AWARE PILOT PROJECT ALONG SOUTH FLORIDA RAIL CORRIDOR

FINAL PROJECT REPORT

FLORIDA DEPARTMENT OF TRANSPORTATION

CONTRACT # BC498

AMENDMENT #2

Prepared by: **Nestor Traffic Systems, Inc.**

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400 Massasoit Ave. Suite 200
East Providence, RI 02914
Telephone: 401-434-5522
Fax: 401-434-5809
Internet: www.nestor.com

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GLOSSARY OF TERMS

APTA	–	American Public Transportation Association
ATCS	–	Advanced Train Control System
AWARE	–	Advanced Warning Alerts for Railroad Engineers
FDOT	–	Florida Department of Transportation
ITS	–	Intelligent Transporation Systems
MMIT	–	Master Mobile Information Terminal
MOT	–	Maintenance of Traffic
NCN	–	Nestor Communications Network
NEMA	–	National Electrical Manufacturers Association
NTS	–	Nestor Traffic Systems
PTZ	–	Pan-Tilt-Zoom
ROC	–	Rail Operations Center
RCG	–	Rail CrossingGuard
RFP	–	Request for Proposal
SFRC	–	South Florida Rail Corridor
SMIT	–	Slave Mobile Information Terminal
SS	–	Spread Spectrum
TRB	–	Transportation Research Board
VPN	–	Virtual Private Network

1 PROJECT BACKGROUND AND ACKNOWLEDGEMENTS

This project was conducted by Nestor Traffic Systems, Inc., with support from GeoFocus, LLC, for the Florida Department of Transportation as an extension of work done under Contract # BC498. Financial support for this project was provided through the Florida Department of Transportation

The AWARE extension to Nestor's Rail CrossingGuard project would not have been possible without the vision and dedication of a number of key FDOT officials. The Rail CrossingGuard project itself was launched by Ms. Anne Brewer, the FDOT Rail Coordinator in Tallahassee. Mr. Michael Dowell, Rail Projects Coordinator, FDOT Tallahassee, led the effort to amend and extend this contract to provide for the AWARE pilot project demonstration, and provided initial project management and oversight for FDOT. As the project moved into the construction phase, local FDOT District 4 project management and coordination was provided by Mr. Larry Merritt, Intermodal Transportation Manager. Nestor wishes to express its appreciation to Ms. Brewer, Mr. Dowell and Mr. Merritt for the valuable roles they played in launching, managing and supporting this project. Additional support and encouragement were provided by Ms. Nancy Bungo and Mr. Raymond Holzweiss of FDOT District Four office in Ft. Lauderdale.

Additionally, Nestor wishes to thank Mr. Murali Pasumarthi, Mr. Larry Hagen and Ms. Delphine Thornton at the Broward County Traffic Operations Center, and Mr. Daniel Mazza, and Mr. Brad Barkman of TriCounty Rail Services (TriRail) for their special participation in the project. Their vision of the role the system can play to enhance the services they provide for improved highway traffic and rail safety at grade crossings was a key component that shaped the appearance and functions of Rail CrossingGuard for end users in the traffic management center. Within GeoFocus, Nestor's partner in the project, we wish to acknowledge the special contributions of Mr. Edward ("Eddy") Malinowicz and Mr. Dwain Jenkins for their visionary role in originating the concept of the AWARE system and to Ms. Jolene Molitoris and Mr. Tom Keane for their support of the project.

Nestor is grateful for the support and cooperation provided by all the other project stakeholders throughout the course of the project, including Herzog Transit Services, CSXT, the FRA and the FHWA. Their support for this demonstration project is an outgrowth of their continued commitment to look for new and better ways to improve grade crossing safety.

The AWARE project was an extension to Nestor's Rail CrossingGuard project to demonstrate video monitoring of grade crossings on the South Florida Rail Corridor. The AWARE project benefited from the very able support provided to Nestor for its Rail CrossingGuard project by a number of very capable subcontractors, including Mr. William Young of Balfour Beatty Rail Services and Mr. Jeffrey Buckholtz of Buckholtz Traffic who furnished construction and installation support; and Mr. Steve Untiedt of SeaRobotics who performed in-field system maintenance. Additionally, Nestor received extremely capable software development, testing and installation support from Merril-Clark, Inc. and from Mr. G. Edward Roberts of Elparazim as well as substantial program management support from James E. Hooper of Sakonnet Technology Group.

2 EXECUTIVE SUMMARY

AWARE, Advanced Warning and Alerts for Railroad Engineers, is a combination of Nestor's Rail CrossingGuard automated video monitoring system and GeoFocus, LLC's TrainTrac system for GPS-based train location and communication. As a synthesis of these two systems, AWARE allows an approaching train to communicate its location to a grade crossing and the crossing to communicate its status to the train. If the crossing is obstructed, AWARE will send a warning message to the train, with the potential for alerting the engineer on the train in time to take action to either stop or slow the train to avoid or mitigate the effects of a collision.

Risks at grade crossings result from vehicles entering or being on the crossing in conflict with train use. Several recently introduced engineering treatments, in particular, median barriers and quad gate systems, are designed to prevent drivers from entering the crossing after the grade crossing warning system activates. Neither will prevent a vehicle from stopping on the crossing, and so *neither can address the problem of vehicles that are already present on the crossing when the crossing warning system activates*. Fully half of the grade crossing collisions that occurred along the South Florida Rail Corridor in the first half of 2001 involved a train hitting a stopped vehicle. This is the central problem that the AWARE system is designed to address. By communicating an early warning to the train, AWARE has the potential to prevent some of these collisions.

This Final Report reviews the activity and accomplishments related to Nestor Traffic Systems' demonstration and proof of concept project contract with the Florida Department of Transportation to install and demonstrate the AWARE system at two grade crossings along the South Florida Rail Corridor in the Ft. Lauderdale area. The project was launched in May 2001 as an extension to Nestor's Rail CrossingGuard pilot demonstration project with FDOT. The Rail CrossingGuard project was a proof-of-concept project to demonstrate automated video monitoring of five grade crossings along the South Florida Rail Corridor. Two of the five crossings equipped with Rail CrossingGuard were chosen as demonstration sites for the AWARE project.

The AWARE project leveraged project work done by Nestor to install and demonstrate its Rail CrossingGuard automated video monitoring system at five crossings in the Ft. Lauderdale area. A separate report has been issued describing that project. As an extension to the Rail CrossingGuard project, the AWARE project consisted of tasks that included project management, site selection, site engineering, construction, equipment installation, field testing, observation, and demonstrations.

Nestor and GeoFocus achieved the central goals of this project; namely, to demonstrate the ability of the AWARE system to transmit real-time train location information from approaching trains to grade crossing monitoring equipment at the crossing, as well as real-time Rail CrossingGuard status and alert information from the grade crossing monitoring equipment to operators of approaching trains. Additionally, the project demonstrated the ability to remotely display real-time grade crossing alerts in a central rail operations center and to view live video of crossing activity to confirm crossing status/alert information. Further, the project demonstrated the ability to remotely configure the status monitoring and/or alert generation functionality of the grade crossing monitoring equipment. In the course of the project, a number of operational issues were identified which need to be addressed either through subsequent development or through the definition of policies and/or procedures governing the use of such a system. This Final Report describes the results of the field demonstration, "lessons learned" from the project and the issues to be addressed in follow-on field testing.

The AWARE system is in the family of Intelligent Transportation System (ITS) applications for safety advisory systems. The potential end users of the system are local/state traffic operations departments and railroad dispatch centers. By providing timely information of hazardous grade crossing conditions to approaching trains, AWARE can create opportunities to reduce the risk or severity of train-vehicle collisions at grade crossings. This project has shown the feasibility of using video monitoring and various communications technologies to detect crossing conditions, to communicate train approach information to the crossing, and crossing status information to the train. The project also showed the feasibility of simultaneously providing grade crossing alert and confirming video information to highway traffic and rail operations centers. With these components, an operational system can be designed that will perform reliably and meet the operational needs of both highway and railroad stakeholders. Among the next steps to be taken include a cost-benefits study to identify the potential savings in risk reduction that can be achieved, the definition of formal performance requirements and demonstration of functionality that can operate to meet those requirements, and the demonstration of alternate means of communicating the alert information to the train, both in terms of onboard equipment and the role of the rail operations center in first receiving and screening alerts.

3 PROJECT DESCRIPTION (AS PROPOSED)

3.A INTRODUCTION

Under an existing contract with the Florida Department of Transportation (FDOT), Nestor Traffic Systems, Inc. (NTS) provided equipment and services to create a pilot installation of its Rail CrossingGuard? grade crossing video monitoring system at five (5) crossings along the South Florida Rail Corridor (SFRC).

Rail CrossingGuard, from Nestor Traffic Systems, Inc. (NTS), is an automated video-based monitoring system that uses advanced image processing technology to detect and monitor vehicle and train activity at grade crossings. It does not require the installation or maintenance of in-ground loops, therefore eliminating the need for pavement cutting and lane closures. Rail CrossingGuard applies patented image processing technology to deliver a video-based solution that automates the detection of vehicles and trains at the crossing, the raised, lowered or altered status of rail crossing gates/arms, and the functional status of signal crossing lights. By detecting these events, Rail CrossingGuard can capture and log operational data on crossing activity as well as data on how the crossing is being used by vehicles and trains. Additionally, Rail CrossingGuard provides live surveillance of monitored crossings. Rail CrossingGuard is also able to detect vehicles violating the crossing signal and record vehicle identification information so that warnings or citations may be issued to violators.

Rail CrossingGuard (RCG) cameras are mounted on roadside poles or mast arms at heights and locations that prevent tampering or unauthorized access. A PC (the RCG "Trackside Station") is installed in a cabinet or enclosure by the roadside. All monitoring equipment is installed off the railroad right-of-way and without the need to electronically interface to railroad signalization equipment.

A high speed communications network, using a combination of wireless and wireline technologies, connects Trackside Stations installed at different crossings to a Rail CrossingGuard Server installed at a central hub station. The hub station Server is connected via a high speed T1 line to remote RCG PC Viewing Stations, essentially PC's with web-browsers that can be located at traffic centers, rail operations centers, police or emergency dispatch centers, etc. Over this network, a user at an RCG Viewing Station can communicate through the RCG Server to access any Trackside Station PC, receiving live video as well as crossing status and alerts of potentially hazardous incidents.

Rail CrossingGuard was an outgrowth of a technology demonstration project funded by the TRB (Transportation Research Board) IDEA (Innovations Deserving Exploratory Analysis) program in 1998. The objective of that project was to demonstrate the application of advanced computer vision-based technology to the detection of grade crossing activity as captured in previously videotaped images of highway rail intersections.

Along the South Florida Rail Corridor, GeoFocus, Inc. (GFI) has installed its *TrainTrac*? communications-based train location and information system for Tri-County Commuter Rail Authority (Tri-Rail). The system uses GPS-based location devices and the ATCS wireless communication system to provide train location information to the Tri-Rail Rail Operations Center (ROC) in Hialeah, Florida and to announce/display train arrival/delay information on electronic message boards at train stations.

In August 2000, GFI and NTS signed a joint marketing agreement for AWARE, Advanced Warning and Alerts for Railroad Engineers. AWARE combines and extends GFI's train-based location and communications equipment and NTS' intelligent grade crossing video-monitoring system to provide grade crossing status and alerts to approaching locomotives.

An extension to NTS' Rail CrossingGuard pilot FDOT project, the AWARE pilot project provided for the installation of additional equipment and provision of services for demonstrating a proof-of-concept field trial of the AWARE system at two crossings equipped with Rail CrossingGuard and on two Tri-Rail trains. NTS served as the prime contractor for this project, with subcontracting support from GFI.

3.B GOALS OF THE AWARE PILOT PROGRAM

The AWARE pilot project has the following specific goals:

- ?? Demonstrate the ability to accurately collect real-time Rail CrossingGuard status and alert information and transmit appropriate warning messages from the grade crossing monitoring equipment to operators of approaching trains.
- ?? Demonstrate the transmission of real-time train location information from approaching trains to grade crossing monitoring equipment at the crossing.
- ?? Demonstrate a variety of real time crossing alert information (within the alert objectives of the original Rail CrossingGuard contract) from the crossing to approaching trains.
- ?? Demonstrate the ability to remotely configure the status monitoring and/or alert generation functionality of the grade crossing monitoring equipment.
- ?? Demonstrate the ability to remotely display real-time grade crossing alerts in a central operations center and to view live video of crossing activity to confirm crossing status/alert information.
- ?? Determine any system factors or operational issues which can affect highway railroad grade crossing system performance so that they can provide the basis for subsequent development, follow-on field testing and/or crossing modifications.
- ?? Provide a Final Report which i) describes the results of the field demonstration, ii) the process of equipment installation, iii) the issues to be addressed in follow-on field testing and iv) any "lessons learned" from the project.

3.C OVERVIEW OF THE AWARE SYSTEM

The AWARE system is a real-time, communications-based train warning system that provides advisory and warning information on the status of grade crossings to the train engineers of approaching locomotives. The AWARE system consists of grade crossing monitoring and communications equipment installed at the grade crossing and information display and communications equipment installed on a train.

The AWARE system augments and combines existing hardware and software already provided by GFI to Tri-Rail and a separate system provided by NTS to FDOT. This strategy of building on already deployed equipment and systems will facilitate deployment and reduce overall project risk.

3.C.1 BUILDING ON EXISTING SYSTEMS DEPLOYED ALONG THE SFRC

The GFI equipment now in service in South Florida is a Train Tracking and Information Management System used and owned by Tri-Rail. This system uses FDOT's ATCS radio system for sending train positional information and two-way train communications. The tracking system is implemented as a distributed, networked system with the primary server based tracking computer located in Tri-Rail's Rail Operations Center (ROC) in Hialeah, FL. The tracking system is monitored and controlled by Herzog Transit personnel in the rail operations center and on the trains.

Under contract with FDOT, NTS is installing its Rail CrossingGuard (RCG) video-based grade crossing monitoring system at 5 consecutive crossings in the Ft. Lauderdale area on the South Florida Rail Corridor. Rail CrossingGuard consists of video cameras and a Trackside Station PC installed in the vicinity of the crossing. The Trackside Station PC uses advanced image processing software to automatically detect vehicle and train usage of the crossing, as well as to gather information on the integrity and operational characteristics of the crossing traffic control devices (e.g., flashing lights and gates).

The Rail CrossingGuard equipment at the crossing transmits grade crossing data and live video over a combination of wireless and wireline communications back to a Rail CrossingGuard Server PC installed at a central monitoring facility. The RCG Server receives this data in real time, stores the data to a data log, and, optionally, provides live video of the equipped crossings. The RCG Server also provides real-time, remote control of all Trackside Station PC's and cameras.

3.C.2 SYSTEM DESCRIPTION

Each crossing using the AWARE system is equipped with Rail CrossingGuard monitoring equipment consisting of several video cameras and the Rail CrossingGuard Trackside Station PC. The Trackside Station PC monitors crossing status through intelligent real-time processing of the images provided by the video cameras.

Each crossing on the AWARE system is equipped with an AWARE Controller Computer (ACC) and a spread spectrum radio (with antenna). The spread spectrum radio enables the ACC to receive/send information from/to the Trackside Station PC and an AWARE-equipped approaching train.

The Trackside Station includes an optional AWARE Interface Module that communicates over an RS-232 connection to the AWARE Controller Computer. This interface module provides logic to handle the oncoming train approach information from the ACC and to generate the appropriate messages and alerts for transmission back to the ACC.

An AWARE-equipped train set has two Mobile Information Terminals (MIT's) at each end of the train to display crossing status messages and alerts, a GPS-based train location device and a two-way spread spectrum wireless radio to communicate between the train and the ACC.

The train will have a Master Mobile Information Terminal (MMIT) installed on the cabcar and a Slave Mobile Information Terminal (SMIT) on the locomotive. The cabcar and locomotive terminals communicate with each other via spread-spectrum radio transceivers connected to each. The MMIT is connected to a Safetran Mobile Communication Package ATCS radio operating on the FDOT 900 MHz system.

The GFI train tracking system provides two-way communications between trains and the base station server computer in Hialeah. The MIT units currently installed on trains can send and receive information. MITs send train ID, location and velocity as a Level 4 priority message on the ATCS system. The Tri-Rail Rail Operations Center (ROC) can send alpha-numeric messages to the train operator via the MIT displays. The train operator, in turn, can use the MIT user interface to send a series of preprogrammed text messages to the ROC.

For the purpose of using Tri-Rail's ROC as a central monitoring site for the AWARE demonstration, a Rail CrossingGuard Server PC was provided to the ROC located in Hialeah, FL. This Server was equipped with an AWARE RCG Configuration Module to enable the definition of status/alarm messages and a specification of their priority levels. The module also displayed AWARE alerts generated by the RCG Trackside Station to the Rail CrossingGuard Server screen, indicating all relevant information, including the crossing identifier. The RCG Server provided the option of viewing live video of the crossing to confirm the nature of the crossing alert. This same AWARE functionality was installed on the Rail CrossingGuard Server PC installed at a FDOT facility in Ft. Lauderdale as part of Nestor's existing contract to install Rail CrossingGuard at the five crossings in the Ft. Lauderdale vicinity.

The Rail CrossingGuard Server installed in Hialeah communicates with the Nestor Communications Network (NCN) over a high speed frame-relay circuit. The Nestor Communications Network uses the latest telecommunications and computer technology to deliver video and data in real-time, connecting Rail CrossingGuard Servers to Rail CrossingGuard Trackside Stations. The NCN is completely scalable to accommodate any number of grade crossings which a client may choose to equip, and can grow as the need arises in the future.

The NCN is built on top of the Qwest national fiber-optic communications backbone. As a private communications network, the Qwest frame relay network enjoys inherent security against unauthorized access, and the Nestor Communications Network is a private circuit within this private network. Over this network, grade crossing video and data flow securely from each Rail CrossingGuard-equipped grade crossing to NTS' Operations Center and to Rail CrossingGuard Servers, which are additional nodes on the network. Use of this high speed communications network allows Nestor to remotely monitor system operation to run automated system health monitoring, remote diagnostics of cameras and computer components, re-start/recovery from some types of system interruptions, and software upgrades.

3.C.3 SYSTEM OPERATION

The Rail CrossingGuard video monitoring system installed at the crossing continuously monitors vehicle and train usage of the crossing, together with the operation of the crossing signalization itself. The Rail CrossingGuard video cameras are mounted on poles and mast arms in the vicinity of the crossing to provide a clear view of the crossing zone including the crossing gates and lights and upstream traffic. The Trackside Station PC will process the incoming video stream from these cameras in real-time to detect vehicles on the tracks, and the status of the crossing gate arms and signal lights.

The Trackside Station is able to detect vehicles that violate the crossing when the signalization is active, and it is also able to detect vehicles that stop on the crossing tracks for more than a user-specified period of time. It can detect the arrival and passage of the train, logging these times to a data log file. Additionally, the system detects gate and light malfunction, such as the gate failing to lower or raise at the proper time prior to the train's entry into the crossing and after its departure. Since all of these events can be detected in real time, the system can generate real time alerts for a number of hazardous crossing conditions.

When used in the AWARE system, Rail CrossingGuard continuously monitors the crossing to provide crossing status messages and alerts to the AWARE Controller Computer. As a train approaches the crossing it sends information identifying itself (train ID) and its approach telemetry (position, speed, acceleration/deceleration) to the AWARE Controller Computer (ACC) at the crossing. The ACC passes this information to the Rail CrossingGuard Trackside Station. The Trackside Station combines this information with information on the status of the crossing (e.g., clear, blocked, gate up/down, gate

OK/malfunction, light OK/malfunction, etc.) to produce crossing status and/or alert messages that it continuously updates and transmits back to the ACC. The ACC communicates this status information directly to the train over a spread spectrum radio, constantly updating the train crew operating in the vicinity of the grade crossing on the status of the crossing.

Alert/status messages are displayed on the MIT's in the train. Each terminal has built-in aural and visual alerting devices. When a message is sent to the train from the ACC, the terminal turns on a bright-red LED indicator and a beeper to alert the train operator that a message has arrived. The alert indications can be made progressively more intense depending upon the level of urgency of the message.

The message is shown on a 40 x 4 LCD display and can be paged until the full message has been viewed. The system can be configured to continue the alert until the crew acknowledges the message by pressing a terminal key. The MIT logs a record of the message acknowledgement.

The MIT contains a menu system that allows the engineer to build a message and send it to the base station. These message menus can be programmed to include emergency, incident reporting and maintenance messages. This will allow the train crew to verify crossing conditions from the train cab directly back to the operations center. A variety of conditions such as defective gates, malfunctioning signals, track maintenance needs or track obstructions can be either automatically detected by the crossing video monitor or by the train crew and communicated both to the rail operations center and to other trains approaching the affected area.

A Rail CrossingGuard Server will be installed at the Rail Operations Center. The Server will enable an operator at the ROC to define the priority level of grade crossing alerts, enable/disable alerts generated at the crossing, view alert status information on the monitor and access live video of the crossing to confirm the crossing status or nature of the alert, and verify a subsequent response.

3.D PROJECT STAKEHOLDERS

The stakeholders in this project consisted of the Florida State Department of Transportation (FDOT); the local county department of transportation, Broward County Traffic Department, the railroads (TriRail, Amtrak and CSXT), the TriRail contract operator, Herzog Transit Services, the Federal Railroad Administration (FRA), the Federal Highway Administration (FHWA) and Broward County law enforcement. Those having direct participation in the project were FDOT, Broward County Traffic Department, Tri-Rail/Herzog and CSXT (by virtue of the approval/permitting process).

Although the project stakeholders all have an interest in the safety of grade crossings along the SFRC, they each play different roles affecting safety. CSX is responsible for maintaining the proper operation of the grade crossing warning system equipment. CSX also dispatches all trains along the SFRC, providing this service for the other users of the corridor, Tri-Rail and Amtrak. The FDOT owns the railroad right-of-way primarily for the Tri-Rail commuter rail service and has an interest in promoting the use of equipment and programs to improve crossing safety. Broward County has responsibility for safe traffic flow on the roadways in the vicinity of the crossing and for the proper operation of traffic control equipment. Broward County law enforcement is responsible for enforcing the laws regarding traffic signal and grade crossing warning system violations.

3.E SCOPE OF SERVICES

The services to be provided under this contract consist of i) furnishing equipment, ii) equipment installation, iii) field testing and observation, iv) equipment maintenance during the course of the project and v) project management. These services are discussed in detail below.

3.E.1 EQUIPMENT

NTS will install the AWARE system at two crossings, Commercial Blvd. and Cypress Creek Road. These two crossings must have Rail CrossingGuard deployed and operational as provided for under NTS' existing FDOT demonstration project.

At each of these two crossings the following equipment will be furnished and installed

?? RCG Trackside Station AWARE Interface Module.

?? AWARE Controller Computer and all associated power supplies, spread spectrum radio transceiver with antenna, and interface circuit (RS-232) to Rail CrossingGuard Trackside Station.

All AWARE system equipment at each crossing will be housed in the same cabinet that contains the Rail CrossingGuard equipment. Power to the AWARE equipment will also be provided from this cabinet.

For the purposes of this proof of concept trial, NTS and its subcontractor will equip two Tri-Rail trains with the following AWARE equipment:

?? 2 AWARE enabled Mobile Information Terminals (MIT's)

?? 1 Safetran, or equivalent, spread-spectrum radio with antenna

The following equipment will be installed at the Tri-Rail Operations Center:

?? 1 Rail CrossingGuard Server

Additionally, the project will make use of the following equipment already installed at the Tri-Rail Operations Center:

?? 1 TrainTrac TIS Server

3.E.2 INSTALLATION

NTS, along with its subcontractor, GFI, will perform all equipment installation, power-on and testing. Access will be required to i) the cabinets housing the Rail CrossingGuard equipment at the Commercial Blvd. and Cypress Creek Road crossings, ii) the Tri-Rail trains selected for this demonstration and iii) the Tri-Rail Rail Operations Center in Hialeah, FL. To provide for future field testing and demonstrations of the system, the equipment furnished for this demonstration will remain after the project has concluded.

3.E.3 EQUIPMENT MAINTENANCE

During the course of the project, NTS and its subcontractor will provide maintenance for all software and hardware systems furnished and installed for the project. Remote troubleshooting and diagnostics will be performed from the NTS facility in Providence, RI over the Nestor Communications Network which provides real-time communications to all Rail CrossingGuard Trackside Stations installed at SFRC crossings.

Onsite maintenance will be provided to inspect problems and repair or replace defective equipment. We do not anticipate a need for any routine maintenance or inspections as part of the project.

Because of the pilot nature of this project, no warranties can be provided for equipment failures or "out-of-operation" time. Any equipment problems that prevent the operation of principal system functionality will be addressed in a timely fashion with reasonable commercial efforts applied to restore equipment to full operation.

3.E.4 PROJECT MANAGEMENT

NTS will provide project management consisting of developing all project task lists and schedules, coordinating equipment installation and maintenance. NTS will support FDOT in coordinating project participation with the project stakeholders by setting up project planning and review meetings, documenting and circulating meeting notes, and providing monthly project reports.

The program management function will also include the coordination and supervision of the AWARE pilot demonstrations as set forth in the project plan component of this document.

NTS will provide a Final Project Report documenting the outcome of the project against stated goals. The Final Project Report will include a description of the Field Demonstrations, noting any issues or problems revealed by the demonstrations along with suggested approaches for problem resolution. The Project Final Report will also document any overall "lessons learned" from the project as it relates to equipment installation, operation or future project planning.

3.E.5 ADDITIONAL ASSUMPTIONS

This proposed scope of services is based upon the following assumptions regarding system equipment, installation and operation:

??No equipment redundancy will be provided for this implementation.

??The system will not tie directly into the ATCS radio system.

??No interface will be provided to any other crossing equipment (e.g., grade crossing event recorders).

??The ACC deployment at the crossing will use the same equipment cabinets, antenna sites and AC power that NTS is using for its Rail CrossingGuard installation.

??No additional construction is assumed to be required at any of the crossings where the AWARE equipment is to be installed.

3.F TASKS AND SCHEDULE AS PROPOSED

3.F.1 TASKS

The original project schedule called for the following principal project tasks:

?? Project Planning

?? Permits/Approvals/Waivers

?? Equipment Installation

?? Field Tests

?? Final Report

?? Project Reporting

3.F.1.a *Project Planning*

NTS and its subcontractor GFI will develop a detailed project plan, schedule and test program definition. This will be the first deliverable of the project. The project plan, schedule and test program will describe all project tasks and principle subtasks in detail, as well as the timeframe for accomplishing them and tasks/subtask dependencies and responsibilities. The test program will identify the exact nature of the field demonstrations to be conducted, the method by which the demonstration will be accomplished and the required participation by FDOT and/or the other SFRC stakeholders. This test program and project plan will be presented for FDOT approval. Additionally, the plan will be presented to the SFRC stakeholders for their approval.

3.F.1.b *Permits/Approvals/Waivers*

To the extent that any formal approvals or permits are required of any federal, state or private parties that have control over the SFRC corridor and its activities, they will be secured in this phase of the project. NTS and its subcontractors will provide information to support this process but will incur no costs associated with permit, approval or waiver fees or travel or other design or certification work required to secure the permits.

3.F.1.c *Equipment Installation*

This task will involve the installation of all equipment at the two crossings involved in the field demonstration, on the two trains and in Tri-Rail's Rail Operations Center in Hialeah. As equipment is installed it will be subjected to a set of installation tests to ensure that all systems are functioning properly.

3.F.1.d *Field Tests*

NTS anticipates a series of field tests will be used to demonstrate the AWARE system. These tests will demonstrate the operation of AWARE subsystem components using either simulated or real-world data inputs.

We anticipate some tests in which simulated events are generated by the ACC in place of real crossing alerts from the Rail CrossingGuard Trackside Station and those events are used to show the proper transmission and receipt of an alert by the trains and by the AWARE equipment in Hialeah.

Where Trackside Station-generated data is used to demonstrate the system, we will in some cases propose the use of previously recorded video data that may have captured an alert-generating event (e.g., vehicle on the tracks for an extended period of time). Field tests involving actual live data at the crossing will be carefully scripted and scheduled so as to not interfere with rail or traffic operations at the crossing. All field tests will require some level of participation by FDOT and/or other SFRC stakeholders.

There are no performance specifications for these tests. The tests are designed as proof of concept tests only and not to demonstrate or evaluate in any way overall system accuracy or long term system reliability. At the end of the field test period, a final system field test will be conducted that will demonstrate the overall operation of the system. NTS will coordinate preparations for this event with FDOT so that the appropriate senior state and federal transportation officials, along with senior representatives of the project team and the SFRC stakeholders will be in attendance.

3.F.1.e *Final Report*

The Final Report will be prepared at the end of the project describing the overall project goals, methodology, results of field testing, issues raised by the project that warrant follow-on development and/or additional field testing and any "lessons learned" from the project.

ID		Task Name	Duration	Start	Finish
1		**Project Start**	0 days	Mon 4/2/01	Mon 4/2/01
2		**Project Planning**	45 days	Mon 4/2/01	Fri 6/1/01
3		**Permits/Approvals**	47 days	Mon 6/4/01	Tue 8/7/01
4		**Equipment Installation**	40 days	Wed 8/8/01	Tue 10/2/01
5		**Field Tests & Observation**	64 days	Wed 10/3/01	Mon 12/31/01
6		**Final Report**	63 days	Wed 1/2/02	Fri 3/29/02
7		**Program Management**	260 days	Mon 4/2/01	Fri 3/29/02
8		**Project End**	0 days	Fri 3/29/02	Fri 3/29/02

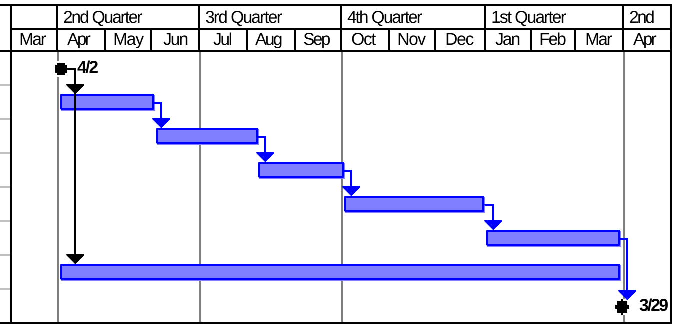


Table 1 Preliminary Project Schedule

3.F.1.f *Project Reporting*

NTS will provide project reporting, including monthly reports tracking progress against project plan, the generation of meeting presentation material, the documentation and distribution of any project meeting notes and the planning and coordination of all project meetings. Monthly reports will be provided at the end of each month during the life of the contract unless otherwise determined by the FDOT project manager.

3.F.2 PRELIMINARY SCHEDULE

Table 1 shows the initially proposed project schedule that was based on receiving a notice-to-proceed date of April 1, 2000. The schedule assumed that Rail CrossingGuard had been deployed and was functional at the crossings where the AWARE system was to be demonstrated.

3.G PROJECT PRIME AND SUBCONTRACTORS

The prime contractor for this project will be Nestor Traffic Systems, Inc (NTS). GeoFocus, Inc. (GFI) will provide subcontracting services directly to NTS. Brief corporate backgrounds on NTS and GFI are presented below

3.G.1 NESTOR TRAFFIC SYSTEMS, INC. (NTS)

Nestor Traffic Systems, Inc. (NTS), a wholly-owned subsidiary of Nestor, Inc., is an emerging leader in providing innovative, video-based monitoring systems and services for traffic management and safety. Its products incorporate patented image-processing vehicle tracking technology to deliver intelligent, real-time solutions that promote traffic efficiency, improved roadway utilization, roadway intersection and highway railroad grade crossing safety.

NTS principal products are CrossingGuard, a video-based red light enforcement and intersection safety system; Rail CrossingGuard, which applies similar technology to a video-based solution that automates the detection of vehicles, trains, signal lights and crossing gates at highway railroad grade crossings; and TrafficVision, a comprehensive traffic management system that collects extensive traffic data to assist transportation agencies in improving safety, monitoring traffic flow, managing congestion, responding to incidents, and planning for maximum highway efficiency. Nestor Traffic Systems is headquartered in Providence, RI and maintains an office for sales, installation and program management support in San Diego, CA.

Nestor Traffic Systems

NTS' clients include: Rhode Island Department of Transportation; Vienna, Virginia; Falls Church, Virginia; Irvine, California; Long Beach, California; Fresno, California; Rancho Cucamonga, California; Germantown, Tennessee; Dubuque, Iowa; Overland Park, Kansas; DuPage County, IL; Florida Department of Transportation; and the Federal Railroad Administration.

3.G.2 GEOFOCUS, INC. (GFI)

GeoFocus, Inc. (GFI) is a rail industry leader in rail vehicle tracking and information management systems. GFI has developed its TrainTrac? Train Information Management (TIMS) product and successfully marketed it to major commuter rail authorities in Chicago, Los Angeles, Salt Lake City and Miami.

GeoFocus, Inc. (GFI) was incorporated in Florida in 1991 and is located at 4611 NW 53rd Avenue in Gainesville, Florida. The University of Florida and IBM formed GFI in 1991 as a technology spin out company for Geographical Information Systems (GIS) and mobile Global Positioning System (GPS) products. GFI developed customized tracking applications including its own, proprietary tracking hardware and software applications with special emphasis on commuter rail Train Information Management Systems (TIMS), a new class of enterprise wide operations and planning product that it has pioneered and successfully implemented on Tri-Rail, Chicago Metra and soon, on Metrolink in Los Angeles and the MBTA in Boston.

Led by Chief Executive Officer and President Jolene Molitoris, GeoFocus, Inc. will work with industry and communities around the world to help them take advantage of leading edge technology to enhance transportation safety.

GeoFocus, Inc. has worked diligently to become a commuter rail industry leader and pioneer in the field of Train Information Management Systems (TIMS). These systems track rail vehicles and manage a full array of information and reports generated from train location. Automated tracking, station platform messaging, on-board announcements, schedule performance reports, and many other operations, safety and customer service functions are being performed by the GeoFocus, Inc. *TrainTrac*™ product for Tri-Rail and other major commuter rail lines.

GFI's first commuter rail customer for its TrainTrac Train Information Management Systems (TIMS) was Tri-Rail, South Florida's commuter rail system. The system was first installed in June of 1997 and has been in continuous operation on all Tri-Rail trains since that time.

The Tri-Rail system was designed to send and receive train location and communications using the Florida Department of Transportation's 900 MHz Automatic Train Control System (ATCS). TrainTrac provides automatic train location and automated audio and visual messaging to each of Tri-Rail's station platforms throughout the South Florida Rail Corridor. All TrainTrac functions are coordinated and monitored from Tri-Rail's Rail Operations Center in Hialeah, Florida. The system can be programmed to remind the train operator of speed restrictions, stop and flag and any other safety related event through the TrainTrac TIMS computer. GFI's experiences in this field have been a critical step in the development of their Advanced Warning Alert for Railroad Engineers System called AWARE.

GeoFocus, Inc. pioneered the AWARE product line and possess the skill, knowledge, and understanding of this unique product - - especially in commuter rail applications. The existing TrainTrac software and hardware have been field-tested and have demonstrated its reliability and suitability in commuter rail applications for over three years now. Mastery of the product and ability to deliver as promised, on-schedule and on budget has built an excellent reputation for GFI in the commuter rail industry. TrainTrac is designed for ease of use and adaptability to a host of third party software applications, paging system interface, data communications options, Internet connections, electronic messaging and radio systems preferences.

AWARE is a natural safety overlay extension of the TrainTrac system's ability to quickly and directly warn the train operator of grade crossing alert events as identified by NTS's Rail CrossingGuard system.

3.G.3 OTHER SUBCONTRACTORS

Additionally, Nestor secured contracting services from Merrill-Clark, Inc. and Elparazim (Mr. G. Edward Roberts) for software design, system testing and field installation/test services.

4 PROJECT EXECUTION

4.A ACHIEVEMENT OF PROGRAM GOALS AND OBJECTIVES

The following table summarizes the project goals and accomplishments.

Project Goal	Comment	Status
Demonstrate the ability to accurately collect real-time Rail CrossingGuard status and alert information and transmit appropriate warning messages from the grade crossing monitoring equipment to operators of approaching trains.	The system was installed and made operational at the Commercial Boulevard and Cypress Creek Road crossings, on two TriRail train sets and at the TriRail Rail Operations Center in Hialeah, Florida. No formal measurement was conducted on the accuracy or reliability of system operation during this project. This task should be undertaken as part of a follow-on project to demonstrate reliability against specified performance objectives.	**Done**
Demonstrate the transmission of real-time train location information from approaching trains to grade crossing monitoring equipment at the crossing.	Shown as part of demonstrations.	**Done**
Demonstrate a variety of real time crossing alert information (within the alert objectives of the original Rail CrossingGuard contract) from the crossing to approaching trains.	The ability of the system to communicate and display all of the alerts as defined in the original Rail CrossingGuard contract was shown during the system demonstration. The alerts were generated through simulation in order to avoid creating any real hazardous conditions at the crossings or interfering with normal rail operations.	**Done**
Demonstrate the ability to remotely configure the status monitoring and/or alert generation functionality of the grade crossing monitoring equipment.	Alert generation information can be turned on/off remotely by Nestor & ROC/TOC.	**Done**
Demonstrate the ability to remotely display real-time grade crossing alerts in a central operations center and to view live video of crossing activity to confirm crossing status/alert information.	Alerts and video available in both Broward County Traffic Operations Center and in Hialeah Tri-Rail Rail Operations Center.	**Done**
Determine any system factors or operational issues which can affect highway railroad grade crossing system performance so that they can provide the basis for subsequent development, follow-	Discussed in the Lessons Learned section of this report.	**Done**

on field testing and/or crossing modifications.		
Provide a Final Report.		**Done**

4.B Project Task Accomplishments

4.B.1 Introduction – Updated Task List

Table 2 shows the project schedule, adjusted by seven weeks for the actual start date of May 21, 2001. The schedule shows an additional lab testing activity for integration of the Nestor RCG equipment with GeoFocus equipment in Providence beginning early in November. Field testing for RCG w/AWARE was scheduled to begin a month later, in early December. Even with these adjustments, all field testing and demonstrations were scheduled to complete by the end of February, largely in compliance with the original project schedule. The system observation task was deferred until after the field testing activity was completed, so that observations of in-field performance could be made based upon fully installed and tested equipment. NTS conducted a system demonstration and training session with FDOT at the beginning of this period.

4.B.2 Project Planning

ID	Task Name	Duration	Start	Finish
1	**Project Start**	0 days	Mon 5/21/01	Mon 5/21/01
2	**Project Planning**	55 days	Mon 5/21/01	Fri 8/3/01
3	**Permits/Approvals**	55 days	Mon 5/21/01	Fri 8/3/01
4	**Equipment Installation**	65 days	Mon 8/6/01	Fri 11/2/01
5	**Field Tests**	75 days	Mon 11/5/01	Fri 2/15/02
6	**Observation & Final Report**	65 days	Mon 2/18/02	Fri 5/17/02
7	**Program Management**	260 days	Mon 5/21/01	Fri 5/17/02
8	**Project End**	0 days	Fri 5/17/02	Fri 5/17/02

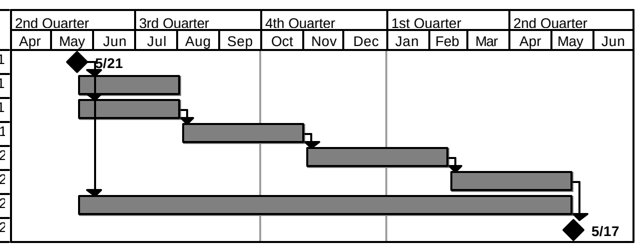


Table 2 Updated Project Schedule

The AWARE Project kickoff meeting was held at the Florida Department of Transportation (FDOT) District Four offices on Commercial Blvd. on June 7, 2001. The purpose of the meeting was to provide a technical briefing on the advanced image processing technology, and to present project information for the FDOT Monitoring project and the AWARE Proof-of-Concept project. Forty-four attendees representing various stakeholders in the project attended the meeting. The host of the meeting was Mr. Michael Dowell, Rail Corridor Programs Engineer, FDOT Tallahassee.

After a technical presentation by Nestor and GeoFocus that included a discussion of the project tasks and schedule, meeting attendees separated into two breakout groups to raise and discuss issues or potential concerns related to project design and/or execution. One group focused on Safety and Operations while the other discussed issues related to Engineering and Management. Both groups later reassembled to review the top three or four issues from each breakout session. During the meeting and in the breakout sessions, attendees discussed a list of Frequently Asked Questions (FAQ's) about AWARE and the AWARE project. This list was updated as a result of these discussions and is included in Appendix D: Frequently Asked Questions re: AWARE.

The attendees formed three committees for supporting the technical and publicity aspects of the project. The three committees were:

Project Advisory Committee — a committee representing the major stakeholders in the project, including: FDOT Tallahassee and District Four, CSX, Amtrak, Amtak Police, Tri-Rail, Herzog, Broward County TOC, Broward County Sheriffs Office, and FHWA Florida Division.

Publicity Committee — a committee that will provide a single point-of-contact and focus for the community. Members of this committee include: FDOT District Four and Tallahassee, Tri-Rail, Amtrak and CSX.

Technical Data Committee — a committee consisting of representatives from the operators: Locomotive Engineers, Rail Operations Control Center (ROCC) and Broward County Traffic Operations Center (TOC). The purpose of this committee is to ensure that the AWARE system provides clear useful data in a proper format to the operators.

As a result of input from the Project Kickoff meeting, the final project plan, schedule, and test plan was delivered to FDOT on September 28, 2001**.** Kickoff meeting minutes and a copy of the presentation were posted on Nestor's website.

A second AWARE Stakeholders meeting was held at FDOT District 4 on November 2, 2001 to update project stakeholders on project status and progress.

4.B.3 PERMITS/APPROVALS

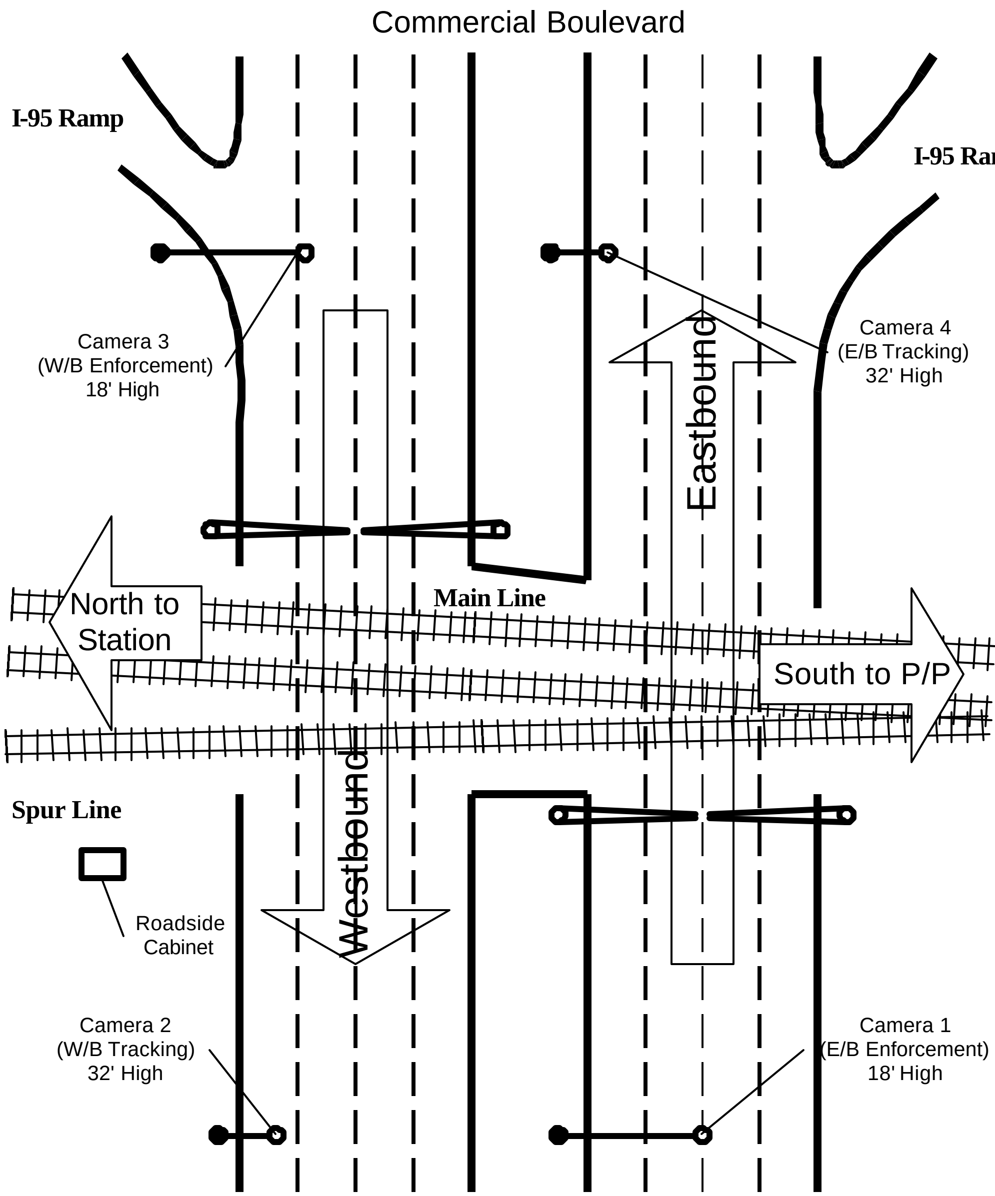
Nestor met with regional FRA officials to discuss the need for any permits or waivers to conduct the AWARE demonstration. Since the AWARE system functioned as a safety advisory system and not as an automated train control system, the FRA agreed that no special permits or waivers were required for the system demonstration beyond the installation/construction permits and approvals provided by state and county authorities for Nestor's RCG project.

4.B.4 EQUIPMENT INSTALLATION

The grade crossing sites chosen for the AWARE installation and demonstration were the Commercial Blvd. and Cypress Creek Road crossings. Each of these crossings was equipped with RCG video monitoring cameras, computers and communications equipment as well as an AWARE computer and wireless communications devices (antennas and spread spectrum radios). The RCG communications equipment consisted of 2.4 GHz line-of-sight communications devices that transmitted video and data to an RCG Server computer installed at the Cypress Creek Road Station. The RCG equipment at the station served as a data and communications hub that allowed direct, real-time communications to each of the RCG-equipped grade crossings.

The RCG video monitoring equipment at each site was designed to include four cameras, two each monitoring vehicle traffic, train traffic and signalization status for each direction of vehicle travel at the crossing. Two of these four cameras were located on one side of the crossing and two on the other. (Figure 1 shows the arrangement of camera locations at Commercial Blvd., which was typical of the other locations.) On each side of the crossing, cameras were installed with a High Mount Camera (the "Tracking Camera") and a Low Mount Camera (the "Signal Camera"). The High Mount Camera was typically mounted at a height of 32 feet or greater. The purpose of this camera was to capture an image of the crossing suitable for the computer vision software to detect and track vehicles approaching and on the crossing, as well as to detect and track a train on the track closest to the camera. The Low Mount Camera was positioned typically at a height of approximately 18 feet. The Low Mount Camera was positioned to allow the computer vision software to image and detect the movement of the gates and the flashing of the signal lights. Appendix A – Images of Equipment, User Interface & Hazardous Driving Behavior shows camera fields of view for each of the cameras installed at the crossings.

Due to difficulty in obtaining approvals for mounting of some cameras, only one direction of travel at the Cypress Creek Road crossing was equipped (involving two cameras) with RCG monitoring equipment.



REV.	DESCRIPTION	DATE	BY
0	Original Drawing	09/26/01	RM

Figure 1 Camera Locations at Commercial Boulevard

A number of T-1 lines and other communications devices (i.e., routers) installed at the Cypress Creek Station site provided connectivity to each of the crossings (video and data) from any of a number of distant monitoring facilities, including the Broward County Traffic Operations Center, the Tri-Rail Rail Operations Center in Hialeah, FL and Nestor's system monitoring facility in Providence, RI.

On-board AWARE communications and display equipment (Mobile Information Terminals, "MIT's") was installed on two Tri-Rail train sets. Additionally, a Rail CrossingGuard PC Viewing Station was installed at the Tri-Rail Rail Operations Center in Hialeah, FL. This system was connected via a T-1 line to the equipment hub at the Cypress Creek Station and could display real-time crossing status alerts as well as live video of crossing activity. A second PC Viewing Station was installed at the Broward County Traffic Operations Center as part of the Rail CrossingGuard demonstration project.

Figure 3 MMIT Unit Onboard Train

AWARE control computers, spread spectrum radios and antennas were installed by GeoFocus at each crossing to provide two-way communications between the crossing and approaching trains equipped with AWARE MIT display units. (See Figure 3 and Figure 2 for images of the MIT units installed on the trains.)

Figure 2 MMIT in Field Testing

Installation of the RCG equipment at the crossings and at the Cypress Creek Station site was largely completed by July 2001. AWARE antenna installation started on August 8, 2001. NTS installed the server at the Hialeah ROC on October 4, 2001. Live video from the crossings and control of cameras was confirmed at the server in the ROC on October 31, 2001.

4.B.5 <u>FIELD TESTS AND DEMONSTRATIONS</u>

4.B.5.a *<u>Bench Tests</u>*

NTS developed a simulator for GeoFocus's AWARE components to unit test the Rail CrossingGuard product with a simulated AWARE subsystem. By using the controls on the AWARE simulation environment, "virtual" trains were created which could communicate their position to the RCG system and receive information about the status of the crossing. This simulator permitted NTS to test RCG in the lab without an actual AWARE subsystem.

NTS also developed an RCG simulator for GeoFocus to use to test its AWARE components. By using the controls on the RCG simulator, RCG messages were generated for the AWARE system to indicate the status of a "virtual" crossing. This simulator permitted GeoFocus to test AWARE in the lab without an actual RCG subsystem.

GeoFocus' field tests of the AWARE subsystem included a test of the radio communications subsystem in actual field conditions before the field testing of the integrated AWARE system.

Complete end-to-end testing of the AWARE system occurred in Nestor's Providence facility on December 31, 2001.

4.B.5.b *Field Tests*

GeoFocus performed the first train-to-wayside radio system test using equipment temporarily installed on-board 2 Tri-Rail train sets on October 8, 2001. Results of this test are included in Appendix E. As a result of the test, GeoFocus ordered and installed an additional radio unit and antenna needed at Powerline/ Prospect Road to resolve the line-of-sight communication problem caused by obstructions within the curve between Powerline/Prospect Road and Commercial Blvd. (This additional equipment was installed early in January 2002.) Shortly after GeoFocus completed their initial testing of the AWARE equipment on the 2 TriRail train sets, these train sets became separated due to unexpected operational and maintenance reasons. The designated locomotives and cabcars were never together again as train sets during the demonstration period.

As part of the project, Nestor developed a new, web browser-based user interface to access grade crossing status and alert information on PC Viewing Stations installed at the Tri-Rail Rail Operations Center and at the Broward County Traffic Operations Center. (Examples of the RCG viewing screens are presented in Appendix A – Images of Equipment, User Interface & Hazardous Driver Behavior.) The RCG Server at the Cypress Creek Station was upgraded for full support of the RCG/AWARE architecture on January 22, 2002.

A demonstration of the obstruction detection function was conducted for FDOT and for Tri-Rail officials at the Broward County Traffic Operations Center (TOC) on January 3, 2002. This demonstration consisted of running the system on previously recorded digitized video clips showing vehicles stopped on the grade crossing at Commercial Blvd. The PC Viewing Station at the Broward TOC displayed the video sequence of the event as if it were occurring live. The RCG component of the AWARE system functioned to detect the vehicles stopped on the crossing and to display an alert on the PC Viewing Station screen.

A similar demonstration was performed for members of the APTA Grade Crossing Committee on January 22 and 23, 2002 as part of a facilities tour that occurred during a Committee meeting in Miami, FL. On January 24, 2002, FDOT officials observed on-board testing of the AWARE MIT installed in a TriRail cabcar. (A copy of the test plan is included in Appendix C: AWARE Field Test Plan (1/24/02 Test).)

The full and final demonstration of the AWARE system was conducted on February 28, 2002. Those attending from FDOT included Michael Dowell, Nancy Bungo, Larry Merritt and Nadir Rodriguez. Representatives from the FRA who attended the demonstration included Michael Woods and Ron Yates. Both Tri-Rail and CSXT also sent representatives to the demonstration.

This demonstration involved a display of real-time alerts generated and displayed on the MIT units of a Tri-Rail train traveling through the crossings. Because of the risk associated even with "staging" a stopped vehicle event at either of the crossings or any other actual crossing related events, the Project Advisory Committee agreed that the most desirable way to demonstrate the system, under the circumstances, was through the use of "simulated" alerts that could be generated manually. These alerts included a simulated output of the RCG video monitoring system indicating that a vehicle was stopped on the crossings. Other simulated alerts included broken gates, false gate activations, etc. The alerts were then communicated over the AWARE spread-spectrum radio system to the MIT equipment on the train. On the day of the demonstration, the MIT equipment was installed and operational on two TriRail cabcars. Project stakeholders from FDOT and CSXT, as well as regional FRA representatives, boarded the Tri-

Rail trains and rode in the cabcars to observe the MIT units in operation. When the simulated alerts were generated, the unit display showed the alert status, the name of the crossing and the nature of the alert. An audible tone was also generated by the equipment and then acknowledged to silence the tone.

During the week of the final demonstration, training was conducted on the RCG/AWARE system for personnel at the Broward County Traffic Operations Center and at the Tri-Rail Rail Operations Center.

The Observation Period began on March 1, 2002. No additional demonstrations of the AWARE equipment were conducted during this time, using any of the on-board MIT devices. Rather, the performance of the video monitoring system was observed in operation at the Broward County TOC and at the Tri-Rail ROC in Hialeah. The system was observed to generate a number of correct stopped vehicle alerts, but also to generate a number of false detections. This is in agreement with observations made on RCG detection performance as part of Nestor's RCG pilot project. This is discussed more fully in the RCG Pilot Project Final Report submitted to FDOT on April 30, 2002.

5 CONCLUSIONS

5.A LESSONS LEARNED

A number of the lessons learned during the Rail CrossingGuard pilot demonstration project apply to the AWARE project as well. (These lessons are discussed more fully in the RCG Pilot Project Final Report to FDOT.) Among them are the need to keep the pilot demonstration project simple in scope to avoid burdening it with unnecessary complexity or issues that should not be addressed in a proof-of-concept demonstration. This was especially true in the context of the AWARE system demonstration where the nature of the system impacted so many different stakeholders.

The need to involve and have the support of Tri-Rail and their operator, Herzog, (arising out of the requirement to install and operate equipment on the train itself) raised a number of concerns about the potential interference of this equipment in day-to-day operations of the train. These concerns immediately surfaced during the Project Kickoff Meeting. The decision to involve all the stakeholders early on in reviewing the purpose of the project and the scope of the activities planned provided a vehicle for raising and addressing all such concerns so that the project could proceed with the necessary stakeholder approval and cooperation.

Although the project showed that it was feasible to use video monitoring and the spread-spectrum radio technologies to detect and communicate information on hazardous grade crossing conditions from the crossing to the train, a demonstration of the reliability of this equipment was outside the scope of this project. Providing and ensuring reliable operation would be among the next steps to address prior to the AWARE system's use for in-service operation. Measures of reliability and acceptable performance will need to be defined and determined in conjunction with the railroad. A number of issues will need to be addressed, including the issue of an acceptable false positive rate for false detections of vehicles stopped on the tracks.

An additional issue, and one that relates to the issue of the false positive rate, concerns the distance from the crossing that the train should be when the crossing initiates a status update to the locomotive engineer. To wait until the train is not able to effectively slow down (if not come to a stop) will mitigate the risk reduction offered by the system since, in the event of receiving a "blocked crossing" warning from the system, it will be too late for the engineer to take any effective action prior to the train entering the crossing. At the same time, communicating the status of the crossing too far in advance of the crossing could create a scenario in which the train engineer is needlessly informed of situations in which vehicles are stopped on the tracks but are able to move off the tracks long before the train arrives. The AWARE system could have a negative impact on train schedule performance if the engineer is required to initiate some braking action every time he receives an alert caused by an obstruction that eventually clears.

Additionally, there are concerns about putting any additional equipment into the locomotive and burdening the engineer with another device to watch. This creates a potential distraction from the critical tasks which must command the engineer's full attention for safe operation of the train. In the AWARE project, the method chosen for displaying alert and status information in the locomotive was simply a means for doing the proof-of-concept demonstration. There was discussion during the Project Stakeholder meetings about other means of displaying information to the engineer, including using the ATCS radio system already onboard the train. A strategy that made use of pre-existing equipment would minimize the risks of burdening the engineer with "information overload" and could meet with greater acceptance on the part of the railroad engineers themselves.

A related issue that was raised concerned whether, in fact, it was desirable or appropriate for the locomotive engineer to directly receive information from the AWARE system. The AWARE system is designed as a safety advisory system, and not as a fully automated train control system that will take action based upon a detected event/condition. In this scenario, the system is designed to provide information to a user/operator who will decide what action is to be taken. Such a decision may require the user to query the system for additional information to verify the nature of the alert that the system has generated.

An alternative architecture to that demonstrated in this project is to have the crossing communicate status and warnings to the railroad dispatch center and for the dispatch center to screen all such alerts in order to pass along only valid alerts to the locomotive engineer for follow-up action. The "call desk" function within the railroad dispatch center might play the role of screening the system alerts and, having access to live video, be able to confirm the nature of the alert before communicating a warning to the railroad dispatcher, who would then inform the locomotive engineer via the ATCS radio network. A concern that must be addressed in this scenario is the time it takes to receive, review and communicate alerts in this fashion. The time expended in this process may virtually eliminate the advanced warning time required by the engineer to take action to avert a collision.

In conclusion, necessary steps that must be taken as part of a plan to move the AWARE system closer to operational deployment include the following:

- Definition of performance requirement and reliability measurements
- Demonstration of functionality against stated performance and reliability requirements
- Demonstrate alternate means of communicating alerts to the train that take advantage of onboard train equipment
- Definition of operational requirements related to when advisory alerts are generated, where they are transmitted and how they are displayed
- Definition of operational roles related to who receives advisory alerts and what their follow-up actions should be in response to alerts

5.B RECOMMENDATIONS

The AWARE system demonstration is one of the projects that is made possible by the Rail CrossingGuard installation along the South Florida Rail Corridor. Based on the promising results of the proof-of-concept demonstration, we recommend the following next steps be taken:

PERFORM A STUDY IDENTIFYING THE EXPECTED BENEFITS OF THE AWARE SYSTEM IN TERMS OF REDUCED COLLISION RISK ALONG THE SFRC.

Although one can naturally expect that the AWARE system, if deployed along the SFRC, should reduce the risk (and frequency) of train-vehicle collisions, this expectation should be formalized by a study that justifies the business case for the system. In particular, we recommend that a study be undertaken to gather recent crossing collision information along the South Florida Rail Corridor using a model of the type of collision that AWARE could prevent to quantify the frequency of such collisions and their cost.

Broadly speaking, the type of collision that the AWARE system could prevent involves vehicles *already stopped on the crossing when the train arrives*. A quick review of grade crossing collision information for the entire South Florida Rail Corridor shows that nearly 50% of all train-vehicle collisions occurring in the first half of 2001 involved a vehicle already stopped on the tracks. This study would further refine the assumptions about the nature of the stopped-vehicle collisions that could be prevented (e.g., ones for which the vehicle was stopped for longer than a certain period of time, etc.) and develop economic savings projections based upon various performance models of the system. The current RCG system in operation at the crossings in Florida can be used as part of the study to gather data on the frequency of stopped vehicle events at a crossing and their durations so that a determination can be made about the threshold of "stopping time" that should be used to trigger the generation and transmission of an alert to the train. The study should take into account the cost of false detections (e.g., on train performance schedules), costs of equipment installations, maintenance, operation, etc. so that the cost justification takes into account not just collision savings to be realized but all the costs of deploying and operating the system.

INITIATE A PROJECT TO DEFINE PERFORMANCE REQUIREMENTS AND TO DEMONSTRATE SYSTEM PERFORMANCE AGAINST THOSE REQUIREMENTS.

This project will necessarily deal with issues related to the definition of an alert, the required accuracy of hazardous condition detection, the best way to generate and display the alerts as well as anticipate some operational solutions to dealing with system performance that may be entirely acceptable for an advisory system, as opposed to a fully automated decision control system.

SHOW PROOF OF CONCEPT FOR ALTERNATE TECHNICAL AND OPERATIONAL MEANS OF COMMUNICATING ALERTS TO THE LOCOMOTIVE.

A follow-on project should be launched to show the feasibility of communicating alerts first to the railroad dispatch center and then from the dispatch center to the train using the ATCS radio network. The role of the dispatch center should be focused around receiving alerts, confirming/screening alerts by rapid access to live video of the crossings and subsequent communication to the locomotive engineer using the ATCS radio network. Not only is the ATCS radio system already onboard the Tri-Rail trains and accepted by the locomotive engineers, it is also onboard all other trains that use the South Florida Rail Corridor (e.g., Amtrak and CSX trains). If it is a requirement to ensure that a grade crossing obstruction alert can be transmitted to any train approaching the crossing, this approach immediately meets this need without requiring any new equipment to be installed onboard the trains. This project would determine the time constraints within which this alert processing would need to occur, create operational guidelines for managing such information flow, as well as identify issues that need to be addressed when managing such a system in operation along a corridor with multiple crossings and significant train volumes.

5.C SUMMARY

Risks at grade crossings result from vehicles entering or being on the crossing in conflict with train use. Several recently introduced engineering treatments, in particular, median barriers and quad gate systems, are designed to prevent drivers from entering the crossing after the grade crossing warning system activates. Neither will prevent a vehicle from stopping on the crossing, and so *neither can address the problem of vehicles that are already present on the crossing when the crossing warning system activates*. The risk of vehicles being stopped on the crossing when the warning system activates is higher for crossings located in areas of heavy travel and congestion, but they also can be greater as a function of the nature of vehicles using the crossing (e.g., large trucks vs. passenger cars) and the physical characteristics of the crossing itself (humped vs. non-humped).

The AWARE system is in the family of Intelligent Transportation System (ITS) applications for safety advisory systems. By providing timely information of hazardous grade crossing conditions to highway/rail operations centers and to approaching trains, AWARE can create opportunities to reduce the risk or severity of train-vehicle collisions at grade crossings.

This project has shown the feasibility of using video monitoring and various communications technologies to detect crossing conditions, to communicate train approach information to the crossing, and crossing status information to the train. The project also showed the feasibility of simultaneously providing grade crossing alert and confirming video information to traffic and rail operations centers. With these components, an operational a system can be designed that will perform reliably to meet the needs of both highway and railroad stakeholders who have an interest in and responsibility for increasing safety at grade crossings. Among the next steps to be taken include a cost-benefits study to identify the potential savings in risk reduction that can be achieved, the definition of formal performance requirements and demonstration of functionality that can operate to meet those requirements, and the demonstration of alternate means of communicating the alert information to the train, both in terms of onboard equipment and the role of the rail operations center in first receiving and screening alerts.

6 APPENDIX A: IMAGES OF EQUIPMENT, USER INTERFACE & HAZARDOUS DRIVER BEHAVIOR

6.A SCREEN SHOTS OF WEB-BASED RAIL CROSSINGGUARD USER INTERFACE

The following images show screen shots of the Rail CrossingGuard web browser-based user interface. Figure 4 shows the topmost view of the Rail CrossingGuard information display. The screen is divided into corridor information and information on a specific crossing – selected by clicking on the crossing icon in the corridor display.

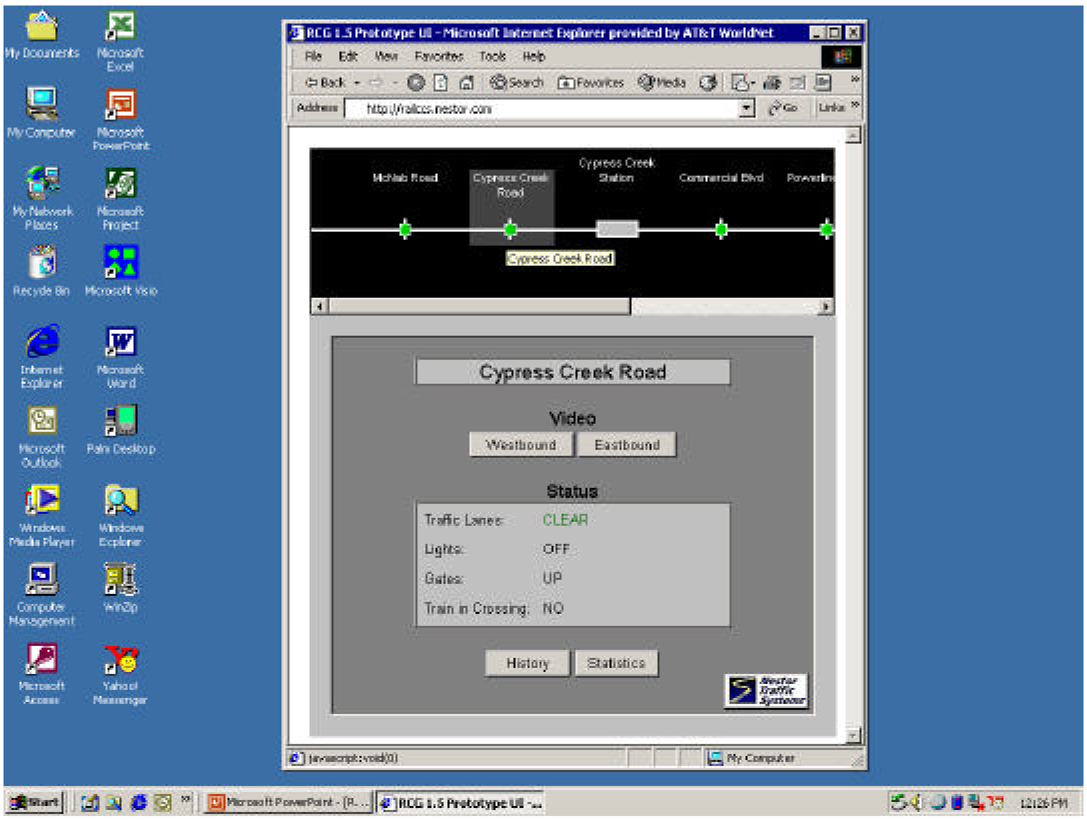


Figure 4 Top Level View of Rail CrossingGuard Crossing Status Display

Figure 5 shows the top view display when the Rail CrossingGuard system detects that a vehicle is stopped on the tracks for more than a specified time threshold. This causes the system to generate an alert for the crossing. The alert screen prompts the user to display live video of the alert to confirm the nature of the problem at the crossing. In this way, the system functions as an advisory system to call attention to a potentially hazardous crossing situation. By viewing the live video, an operator at a traffic management center or a rail dispatch center can confirm the alert and determine the appropriate follow-up action. Alerts can be generated based on a number of conditions. They do not require the train to be in the immediate vicinity of the crossing. In this way, an operator's attention can be called to a situation that has developed at the crossing in time to alert an approaching train to come to stop or slow down when approaching the crossing.

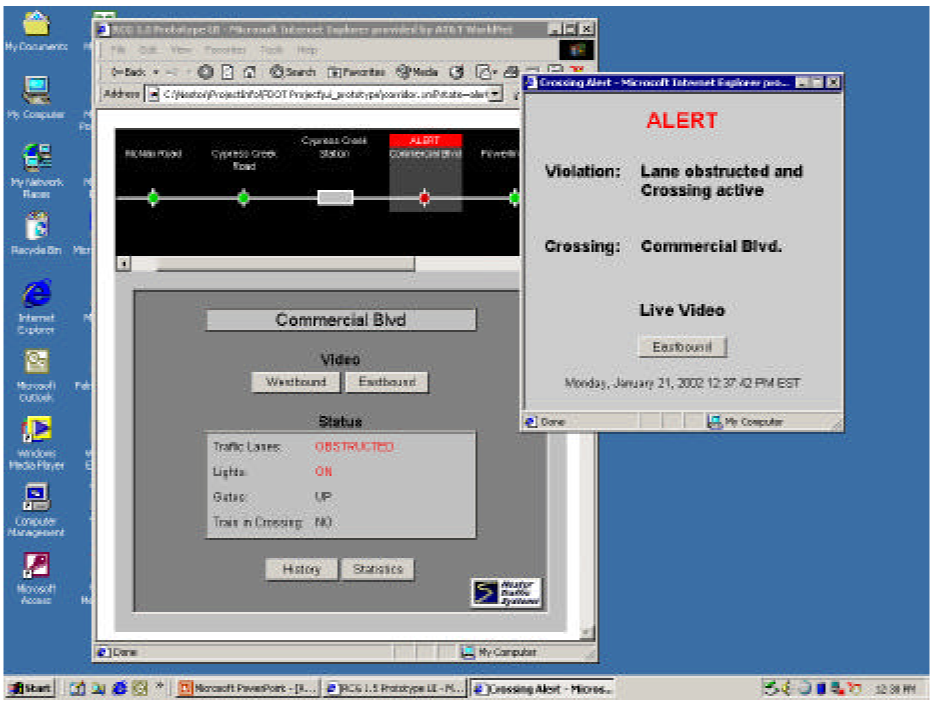


Figure 5 Real Time Alerts

Figure 6 shows the system displaying live video to confirm the nature of the alert generated by the system.

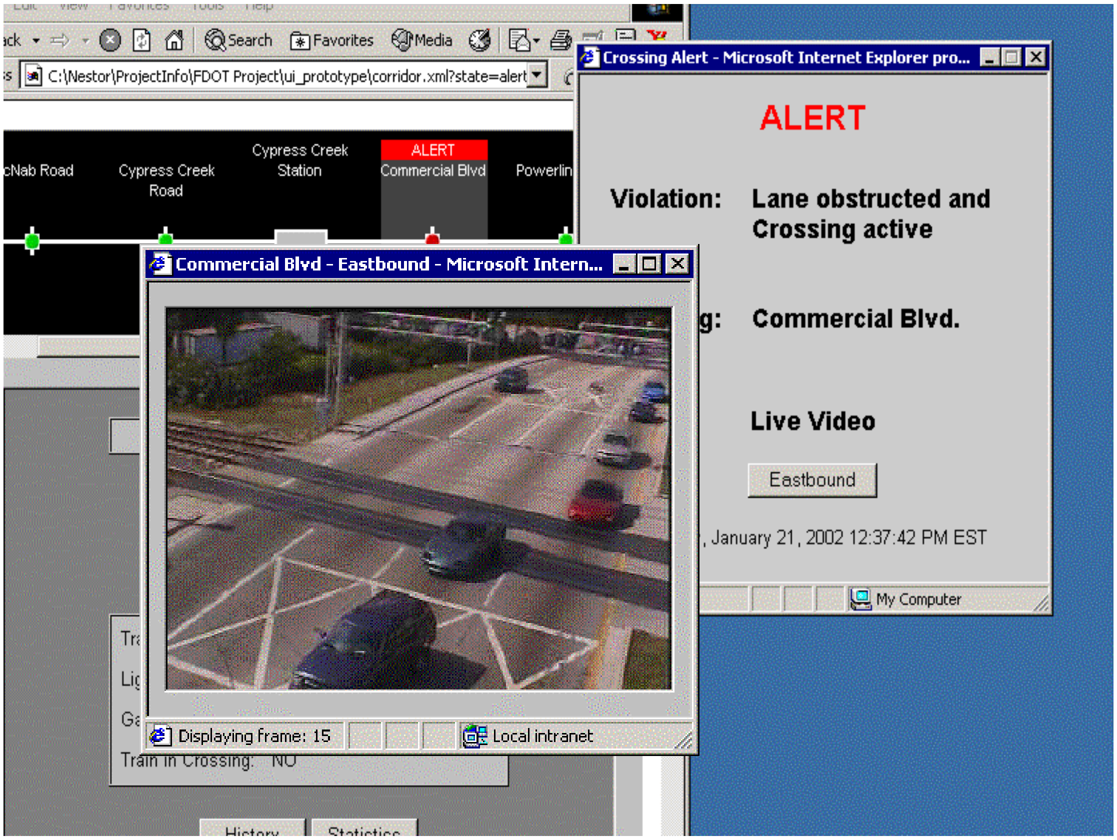
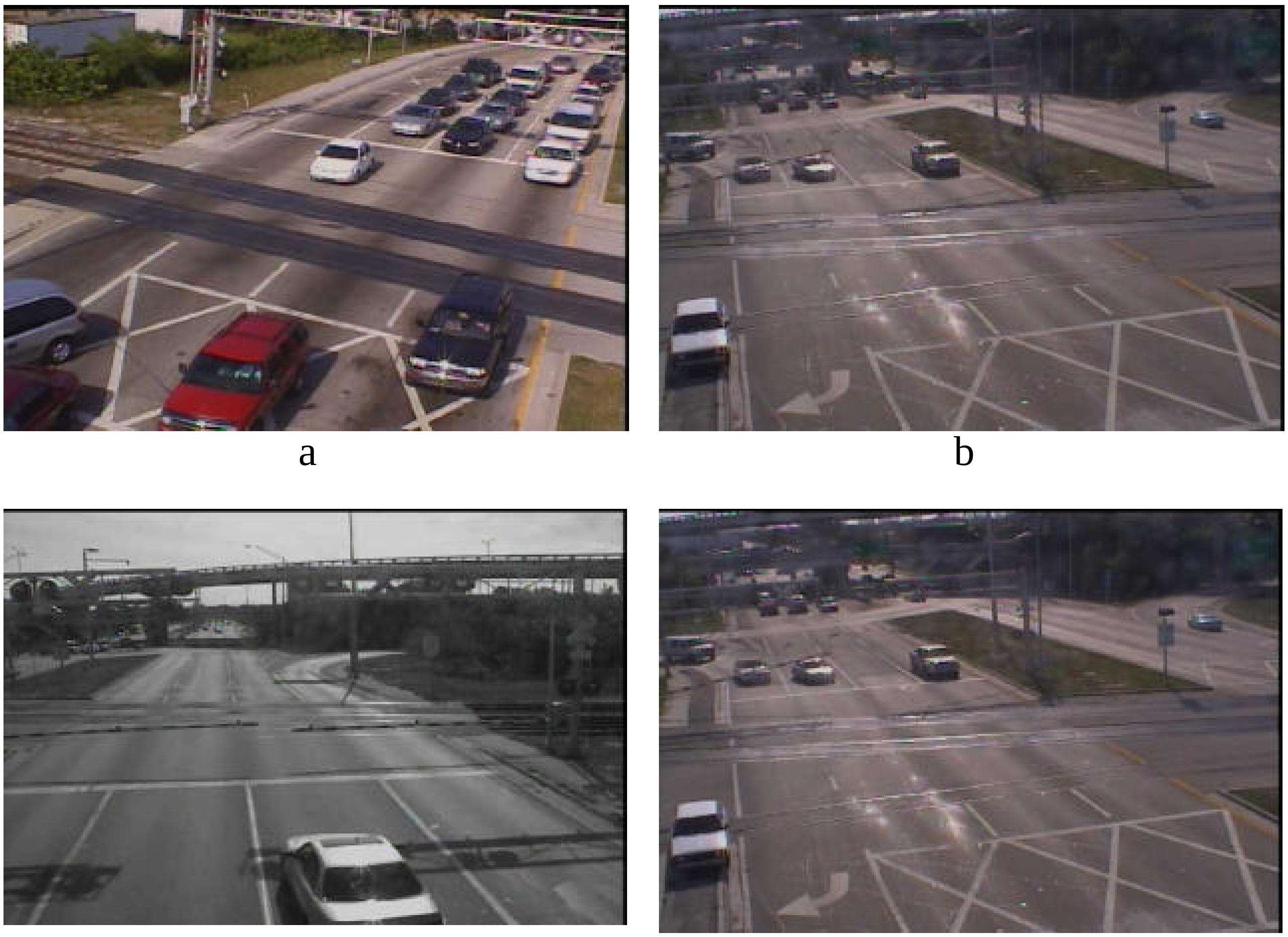


Figure 6 Alert Screen with Video Display Confirming Cause of Alert: Vehicle Stopped on Tracks

6.B SCREEN SHOTS OF CAMERA FIELDS OF VIEW AT AWARE-MONITORED CROSSINGS

The following figures contain the fields of view from the Tracking Cameras ("High Mount Cameras") and the Signal Cameras ("Low Mount Cameras") at each of the crossings. In the case of Cypress Creek Road, no Tracking Camera was mounted for the Westbound direction.



a b

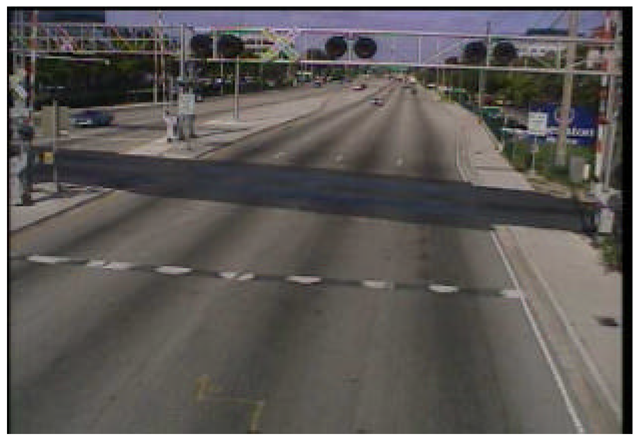
c d

Figure 7 Commercial Boulevard Camera Fields of View

(a) Tracking Camera Eastbound (b) Tracking Camera Westbound (c) Signal Camera Eastbound (d) Signal Camera Westbound

a

c



d

Figure 8 Cypress Creek Road Camera Fields of View

(a) Tracking Camera Eastbound (c) Signal Camera Eastbound (d) Signal Camera Westbound. No Tracking camera was mounted for the Westbound direction due to problems with mounting on existing poles at the crossing.

6.C IMAGES OF INSTALLED AWARE EQUIPMENT

Figure 9 Rail CrossingGuard Trackside Station

(Image shows two Trackside Stations in a controller cabinet.)

Figure 10 Signal Cameras Installed at Cypress Creek Road

Figure 11 Signal Cameras Installed at Commercial Boulevard

Figure 12 MMIT Installed in Locomotive

Figure 13 AWARE Antenna Mount Area on Locomotive

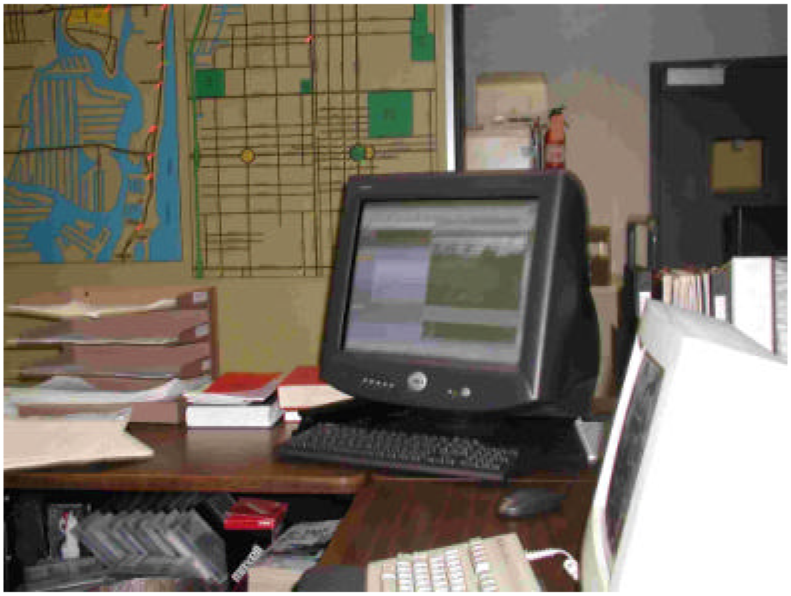


Figure 14 Rail CrossingGuard PC Viewing Station at Broward County TOC

(Similar to the Rail CrossingGuard PC Viewing Station in Hialeah)

Figure 15 Rail CrossingGuard Server Installed at Cypress Creek Station

Nestor Traffic Systems

6.D RAIL CROSSINGGUARD-CAPTURED VIDEO OF ANOMALOUS DRIVING BEHAVIOR

The following are still images that have been extracted from the video captured at the Commercial Boulevard crossing. These segments have been chosen to illustrate various conditions and driving behavior observed at the crossing that have triggered Rail CrossingGuard to issue alerts to the Operations Center.

Figure 16 Traffic Backed Up on the Crossing as the Gates are Coming Down

Figure 17 Vehicle Violating the Crossing Signals and Gates

Figure 18 Vehicle Stopped in the Crossing with the Gates Down

The video showed the blue vehicle hesitating as the gates began to lower. The driver stopped, but ended up inside the crossing as the gates came down. The vehicle stayed there as the gates lowered completely and then drove through the crossing. The train arrived shortly thereafter.

7 APPENDIX B: ON-TRAIN INSTALLATION OF AWARE EQUIPMENT

This document describes the methods and procedures for temporary installation of AWARE on-train equipment as mutually agreed upon by Herzog, GeoFocus and SeaRobotics (GeoFocus' hardware design subcontractor). Herzog has been asked by Tri-Rail to oversee the installation of AWARE trial equipment and witness tests to be performed as part of the FDOT combined Nestor Rail CrossingGuard and GeoFocus AWARE system proof of concept project on the South Florida Rail Corridor (SFRC).

Herzog has asked that a temporary mounting scheme be provided for the on-train AWARE equipment such that installation will not take any special installation labor on their part, will not interfere with safe train operation and will be easily removed after the actual test are performed. This approach also gives them a very flexible way to manage the trains to be used as no permanent install will be required and hence no need to schedule that equipment for every test scenario.

The approach described below also allows the tests to be performed without directly involving the train operator. All tests will be performed away from the direct view of the train operator so that we do not distract them from safe operation of the train during the proof of concept phase. As a group we have decided to have one of Herzog's train operators be an "observer" for all tests and all tests will be described in detail and scheduled with all parties well in advance of actual testing.

Proof of Concept Equipment: The full AWARE system tests will involve the following hardware installation:

(1) Cabcar -

- Master Mobile Information Terminal (MMIT)
- Spread-spectrum (SS) radio
- Combined Spread-spectrum radio/GPS Antenna Device (magnetic/clamp mount)

(2) Locomotive -

- Slave Mobile Information Terminal (SMIT)
- Spread-spectrum radio
- Spread-spectrum radio antenna (magnetic/clamp mount)

Installation Description: The following procedures are to be used

(1) Cabcar – The typical cabcar installation will be performed by SeaRobotics/GeoFocus personnel at either the West Palm Beach maintenance yard or the Hialeah Yard with West Palm being the preferred location. GeoFocus will provide all installation materials, cables, tools and labor. All work will be pre-scheduled through Herzog's Safety Officer, Peter Kane.

The equipment described above will be portable and carried onto the train at the time of installation. The MMIT unit will be set-up in the cabcar nose adjacent to the operator cab. The power and electrical equipment/connections will be made in the car's electrical locker. Cabling for power will be extended from the locker to the front seat/table area and all cables safely dressed with tape and mechanically secured so as not to present and trip hazard.

The combination SS/GPS antenna mount will be placed on the roof near the horn and lighting superstructure similar to that of the current tracking system antenna location. The unit will be physically clamped into place and may also involve use of strong magnets.

The cable will be safely dressed and tied to prevent snag hazards and routed through the A/C vent on the side off the cabcar. Herzog mechanical personnel have suggested that this route be used since the vent area has an easily reached opening that leads directly down into the electrical locker below.

Once the cabling is installed, the unit will be connected, checked and readied for the next scheduled train run.

At the end of testing, the reverse installation process will take place and the car cleared of any sign of AWARE equipment until the next scheduled test run.

(2) Locomotive – Installation in the locomotive will involve equipment set-up in the area to the left of the train operator and so as not to be in their direct view. Effort will be made to keep the actual tests as unobtrusive as possible to lessen any distraction of the train operator.

The SMIT and SS radio will be installed in this area and power cable routed to the location from the electrical power access panel located on the lower left of the train operator, up through a window channel and out of an access plate on the window frame above the work location.

The SS radio antenna used on the locomotive end of the train will be mounted on the train roof and clamped to train superstructure. The antenna cable will be routed from the roof through a cab vent window directly into the work area. All tests will be performed in the area to the left of the train operator.

8 APPENDIX C: AWARE FIELD TEST PLAN (1/24/02 TEST)

The AWARE MMIT is installed on Cab Car 511 (Train P613), a Southbound train departing from Mangonia Park Station at 10:40am and arriving at Miami Airport Station at 12:39pm.

Train P613 passes through:

?? Deerfield Beach Station	11:26am
?? Pompano Beach Station	11:31am
?? Cypress Creek Station	11:38am
?? Ft. Lauderdale Station	11:48am

Action Plan

11:00am:	AWARE Test Engineers MK and JJ meet at Deerfield Beach Station
11:26am:	MK and JJ board Train P613 (Southbound Platform)
11:27am:	JJ powers up the MMIT
11:31am:	Train will pass through Pompano Beach Station
11:32am:	MMIT will establish communication with Cypress Creek Road
11:33am:	MMIT will establish communication with Commercial Blvd
11:34am:	Train will enter two-mile range with Cypress Creek Road
11:35am:	Train will enter two-mile range with Commercial Blvd
11:36am:	Train will cross McNab Road
	ER to create simulated obstruction at Commercial Blvd
	JJ will acknowledge the audible alarm
	The MMIT will show an O for Obstruction at Commercial Blvd.
11:37am:	ER will clear the obstruction at Commercial Blvd.
	The MMIT will remove the O for Obstruction at Commercial Blvd.
11:38am:	The train will enter Cypress Creek Station.
	The MMIT will blank out the crossing information for COM (bug).
11:39am:	Short window for completing or repeating test, as needed
11:40am:	Train leaves communications range
11:48am:	MK & JJ will disembark at Ft. Lauderdale Station
12:00 noon:	MK & JJ will board Train P614 (Northbound)
12:08pm:	Train passes through Cypress Creek Station
12:24pm:	Train passes through Deerfield Beach Station

9 APPENDIX D: FREQUENTLY ASKED QUESTIONS RE: AWARE

AWARE Kickoff Meeting Questions:

The following questions were recorded during the June 7th Florida Department of Transportation (FDOT) RCG/AWARE Kickoff meeting:

1. Q: How many targets can RCG track simultaneously? A: 100s of targets can be tracked.

2. Q: Can it perform in adverse weather conditions? A: Yes, with rule of thumb that as long as you can see, it can also see.

3. Q: Have the RCG crossing sites been surveyed for night lighting conditions? A: Yes, this was done a part of the FDOT Monitoring project. Those crossings that require additional lighting beyond ambient conditions have been specified.

4. Q: What cameras will be used? A: Sony with Ultrak domes.

5. Q: Can the equipment also monitor magnetic loops and other sensing technologies as well? A: Yes, but additional interfaces would need to be provided to these other sensor systems.

6. Q: Any concerns with spread-spectrum radio interference? A: No, radios chosen for this purpose but the exact frequency to be used is yet to be determined.

7. Q: Are the images in black & white or color? A: Color cameras will be provided for this project.

8. Q: Will lightning affect images? A: No, software filters transient effects.

9. Q: Number of cameras and locations for each? A: varies per crossing.

10. Q: Is there a size limit on images tracked – pedestrians for example? A: Yes there is a practical size limit for small objects but the system has detected and tracked pedestrians in the camera field of view. However, we do not support this capability in the system at this time and it will not be demonstrated as part of this project..

11. Q: Can the camera detect the shape of an object? A: Yes, the software "sees" edges and can interpret the edges to determine shape. It uses "biologically inspired" algorithms for visual information processing..

12. Q: Can the images at the 5 RCG crossings be selected for viewing? A: Yes they can be viewed independently on command. System can even update target-sensing algorithms.

13. Q: Will Event Recorders be part of the proof of concept? A: No, they will not be part of the Proof of Concept" but the AWARE system will be able to interface to them in the future.

14. Q: Will the ROC be able to see the tracking boxes around targets? A: They will see video images but not tracking boxes per se.

15. Q: Will the event data be stored? A: Yes, the RCG Server will only store event data for analysis and categorize it by event type. The amount and quantity are a function of the event rate and storage capacity. The stored data is intended to be used to verify system operation.

16. Q: What operating system will the RCG use? A: Microsoft Windows NT.

17. Q: What is the spread-spectrum radio connect range? A: 2 to 5 miles with the 2 mile range selected for the POC start.

18. Q: What about spread-spectrum radio communications to two trains? A: The AWARE system will have the capability to communicate with multiple trains and grade crossings at the same time since each will have its own unique ID number.

19. Q: Will there be an AWARE server in Hialeah at the ROC? A: Yes.

20. Q: Will the engineer be required to read and acknowledge an AWARE alert message on the train? A: Yes, the current proposal for proof-of concept of the on-train Mobile Information Terminal (MIT) calls for a 4 line by 20-character LCD display and separate red LED warning light indicator and loud audible alert device. However, the design can be changed to accommodate a consensus approach to the MIT design.

21. Q: Will the FDOT POC Project equip all Tri-Rail trains? A: No, only 2 trains will be equipped. Each train has a unique address for tracking purposes.

22. Q. Concern was expressed that the locomotive engineer will have to take time to read the MIT message while operating a train at 79 MPH. A. The ease or simplicity in providing the warning to the Engineer was stressed so as not to overburden the Engineer.

23. Q: What does the Engineer do when the alarm is displayed, slow the train down? A: The engineer will not be required to view the display during the proof of concept. During a full system implementation the engineer will be expected to handle the train in accordance with the applicable operating procedures.

24. Q: Will the Engineer need to take action to warnings during the POC demonstration? A: No.

25. Q: Will there be a cut-off date for design suggestions? A: Yes, although the POC AWARE design is to be flexible in nature and allow for quickly changing variables and interface designs, including MIT. On-going input including questions and suggestions will be accepted, logged and prioritized for action.

26. Q: Does the ATCS radio system come into play for AWARE operation? A: For the POC, the ATCS radio system is not required since information is being sent back to the ROC using the Nestor Communication Network. The ATCS system offers a secondary means of sending crossing event information to remote sites.

27. Q: The existing MIT's on the Tri-Rail trains are not used currently due to TriRail's preference not activate the TrainTrac two-way text communication feature. They were designed to allow ROCC messages to be sent to the Engineer. What other means of communicating the crossing warning could be considered? A: Bringing video to the train itself is a possible alternate means. This would need to be addressed with the FRA.

28. Q: What radio licensing fees and communications costs are involved after the POC that will affect FDOT budgets? A: There will not be any licensing costs for the spread spectrum radios but there will be costs associated with maintaining the T1 communications line for the RCG reporting.

29. Q: Will users be able to log in remotely to see exception and alert information? A: No, not in the POC but in the future, this feature can be provided if desired.

30. Q: Will fiber optic be considered for live video in the future? If yes, someone needs to decide now to add additional fiber into cable troughs now being run along I-95 or along the SFRC right-of-way for RTO use? A: Although fiber would allow for improved video, it is not part of this POC and is a future issue for FDOT, Tri-Rail and others to decide. Tri-Rail has future plans for CCTV monitoring at their stations along the SFRC.

31. Q: Can the AWARE system be tied into traffic signaling and pre-emption systems to provide additional time for clearing the grade crossing without relying on the current fixed approach circuit? A: Yes, the system can provide an interface and allow for additional clearance when a train is near but allow for normal light timing otherwise.

32. Q: Can the system be tied into traffic message signs? A: Yes the RCG system will provide NTCIP interface to Dynamic Message Signs.

33. Q: Will the equipment cabinets meet all the NEMA requirements and will the system components at the wayside be able to survive environmental conditions in the cabinets? Can a temperature probe be added to the cabinet to track temperature? A: Yes, the cabinets, although air conditioned, can be outfitted with temperature probes.

34. Q: What will the AWARE system cabinet size be? A: The approximate cabinet size is 4 feet x 4 feet x 2 feet deep.

35. Q: How many Harmon/Devtronics event recorders are already in the field? A: There are currently units installed at the 5 POC crossings and at several other crossings throughout the SFRC where those crossings have been upgraded in recent years. Any work at other crossings will automatically require installation of compatible event recorders as part of the work performed under the Segment 5 Project.

36. Q: What about length of data archival? What will be stored and for how long? (a potential liability issue). A: This is a point to be fully discussed with the group but many things can be archived and stored for later analysis if FDOT decides to do so.

37. Q: Will the AWARE system be required on all trains operating on the SFRC? A: Not for the POC but possibly in the future with Segment 5 implementation.

38. Q: Can the on-train equipment be made portable for CSXT and Amtrak usage when operating on the SFRC? A: Yes, a portable system is possible - - the antennas and MIT mounting for temporary use will be important.

39. Q: Will the enforcement aspect being demonstrated at Commercial Blvd. be possible at the other POC crossings? A: Yes, with relatively minor upgrades this capability can be extended to those crossings.

40. Q: What value would the detection of gate and flasher operating status be? A: It would be useful to CSXT Signal Maintenance provided the information could be communicated effectively. On the other hand it may present a liability concern as it presents perhaps too much information to manage and control.

41. Q: Who will own the server computers at the Rail Operations Control Center (ROCC) and the Broward County Traffic Operations Center (TOC)? What about maintenance? A: After the Proof-of-Concept project is completed it is expected that the computers will remain in the ROCC and the TOC. Maintenance is a separate issue. Under the existing contract there is no provision for maintenance after the project completes, but this can be addressed.

42. Q: You have described a test program that will use live trains and blocked crossings. Why not conduct the final test with video tape? A: This can certainly be done. It is really up to FDOT and TriRail.

43. Q: What do we do with test information and what is the liability for the AWARE project? A: This is a demonstration project. Test data from the project will be collected by the contractor and subcontractor for purposes of evaluating the AWARE system performance. Because the reliability of the system data has not been established, there is no requirement to make operational decisions based upon the data and no liability for not acting upon any information contained in the data. Liability is treated differently from an installed operational system.

44. Q: How does the train Engineer, Rail Operations Control Center (ROCC) and Traffic Operations Center (TOC) use the information from the AWARE system? A: AWARE is intended to provide a warning or alert to the train engineer. It will be in the form of a tone or light indication. The RCG component of AWARE will provide a wide array of data to the ROC and the TOC. The available data will characterize vehicle and train operational use of the crossing, as well as, information about the crossing warning system (gates and lights). Additionally, the ROCC and TOC can use the crossing cameras for surveillance and see real-time video of the crossings. One part of this Proof-of-Concept project is to work with the ROCC and TOC staff to determine what types of data will be useful.

45. Q: How are you going to ensure that system testing does not interfere with normal rail operations? A: All system tests will be scheduled in advance and in coordination with FDOT, TriRail, Herzog and other project stakeholders. Whenever there is a system test, an NTS or GeoFocus test engineer will be present. In some cases the test will simply involve sending test information to ensure that the communications links are functional. Existing operational TrainTrac systems will not be impacted by AWARE functional tests.

10 APPENDIX E: NOVAROAM RADIO FIELD TEST