Portable)	Same as dynamic, except deployed immediately prior to evacuation.	**9**	**9**	**1**	**9**	**1**	**7**
Traffic Signal Systems	Implement special timing plans to assist with ground control, reduce congestion at freeway interchanges, utilize major arterials for alternate routes.	**1**	**4**	**7**	**10**	**7**	**7**
Highway Advisory Radio & (AM/FM Override)	Communication with both pre-trip and enroute motorists, safety messages, alternate route usage, shelter information, regulatory advisories.	**9**	**4**	**1**	**1**	**1**	**6**
Satellite Imaging **	Utilization and display of satellite images for statewide roadway utilization tracking.	**1**	**4**	**9**	**4**	**9**	**6**
Data Collection Systems	Obtain traffic counts and traffic flow characteristics.	**4**	**1**	**7**	**7**	**9**	**6**

***1-3 Modest Benefit. 4-6 Potentially Useful. 7-9 Highly Beneficial. 10 Required for Safety.**

**** Satellite imaging is not in the ITS National Architecture. It is included here for purposes of comparison.**

The subjective ratings provided in the utility table require further evaluation by ITS experts in the Department of Transportation and ITS community to provide a consensus on utility.

2.2.1 Video Surveillance Equipment

One of the mainstays of ITS is video surveillance. Video cameras are typically deployed with pant, tilt and zoom (PTZ) capability, to provide operators with maximum flexibility. Cameras provide an instantaneous assessment of roadway conditions. Although most existing highway surveillance cameras utilize the ½ inch charged couple device (CCD) cameras, 1/3 inch and more recently ¼ inch formats are finding their way onto the roadways. The advantage of the 1/4 inch format is that it is considerably smaller and lighter, with less infrastructure required to mount, support and protect it from the elements.

Video images are typically transmitted to the TMC by fiber optic cable transmission, however compressed video can be transmitted over standard telephone lines. High quality lines are capable of providing MPEG 1 quality video (Motion Picture Experts Group) which is essentially equivalent to thirty (30) frames of video every second. Compression equipment and high quality lines can be expensive, therefore operational considerations govern whether or not the cost is justified.

ITS PTZ Video Surveillance Camera on I4, Orlando

Cameras are highly useful for incident management purposes, allowing decision makers to dispatch the right complement of equipment to an incident scene quickly. Cameras also provide immediate confirmation and monitoring of the effect of decisions and strategies in the field.

Digital video images can also be converted to JPEG format and made available as snapshots over the internet. These images could be utilized by evacuation activity managers far from the scene to monitor conditions and improve traffic control. These images could also be made available to the public, although high demand could prevent access to servers during event conditions. Agency personnel should therefore have priority access of images.

2.2.2 Dynamic Message Signs

Dynamic Message Signs (DMS) also called Variable Message Signs (VMS), provide ITS operators with the capability of communicating with over two thousand vehicles per hour for each lane of traffic from which the sign can be viewed. On a typical three lane freeway section during a ten hour evacuation, a single VMS can communicate messages to as many as sixty (60) thousand drivers. Sign messages can be tailored to the specific travel stream viewing them, having the advantage over Highway Advisory Radio (HAR) in that very specific messages can be delivered that are relative to the specific location and direction of travel.

The utilization of both permanently mounted DMS like the one shown and portable DMS which are trailer or truck mounted is a well established priority with FDOT for traffic management. The signs have considerable application to many of the activities involved with providing improved highway transportation during evacuations. DMS can also be utilized to close roadway segments in emergencies, such as the scenario of clearing the roadway once a hurricane makes landfall.

ITS Dynamic Message Sign (DMS) on I4, Orlando

Portable DMS technology does have limitations that are relevant for discussion in the context of hurricane evacuation. Portable DMS take time to deploy, and the effort required to transport the sign to what may be a rural location (for example, I-75 in the Alligator Alley) and make the sign operational on site must be factored into the plan. Portable DMS are typically generator and or solar powered, and can be remotely operated by cell phone or radio technologies.

Portable DMS are usually advisory in nature, although relatively simple legislative support can be provided to make the messages regulatory and enforceable in certain situation (e.g. speed limits in work zones).

2.2.3 Traffic Signal Systems

The potential utilization of traffic signal systems should not be overlooked in the context of improved highway transportation during hurricane conditions. The importance of ground traffic control has been noted in the Report by the Governors Hurricane Task Force[4]. Consider the following quote from the report:

> "The Task Force identified problems with some of these during the Hurricane Floyd evacuations. There was poor "ground level" (non-interstate) traffic management which resulted in congestion caused by vehicles entering and exiting the interstates,

[4] Florida Department of Transportation, Governor's Hurricane Evacuation Task Force Report, published at http://www.dot.state.fl.us/EvacuationStudy/report.htm, text extracted 5/19/2000.

adequate numbers of shelters not being opened and advertised to the evacuating public, and limited emergency public information available for motorists."

The implementation of traffic signal systems in and around interchanges, as well as production of special timing plans are one of the potential ITS measures that could have great benefit during evacuations. In major urban coastal urban areas including Tampa and Miami, traffic signal systems already exist for which special evacuation timing plans could and should be developed.

2.2.4 Highway Advisory Radio

Communications with motorists and even pre-trip travelers is possible through highway advisory radio (HAR). Radio coverage can be limited to specific areas, such as could be implemented with 10 watt a.m. monopole transmitters. Traveler advisories can also be provided through existing emergency broadcast communication infrastructures. HAR has the advantage of providing a longer and more detailed message to the traveler. HAR has the disadvantage of having a mixed reputation with the public. Transmission quality is usually less than what motorist are used to receiving from commercial broadcast stations. Timeliness of information is also an issue, but can be overcome by adding a tag line such as "updated at 4:50 p.m." HAR could be implemented through installation of permanent infrastructure in key locations, or the utilization of portable transmitters during evacuation events. The same considerations regarding timeliness of deployment of portable devices applies, however there is potential for co-location of portable signs and HAR on the same truck or trailer.

2.2.5 Reversible Lane Control

Most permanent reversible lane operations on urban freeways around the country are operated utilizing a combination of enforcement, ITS, and field personnel. ITS has a track record with reversible lane operations, and many of the same elements (i.e. cameras and signs) apply. Temporary reversal of entire directional freeway segments and interchange movements is a special case. The placement of permanent infrastructure such as gates and signals would require evaluation of cost justification. Safety, and the potential for wrong way movement and head on collision is sufficient cause to warrant evaluation of utilizing special ITS measures during reversible lane operations. Ramp control through metering, and detection technologies (including video image processing) to monitor vehicle velocities (defined as vehicle speed and direction) should be investigated.

In the Executive Summary of the Multi-Regional Evacuation Meetings held November 8 - December 2, 1999, the following roadway segments were suggested by County officials for evaluation for reversible laning:

I-10 (east bound) Pensacola to Tallahassee

I-4 (east bound) Tampa to Orlando area

I-75 (north bound) Charlotte County to I-275

Florida Turnpike (north bound) Florida City to terminus

SR 528 (both directions) Entire length

I-10 (west bound) Jacksonville to Tallahassee

I-75 (Alligator Alley) (east and west bound) Coast to Coast

Evaluation of the manpower required to implement reversible operations during emergencies without the use of ITS technologies was identified in the Governor's Hurricane Evacuation Task Force Report and is summarized in the following table:

Table 2 Governor's Hurricane Evacuation Task Force Report Reversible Laning Manpower Estimates[5]

Roadway	Location	Personnel Estimate
Interstate 10 (east bound) -	Pensacola to Tallahassee	155
Interstate 10 (west bound) -	Jacksonville to Tallahassee	156
Interstate 4 (east bound) -	Tampa to Orange County Line	210
Interstate 75 (north bound)	Charlotte County to I-275	209
Florida's Turnpike (north bound) -	Ft. Pierce to Orlando	77
State Road 528 (west bound) -	SR 520 to SR 417	20
Interstate 75 (Alligator Alley)	(east and west bound) - Coast to Coast	155

Although a combination of ITS technology and appropriate personnel can be utilized to operate a **permanent** reversible roadway, it is unclear and would require considerable study to determine if application of ITS technologies on the identified Florida evacuation routes in a temporary deployment could significantly reduce the personnel requirements identified in Table 2.

2.2.6 Satellite Imaging

Although Satellite imaging is not specifically identified in the ITS National Architecture for roadside data collection, the technology deserves consideration for utilization in hurricane evacuation situations. Satellites for weather, communication, imaging and military operations may certainly have application. Commercially available satellite imaging for routine traffic management, is likely to be cost prohibitive. The infrequency with which hurricane evacuations are implemented, however, gives cause to justify evaluation of these technologies for evacuation management. The following table is a recreation from the Governor's Hurricane Evacuation Task Force Report[6] on anticipated frequency:

Table 3 Florida Hurricane History and Year 2000 Forecast

[5] Florida Department of Transportation, Governor's Hurricane Evacuation Task Force Report, published at http://www.dot.state.fl.us/EvacuationStudy/report.htm, text extracted 5/19/2000.
[6] Florida Department of Transportation, Governor's Hurricane Evacuation Task Force Report, published at http://www.dot.state.fl.us/EvacuationStudy/report.htm, text extracted 5/19/2000.

	Named Storms	Hurricanes	Major Hurricanes (≥ 111 mph)
Annual Average 1950-1990	9.3	5.8	2.2
1999	12	8	5
2000 Forecast	11	7	3

Given the relative infrequency of utilization, and the anticipated duration of transportation impacts being less that 24 hours, utilization of satellite imagery may be possible. Existing ITS TMC's may be capable of utilizing existing display equipment to make the images available to transportation decision makers.

Commercially available satellite imagery may be limited by weather conditions, the precise condition which its utilization would be implemented to address. Military imagery technologies are more capable of imaging beneath cloud cover. It could be investigated to determine if emergency access of imagery could be established through the cooperation of federal agencies already involved in hurricane evacuation planning and management (i.e. FEMA, FHWA, National Guard, etc.).

2.2.7 Data Collection Stations

Intelligent Transportation Systems utilize traffic data collection through various electronic means for the purpose of determining and improving traffic performance characteristics. Mots ITS utilize in-pavement vehicle detection, video image processing, low power microwave radar detection or other means. Data collection stations are also documented to be highly useful in determining and evaluating actual transportation system performance after the fact, with improvement of future strategies as a goal.

ITS detection capability is increasing vastly on Florida highways due to the arrival of literally hundreds of thousands of electronic toll collection devices on the roadways. A Florida turnpike official recently reported to a national conference audience that as many as 200,000 SunPass transponders are on the road, and as many as 600,000 more are possible in the relatively near future. Later this year, it is also anticipated that the Orlando Orange County Expressway Authority's E-Pass transponders will be converted over to the SunPass technology. These transponders can be read outside of toll barriers, virtually anywhere on the highway system, for the purpose of determining actual travel times. Installation of readers on the key evacuation routes is essential.

2.3 ITS Communications

Although Intelligent Transportation Systems can be diverse in terms of field equipment types and operational purposes, all ITS have one thing in common: communications links between field devices and a central location. The proliferation of video monitoring as part of ITS has been fueled by technology improvements and cost decline in camera equipment. The

proliferation of video has placed an increased emphasis on the importance of providing high bandwith communications systems to support ITS. These requirements have lead to the incorporation of fiber optic communications into ITS deployments, such as the one in place on I-4 in Orlando.

The Florida Fiber Network initiatives underway at the Department of Transportation are likely to have the effect of providing a statewide capability for communication to support widespread ITS deployment. This deployment will have the ancillary effect of providing a state of the art communications backbone for the use of hurricane evacuation managers.

In addition to fiber optic facilities, ITS engineers routinely utilize other forms of communication links, both wireless and wireline, to communicate with field devices when fiber optic cable is not available or is not practical from a cost standpoint.

2.4 Traveler and Vehicle

Intelligent Transportation Systems technologies extend directly to the traveler in his or her home (internet, broadcast media, and informational paging systems such as those available for the Palm pilot type of computer). ITS also extend directly to the traveler in his or her vehicle (e.g. GM's OnStar, broadcast media, cell phone, etc.). The future of in-vehicle computing and communications, often referred to as Telematics, is rapidly approaching. Already, motorists in Singapore can view downstream traffic camera images on hand held computers from inside vehicles. The emphasis that Microsoft and other technology super-powers are placing on the automobile-PC platform means that there is a potential market in the U.S. for these services. It is not necessary to deploy these technologies in addressing hurricane evacuation needs, it is very important to be aware of developments and incorporate consumer provided technologies into the overall picture as they become available.

3 ITS Implementation for Hurricane Evacuation

Intelligent Transportation Systems deployments provide a unique opportunity to the state of Florida for implementation of a system that takes full advantage of the technology infrastructure during emergency evacuation events.

3.1 Implementation Considerations

The development of a statewide transportation management system for evacuation needs to consider the existing investments and transportation systems across the state. Existing operations areas for consideration include:

- Data Collection Devices (operations and planning)
- CCTV Support
- Construction Information
- Event Data
- Weather Data
- DMS Support
- Existing operations centers
- Highway (Traffic) Advisory Radio Systems

- Incident Management
- Florida DOT Communications Systems and Networks

3.2 Conclusion:

Hurricane evacuation is a serious business, and the government and private sector decision makers who bear responsible charge for public safety have a solemn task. The technologies of ITS cannot create a system that will completely eliminate traffic congestion during evacuations, but they can provide managers and operators with the best tools to get the job done quickly and safely. The great synergy that exists between evacuation planning activities and ITS lie in the long standing sharing of identical goals:

- Protect and improve traveler (public) safety

- Reduce the effects of unplanned events on the orderly and efficient movements of people and goods

- Minimize delay for travelers to reduce motorist frustration, fuel consumption, accidents and breakdowns. Intelligent Transportation systems capabilities define a system solution to the statewide problem of managing major evacuations and emergency events.

Some of the operational capabilities to be incorporated in an engineered systems approach would be as follows:

Common User Interface – The solution should integrate information from the existing systems in the field today. The system should have a graphical representation (map) of the state, including customized maps for evacuation routes. Icons for sub area maps would lead to more detailed information.

Communications – The solution needs to evaluate the communications infrastructure to be as redundant and fault tolerant as possible. Losses in the system should only take out small pieces, and not the entire system. Separate studies will be required to evaluate the existing FDOT WAN, and future Florida Fiber Network for capacity based on need.

Location of Evacuation Center – A center should be centrally located where the likelihood of a major incident is smallest, where communications infrastructure is available, and management staff have easy access. Building upon an existing successful operation would provide the quickest solution, in Florida this would most likely be the Orlando RTMC.

Remote Access – System should have remote access capabilities, and the ability to implement transfer the primary location to a back up location in the event of a major incident. The back up location would have full monitoring capabilities at all times, and the ability to assume control as the primary center if required. The location could be in a region distant from the primary, and possibly further inland (e.g. Tallahassee).

Architecture – The system solution might involve a hybrid implementation of new and existing equipment. The software could be “distributed” for fault tolerance purposes.

CCTV – Video images could be managed over the FDOT WAN. Each field system with video would make access to their video through the WAN using Internet based technologies/methods. The central and back up transportation evacuation center would have the capability select video form anywhere in the state.

Incident Reporting – Software would have a reporting mechanism for tracking incidents, operator actions, events, and jurisdictional interactions at the federal, state, county and city level.

Construction Reporting – All of the DOT/County and Cities should keep the database current with construction data so that the evacuation process can avoid construction or invoke actions to minimize construction zone problems on the evacuation process. Nothing is worse than sending people to a route that has construction and construction delays.

Based upon the potential benefits to be accrued from the utilization of ITS for hurricane evacuations, there is great benefit to develop specific plans for incorporating ITS technologies into the hurricane evacuation plans for the State of Florida.