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16. Abstract
This report contains guidelines for installing an intelligent traffic control system for detecting and progressing platoons at isolated traffic signals located near an upstream traffic signal. The system can also be installed at sites where an upstream signal does not exist but where platoons naturally form. This system uses advanced detection to obtain information about the presence and speed of individual vehicles. Then, it uses an algorithm to identify if a platoon — of a user-specified size and density — is approaching the signal and estimates platoon arrival time at the stopbar. When the system detects a platoon of vehicles, it issues a low priority preemption signal to progress the detected platoon. The duration of the initial preemption signal is based on the platoon's estimated arrival time and the user-specified minimum platoon size used to detect the platoon. Then, the system switches to an extension mode and provides progression to any additional vehicles determined to be in the platoon. It accomplishes this by increasing preemption time until such time as no more vehicles are determined to be in the platoon or the max-timer expires. This document describes the system and provides guidelines for use by the Texas Department of Transportation for installing and operating future systems.

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GUIDELINES FOR INSTALLING AN INTELLIGENT CONTROL SYSTEM TO DETECT AND PROGRESS PLATOONS AT ISOLATED TRAFFIC SIGNALS

by

Nadeem A. Chaudhary, P.E.
Research Engineer
Texas Transportation Institute

Montasir M. Abbas
Assistant Research Scientist
Texas Transportation Institute

Hassan Charara
Associate Research Scientist
Texas Transportation Institute

and

Ricky Parker
Engineering Research Associate
Texas Transportation Institute

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ACKNOWLEDGMENTS

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1. INTRODUCTION

BACKGROUND

A significant number of TxDOT's signalized intersections operate under isolated control. At many of these signals, it is not uncommon for an approaching platoon of vehicles to face a red signal when it arrives at the stopbar. Often, these platoons are forced to stop because of a single vehicle on one of the side-street approaches. This condition results in driver aggravation, excessive stops, higher delay and fuel consumption, and excessive pavement wear and tear.

The platoon identification and accommodation (PIA) system developed and field-tested by TTI in this research project will remedy this situation without unnecessarily taxing traffic on minor approaches. This document describes the PIA system and presents guidelines for installing and operating this system.

SYSTEM APPLICATIONS

The PIA system is useful for signals that face the following traffic conditions during significant parts of a normal day:

- Platoons of vehicles arrive at one of the main approaches.
- There is light demand for movements being serviced by phases conflicting with the main-street phase.
- The traffic signal faces varying and unpredictable demand levels.

A candidate approach for providing priority treatment to platoons of through vehicles may belong to one of the following two categories:

- The signal approach receives traffic from an upstream signal, but it is not interconnected to the upstream signal to provide coordinated operation.
- There is no signal upstream of the signal approach, but platoons form naturally due to vehicles slowing down as they approach the intersection.

In Texas, signals meeting these criteria are generally located on highways near small towns or on suburban arterials.

HOW PIA WORKS

The PIA system consists of hardware and software that perform the following functions using a detector trap installed a certain distance upstream of the stopbar:

- detect the presence of a platoon of vehicles;
- measure speed of each vehicle and calculate estimated platoon arrival time at the stopbar;
- when appropriate, override normal controller operation to progress the platoon; and
- provide dilemma-zone protection to vehicles at the back end of the platoon.

PURPOSE OF THIS DOCUMENT

This document describes the PIA system and provides guidelines for installing and operating the system. Chapter 2 provides a description of hardware and software required for system installation. Chapter 3 provides guidelines for installing and configuring the system. The appendix provides detailed descriptions of various screens in the PIA software.

2. SYSTEM DESCRIPTION AND REQUIREMENTS

INTRODUCTION

This chapter provides a detailed description of the PIA system. As mentioned previously, the system consists of software and hardware components. Figure 1 provides an overview of the system architecture.
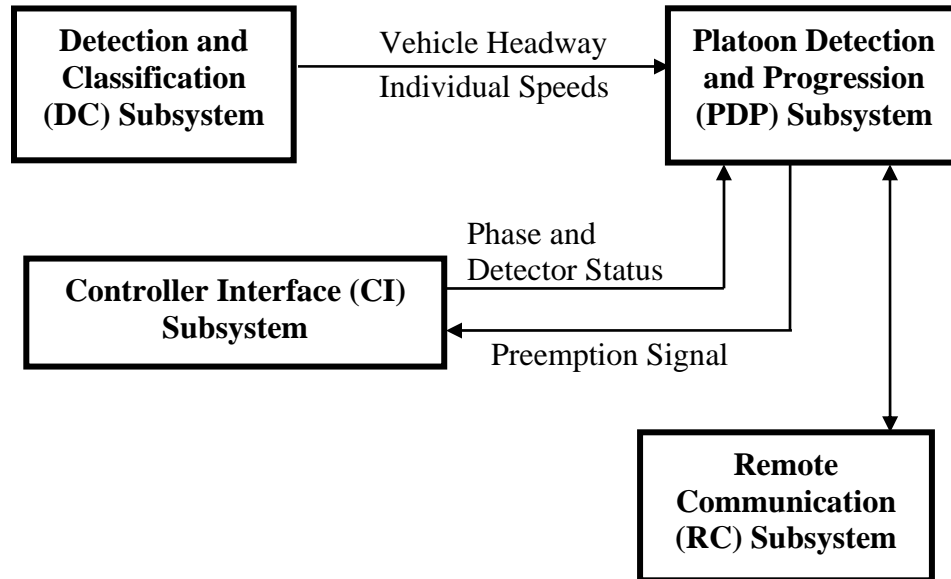
```
┌─────────────────────┐   Vehicle Headway    ┌─────────────────────┐
│   Detection and     │ ───────────────────▶ │ Platoon Detection   │
│   Classification    │   Individual Speeds  │ and Progression     │
│   (DC) Subsystem    │                      │ (PDP) Subsystem     │
└─────────────────────┘                      └─────────────────────┘
                                                       ▲
                             Phase and                 │
                             Detector Status           │
┌─────────────────────┐                                │
│ Controller Interface│ ◀──────────────────────────────┤
│ (CI) Subsystem      │   Preemption Signal             │
└─────────────────────┘                                 │
                                                        ▼
                                              ┌─────────────────────┐
                                              │     Remote          │
                                              │  Communication      │
                                              │  (RC) Subsystem     │
                                              └─────────────────────┘
```

Figure 1. System Architecture and Subsystems.

PIA SUBSYSTEMS

Platoon Detection and Progression Subsystem

The PDP subsystem consists of a set of software subroutines that run on a field-hardened personal computer (PC). These subroutines use real-time information from the DC and CI subsystems to detect the presence of platoons and to progress the detected platoons when appropriate. This subsystem also provides dilemma-zone protection to vehicles at the back end of a platoon. The PDP algorithm uses several parameters specified by the user. Figure 2 illustrates the main program window for the PIA system. Key sections on this screen are those with the following headers:

- Platoon Information,
- Activation,
- Preemption Information,
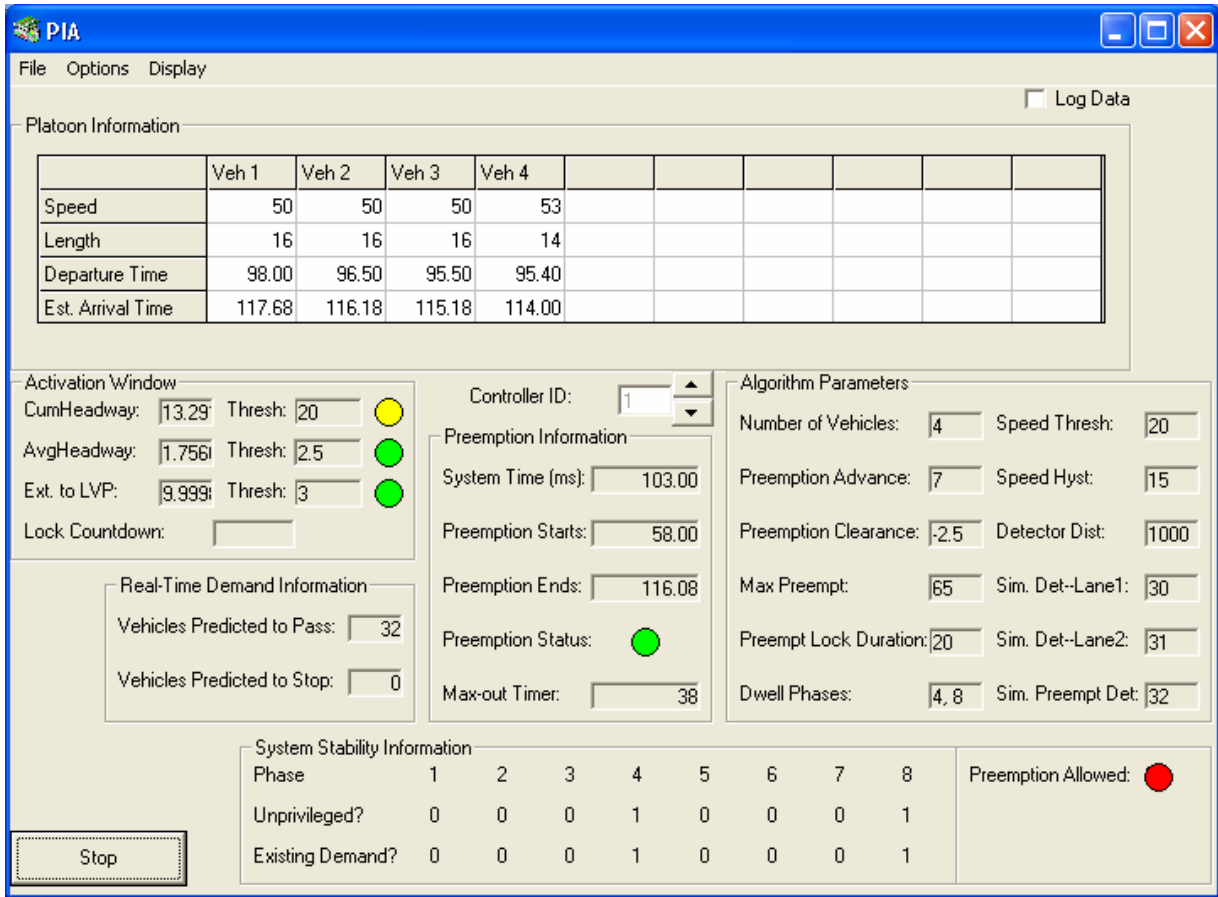- Algorithm Parameters, and
- System Stability.

PIA

File   Options   Display

☐ Log Data

Platoon Information

	Veh 1	Veh 2	Veh 3	Veh 4					
Speed	50	50	50	53					
Length	16	16	16	14					
Departure Time	98.00	96.50	95.50	95.40					
Est. Arrival Time	117.68	116.18	115.18	114.00					

Activation Window
CumHeadway: 13.29   Thresh: 20   ⬤ (yellow)
AvgHeadway: 1.756   Thresh: 2.5   ⬤ (green)
Ext. to LVP: 9.999   Thresh: 3   ⬤ (green)
Lock Countdown: [   ]

Real-Time Demand Information
Vehicles Predicted to Pass: 32
Vehicles Predicted to Stop: 0

Controller ID: 1

Preemption Information
System Time (ms): 103.00
Preemption Starts: 58.00
Preemption Ends: 116.08
Preemption Status: ⬤ (green)
Max-out Timer: 38

Algorithm Parameters
Number of Vehicles: 4   Speed Thresh: 20
Preemption Advance: 7   Speed Hyst: 15
Preemption Clearance: -2.5   Detector Dist: 1000
Max Preempt: 65   Sim. Det--Lane1: 30
Preempt Lock Duration: 20   Sim. Det--Lane2: 31
Dwell Phases: 4, 8   Sim. Preempt Det: 32

System Stability Information

Phase	1	2	3	4	5	6	7	8	Preemption Allowed: ⬤ (red)
Unprivileged?	0	0	0	1	0	0	0	1	
Existing Demand?	0	0	0	1	0	0	0	1	

Stop

Figure 2. PIA Main Screen.

The following subsections provide detailed information about these sections.

Platoon Information Window

This window provides a real-time display of vehicles as they pass over the advance detectors. The amount of information displayed (that is, the number of columns with information) depends on the number-of-vehicles value specified by the user. This parameter is described later. At this time, it is sufficient to note that in the illustration of Figure 2 this value is 4. Therefore, the program is displaying the following rolling horizon information about the last four vehicles:

- Speeds: speeds of vehicles as they passed over the advance detectors,
- Lengths: lengths of vehicles as they passed over the advance detectors,
- Departure Time: time at which the vehicle passed over the advance detectors, and
- Est. Arrival Time: Time at which the vehicle is estimated to arrive at the stopbar. If a vehicle's estimated arrival time is less than the estimated arrival time of the previous vehicle in the same lane plus a minimum headway, the estimated arrival time of the subject vehicle is modified to reflect a minimum headway between the two vehicles.

Activation Window

The activation window shows the real-time algorithm parameters and their corresponding thresholds. If a parameter is less than its corresponding threshold, the light located in its row is lit. Light status is based on the decision made for the last vehicle, not the current time step. That is, if the vehicle that passed over the advance detector 10 seconds ago satisfied a condition, the light will be lit even though there is no vehicle over the advance detector at this moment. The light will remain lit until the condition is re-evaluated. Re-evaluation takes place when the next vehicle passes over the detector. The following is a description of each parameter in the activation window.

Cumulative Headway (CumHeadway)
The difference between the estimated arrival time of the first and last vehicles in a platoon, respectively. This parameter is only relevant in the platoon identification step. Once the system recognizes a platoon, it evaluates successive vehicles using the platoon extension criteria.

Average Headway (AvgHeadway)
The average headway of vehicles in the platoon calculated from the first vehicle in the platoon to the subject vehicle. This value is compared to its corresponding threshold to decide whether a vehicle should be considered as a part of a previous platoon based on the average headway with the vehicle included. This parameter is important when a secondary platoon follows a primary platoon.

Extension to Last Vehicle in Platoon (Ext. to LVP)
The difference between the estimated arrival of the subject vehicle and the last vehicle in an identified platoon. Note that if a vehicle is not deemed to extend the platoon, then it is not considered in the Ext. to LVP calculations for the next vehicle.

Lock Countdown
When a preemption is terminated, the program enforces a preempt lock period during which no platoon can be identified. This period is intended to serve the minor movement phases. The Lock-Countdown box shows the time left in the lock countdown period before the algorithm resumes platoon detection mode.

Real-Time Demand Window

This window shows real-time estimates of vehicles predicted to pass and vehicles predicted to stop. The information is used in conjunction with the platoon information to set up the preemption schedule as described below.

Vehicles Predicted to Pass
This estimate appears at the end of each preemption cycle.

Vehicles Predicted to Stop
Vehicles that arrive during red or do not meet the platoon identification/extension criteria form queues at the signal. The algorithm uses this estimate to expedite a preemption schedule in order to accommodate the waiting queues.

Preemption Information

This window shows the preemption schedule information while the program is running. Information in this category is described below.

System Time
In the field implementation, this box displays computer clock time. In a lab setting, this box displays time-step for the current simulation run.

Preemption Starts
This field displays the time the preemption is scheduled to start.

Preemption Ends
This field displays the time the preemption is scheduled to end.

Preemption Status
This circle is lit when the counter falls between the scheduled start and the end of preemption times. It indicates that the algorithm has issued a preemption signal.

Max-out Timer
This counter keeps tracks of the preemption duration, similar to the max-out timer in actual controllers. The program increments the counter only when there is demand at a conflicting phase.

Algorithm Parameters Window

This window contains the current setup of algorithm parameters. These user-configurable parameters are described below.

Number of Vehicles
This parameter identifies the smallest number of vehicles that can be classified as a platoon. The recommended value for this parameter is 4. This number, together with cumulative headway, is used for initial platoon identification.

Preemption Advance
This field displays the time between signal preemption activation and the predicted arrival of the start of the platoon at the downstream signal. Note that preemption is activated prior to the platoon arrival.

Preemption Clearance
This field displays the time between predicted arrival of the last vehicle in the platoon at the downstream signal and signal preemption termination. Setting this time equal to –2.5 seconds is equivalent to terminating the preemption as the last vehicle in the platoon exits its dilemma zone.

Max Preempt
This is the maximum time preemption will be allowed to continue when there is continuous conflicting demand.

Preempt Lock Duration
This is the time no platoon identification is allowed once preemption is terminated.

Speed Threshold
This field displays the speed value below which the program recognizes a gridlock condition and activates a flush mode. The flush mode applies a continuous preempt while this condition remains true.

Speed Hysteresis
The summation of speed threshold and speed hysteresis determines the speed above which the program recognizes a return-to-normal condition after a gridlock occurs.

Simulation Detector—Lane 1
This entry is for simulation only. The entry is the detector number acting as the classifier in the first lane.

Simulation Detector—Lane 2
This entry is for simulation only. The entry is the detector number acting as the classifier in the second lane.

Detector Distance
This field displays the distance between the advance detector used by the classifier and the downstream signal.

Preempt Detector (preemptDet)
This entry is for simulation only. The entry is the detector number acting as the preempt detector.

System Stability Window

The system stability window displays additional parameters and indicators of the current status of the algorithm. Descriptions of key elements are provided below.

Unprivileged Phases
An unprivileged phase is a phase that does not get served when the signal is preempted (such as opposing left-turn or side-street phases) and, therefore, needs special attention from the PDP subsystem. A "1" under a phase in the system stability window means that this phase is designated by the user as an unprivileged phase. The PDP subsystem monitors the demand on all unprivileged phases while a preemption call is active to ensure that the phase is served before a subsequent preemption is allowed. This treatment is important to ensure that excessive queues do not build on unprivileged phases.

Existing Demand

If a call is placed on an unprivileged phase during preemption, the PDP subsystem raises a flag for that phase (a "1" is shown in the existing demand row). If an existing demand flag is raised for any of the unprivileged phases, the PDP will disable preemption (preemption allowed light will be lit red). The existing demand flags are cleared only under two conditions: 1) the detector call is cleared during phases other than the phase the call is registered for; and 2) the phase that has the call displays green and ends with a "gap-out" condition. The first condition accounts for cases when a demand is cleared by a permitted operation such as right-turn-on-red or permitted left turn. The second case makes sure that the phase that has the demand was served sufficiently and no queues were left unserved (i.e., the phase did not end with a "max-out"). The program provides platoon identification and progression function only when there are no existing demand flags (i.e., when preemption allowed is lit green). This mechanism ensures that all vehicles arriving at specified unprivileged phases during preemption get serviced before providing priority treatment to the platoon. This feature is similar to the "Skip Phases" feature provided by modern controllers used in Texas. This feature in a controller provides for either skipping of all conflicting phases or no skipping at all. In contrast, the feature provided in the PIA software is more flexible in that the user can select a subset of phases to be in either category. The main objective of this PIA feature is to ensure system stability before intervention with a platoon preemption request.

When the main street priority phase turns green to serve a waiting queue, the PDP subsystem issues a short (5-second) preemption to evaluate the presence of an approaching platoon. This is known as "Green Grab."

Different System States

Figures 3, 4, and 5 illustrate the three common scenarios of program operation. Figure 3 illustrates the case when a platoon was identified and was being progressed, and the last vehicle passing over the classifier meets extension conditions for both average headway and dilemma zone. Figure 4 illustrates the scenario when a platoon was identified and progressed, while an additional vehicle meets only the average headway condition. Figure 5 identifies the scenario when the algorithm is locked (prevented) from detecting and progressing platoons.
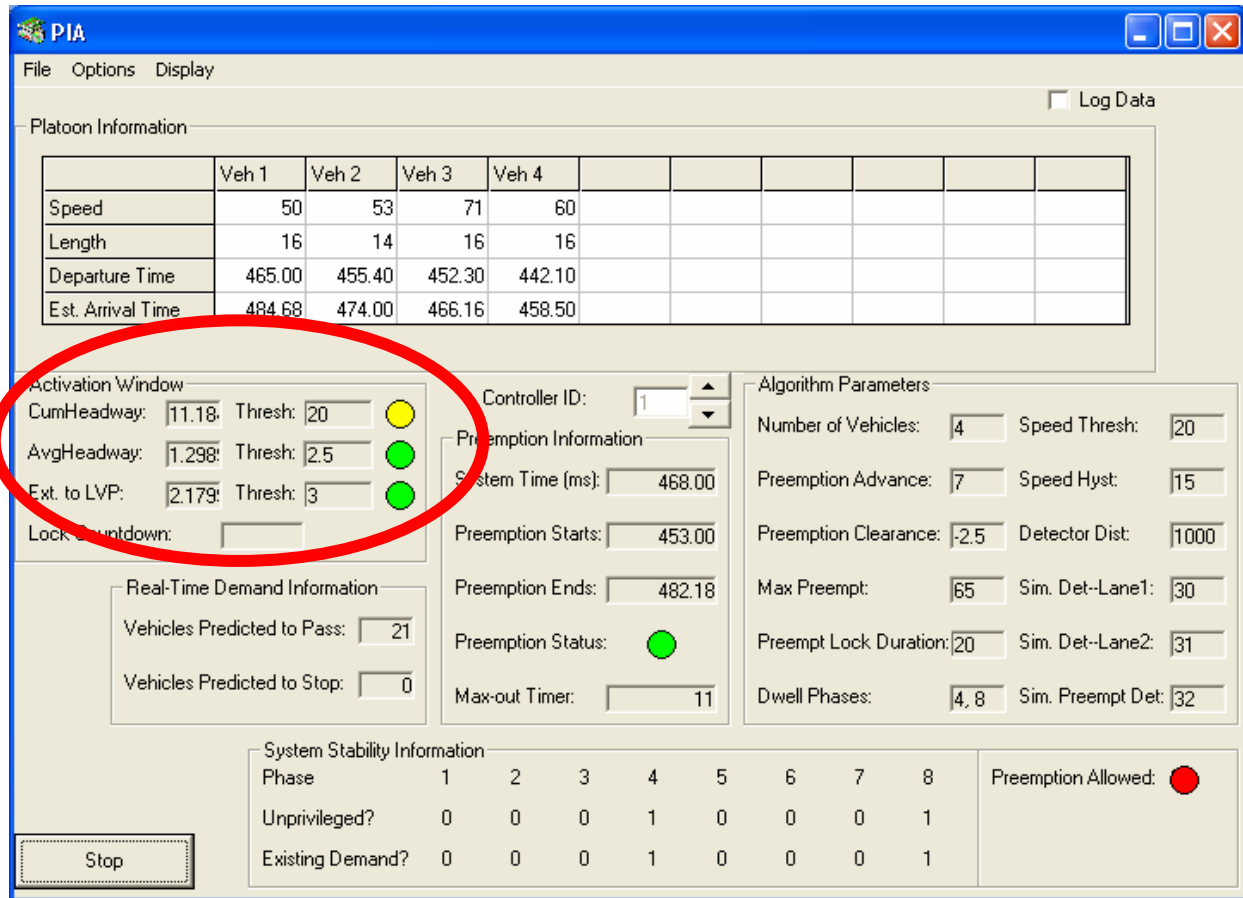
8

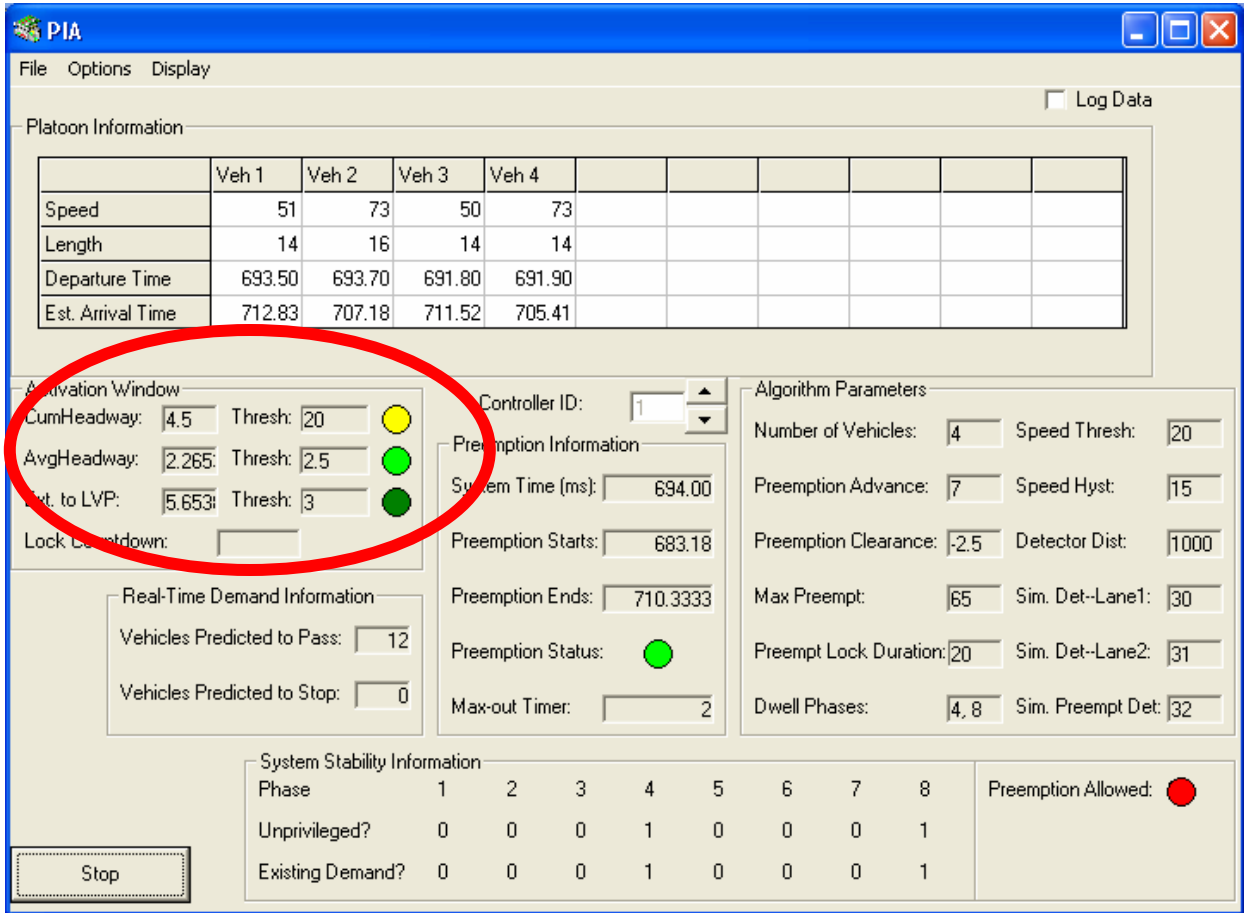**Figure 3. Platoon Identified, Last Vehicle Meets Both Extension Conditions.**

**Figure 4. Platoon Identified, Last Vehicle Meets Average Headway
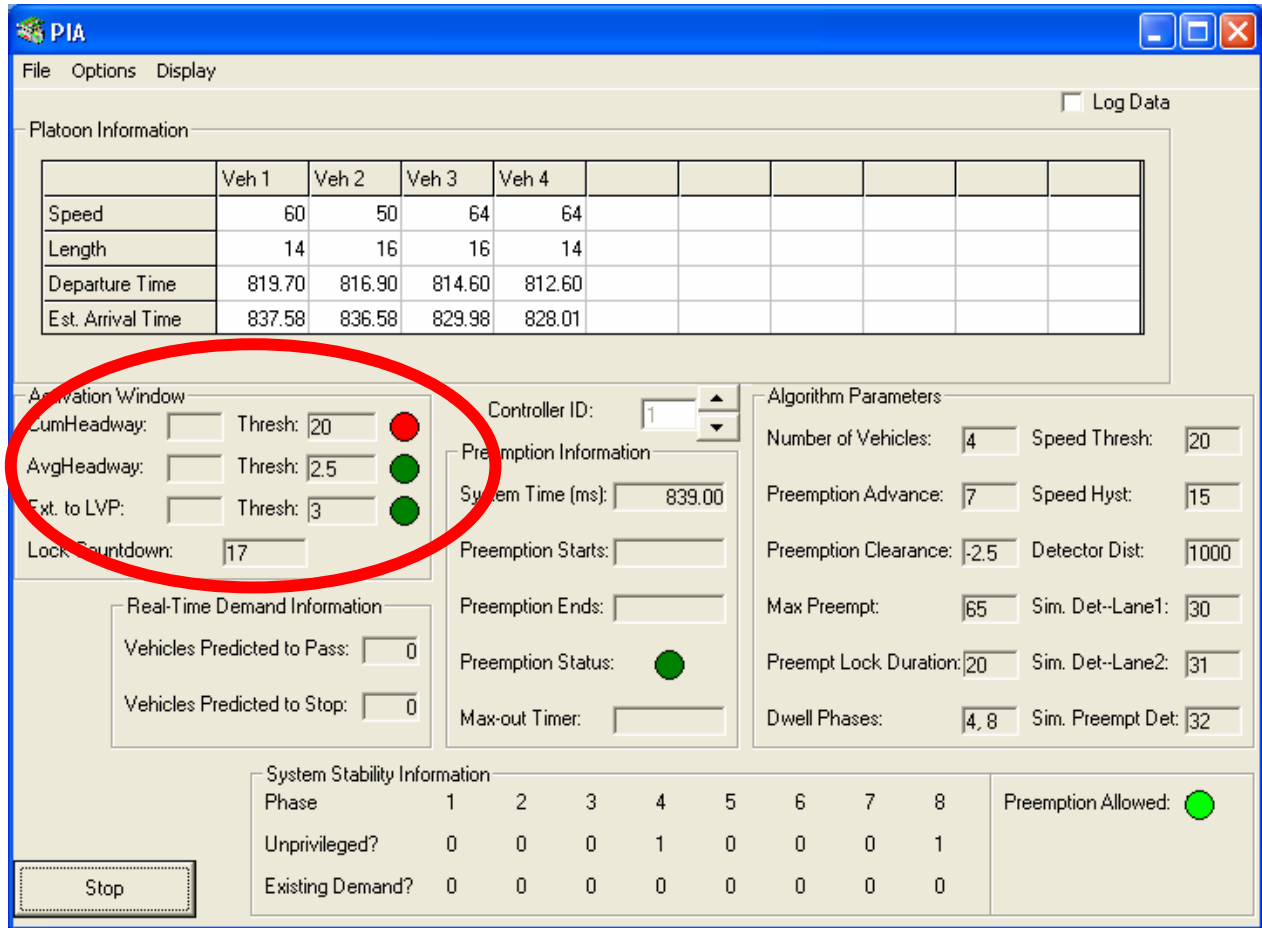Extension Condition Only.**

Figure 5: Lock Period Active.

Detection and Classification Subsystem

The purpose of the DC subsystem is to provide vehicle detection and speed information for each vehicle well in advance of the stopbar. The system should consist of the following components:

- one speed trap (inductive loops or video camera-based) per lane,
- detection unit(s) (loop amplifier or video processor) to provide contact closure information from the trap (both loops),
- communication between the trap detectors and detection unit(s) (hardwired or wireless), and
- a classifier which obtains contact closure information and calculates speeds and lengths of individual vehicles.

Upon each detection, the classifier sends a message over a serial connection to the PIA software. The message consists of the lane number, vehicle speed, and vehicle length. One module in the PIA software checks continuously for messages sent by the classifier. The information received is then used by the PDP subsystem to determine the schedule of preemption start and end times.

Controller Interface Subsystem

Controller interface subsystem provides the interface between the PDP algorithm and the controller cabinet. The PDP algorithm requires several inputs from the controller cabinet including phase status (green/yellow/red) of each phase in the controller and status of each stopbar detector (on/off). The PDP algorithm needs to send a signal to the controller cabinet any time it decides to activate one of the low-priority preempts.

The CI subsystem consists of a software module and a number of hardware components depending on the type of controller cabinet. The CI software module is integrated with the PDP algorithm routines and is referred to as the PIA software. For TS-1 controller cabinets, the CI subsystem requires a digital input-output card that is installed in the field-hardened industrial PC, where the PIA software resides and runs, and has at least 24 inputs and eight outputs. Researchers are currently using a National Instruments Data Acquisition (NI DAQ) PCI-6527 digital I/O card with 24 inputs and 24 outputs. The digital I/O inputs are connected to eight phase-on contact-closure connections on the TS-1 controller cabinet's back panel, six contact-closure connections that provide the ring-status bits A, B, and C (three per controller ring), and to eight contact-closure connections that provide the status of stopbar detectors. Based on the status of the three ring-status bits (A, B, and C) and phase-on status of each phase, the software determines if a phase is in green, yellow, or red state.

In addition to the digital I/O card, TS-2 controller cabinets require a special TS-2 breakout panel. This panel provides contact-closure connections to the required controller cabinet inputs (i.e., phase and detector status needed by the PIA software).

The CI subsystem's software module checks the status of the controller's back panel phase-on, ring-status bits, and stopbar detector contact-closure connections once every 10 milliseconds. It determines the status of each phase (main-street or side-street) whether it is green, yellow, or red. It also determines the status of the stopbar detectors whether they are on or off based on the contact-closure connections. The CI software module updates the intersection display with the current status of the phases and stopbar detectors. The CI software module also makes available the current phase status and stopbar detector status to the PDP subsystem and activates the low-priority preemption by sending a contact-closure signal to the controller's back panel upon request from the PDP subsystem. A timer relay provides fail-safe operation for the low-priority preemption (LPP) signal sent by the PDP subsystem. This relay is installed to terminate the LPP signal any time it continues beyond a user-specified time.

Remote Communication Subsystem

The RC subsystem is optional. Its purpose is to provide a capability to remotely access the PC in the cabinet for maintenance and monitoring purposes. It also provides functionality to shutdown and/or to restart the PC if such a need arises, or stop/restart the PIA software. The RC subsystem contains the following components:

- a standard telephone line or a digital subscriber line (DSL) in the cabinet,
- an appropriate modem (standard or DSL) connected to the remote PC in the cabinet,

- PcAnywhere software running on the remote PC and on a computer in the office, and
- a remote power on/off switch.

PcAnywhere program provides a dialup capability and allows a user to use a remote PC as if it were present on the desktop. The remote power on/off switch is connected to the phone line in the controller cabinet and allows a user to re-power the PC via a sequence of calls to the controller cabinet.

SYSTEM COMPONENTS

This section provides a brief summary of hardware and software components needed to install the PIA system at a single site. An additional cabinet may be required if the existing cabinet does not have sufficient room to install system components.

Required Hardware and Software Components

Advanced Detector Trap

Advanced detection can be provided using inductive loops or video cameras. In addition, detector-to-cabinet connections can be hardwired or wireless. Depending on the detection technology used (loops or video), the following items may be needed: loop detector amplifiers or video detection unit.

Field Hardened Personal Computer

A field hardened PC is needed to run the PIA software and any additional software needed for monitoring and maintaining the system from a remote location.

Digital Input/Output Board

A digital I/O board with 48 (24 input and 24 output) channels is used to access the phase and detector status contact-closure connections on the cabinet back panel. Researchers used NI DAQ 6527 manufactured by National Instruments.

Classifier

A classifier is needed to detect individual vehicles in each lane and provide over a serial connection the lane number and vehicle speed in real time. Researchers used a Peak ADR-2000 classifier in this research project.

TS-2 Breakout Panel

A TS-2 breakout panel is needed only if the system is to be installed in a TS-2 cabinet. The breakout panel is connected to Bus Interface Units (BIUs) 3 and 4 to communicate the status of ABC pins from both rings in the controller to the PIA system.

Timer Relay

A timer relay is needed to provide a fail-safe operation. Its purpose is to terminate controller override (preemption signal) issued by the PIA software after a preset time. It provides protection against any possibility of program malfunction before getting a chance to terminate its override. Such a situation may occur due to power failure or unknown bugs in the software.

Connector Panel

The connector panel is a resistor input interface circuit for NI DAQ 6527. The interface circuit consists of a double layer terminal strip with 24 individual terminals. A bus connecting all 24 bottom level terminals supplies all 24 16 kilo-ohm resistors with 24 volt direct current (VDC). The supply to the bus is fused by a 1/5 amp fuse to protect the output of the traffic signal controller. The current flowing through each resistor is approximately 1 milli-ampere (mA) when the output from the traffic signal controller is "active low" on a particular output. Each input for the NI DAQ card requires 1mA for its optical isolator's light-emitting diode (LED) to work reliably. The current from the 24 VDC supply flows through the fuse, through the resistor into the NI DAQ optical isolator, and into the output of the traffic signal controller. Current sinks into the output only when the output of the traffic signal controller is active low.

PIA Software

PIA software developed by TTI runs on the PC described earlier. It communicates with the cabinet and the classifier to obtain needed information to detect the existence of platoons and to override the normal controller operation to progress the detected platoon of vehicles.

OPTIONAL HARDWARE AND SOFTWARE

If the selected site is located in a remote location, additional hardware and software can be installed to provide remote communication with the PIA system. In this case, the following items will be needed:

- a telephone (standard or DSL) line to the controller cabinet,
- a modem,
- remote control software such as PcAnywhere, and
- a power on/off switch.

3. INSTALLATION AND OPERATIONS GUIDELINES

This chapter provides guidelines for installing and setting the system. There are three preliminary steps in this process:

1. Identify and acquire the components needed to install the system.
2. Inspect the site to determine the location for installing detector trap.
3. Inspect the existing cabinet to determine if it has room to install the selected (required and optional) hardware.

The following subsections provide additional information.

SYSTEM INSTALLATION

Advance Detection

The PIA system requires the ability to detect individual vehicles and measure their speeds well in advance of the stopbar to allow sufficient time to detect platoons and provide controller override before the platoon arrives at the intersection. Either inductive loops or video cameras can be used for such advance detection. This section provides information needed to determine which of these technologies are to be selected for installation at a selected site.

Detector Trap Location

The detector trap should be placed such that the trailing edge (illustrated in Figure 6) of the second detector meets the following criterion:

- For a high-speed (55 mph or higher) approach, the detector should be placed approximately 1000 ft from the stopbar.
- For a low-speed approach (40 mph or lower), the detector should be placed 600 to 700 ft from the stopbar.
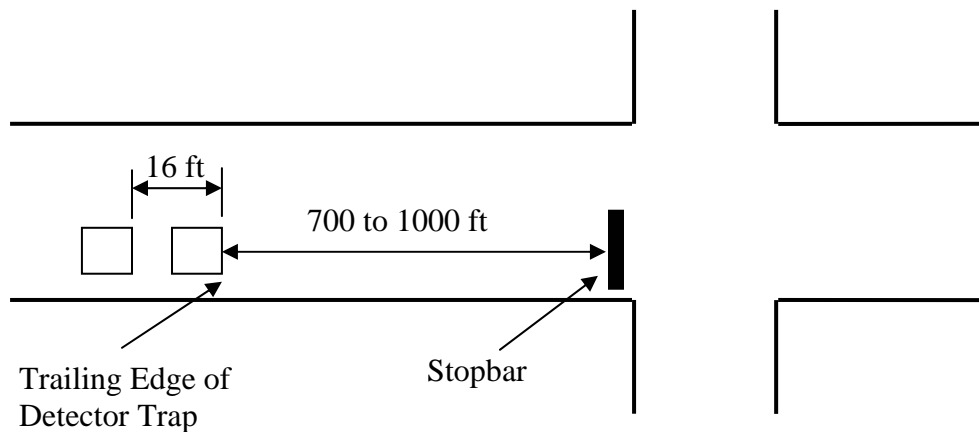
Figure 6. Placement of Detector Trap.

Video-Based Detection

In this project, TTI research shows that inductive loops are more reliable and more accurate than video-based detection for detecting speeds of individual vehicles. However, if video-based detection is selected, the system should be installed using the guidelines provided here.

Video-based speed detection can be of the following two types:

- using two detectors as shown in Figure 6 (i.e., Iteris Intersection Model), or
- using one detector to emulate a trap (i.e., Iteris Freeway Model).

In either one of the above cases, one camera can be used to provide detection in one or two lanes of an approach. Researchers recommend that the camera be installed on the near side at angles as shown in Figure 7. These angles ensure that the top plus side of each vehicle is captured as it approaches the camera. This type of camera placement results in better detection of trucks.
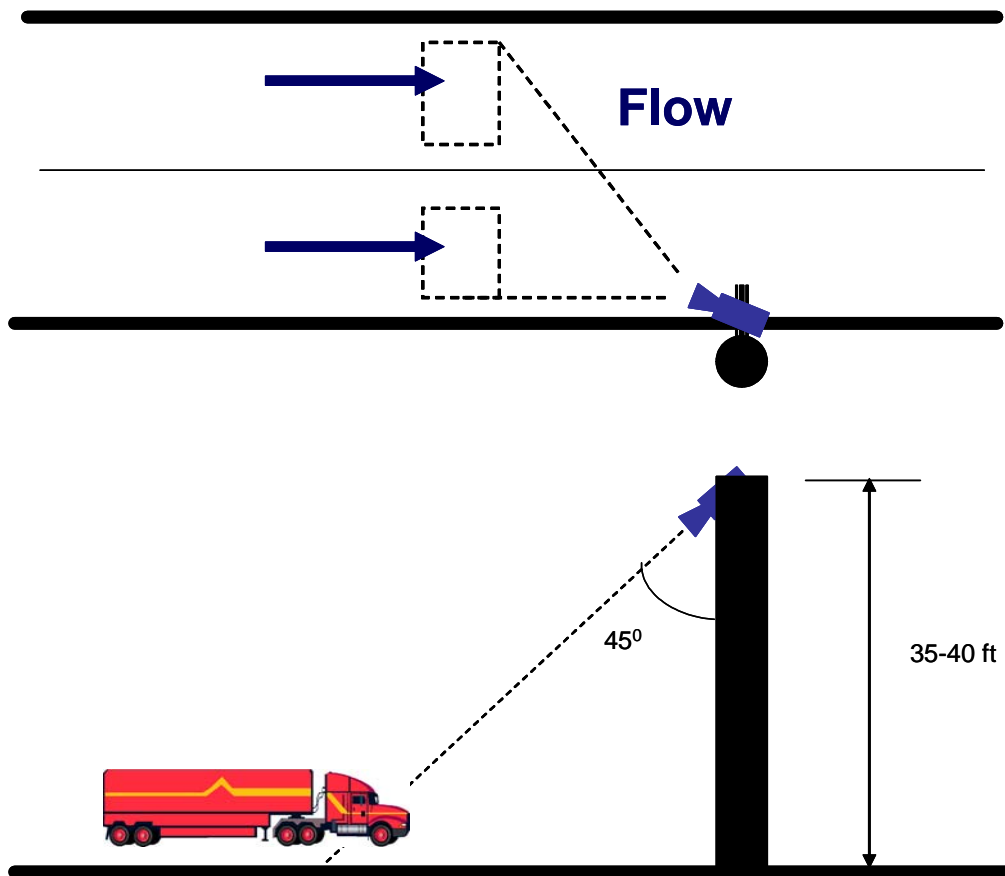
Figure 7. Camera Installation Guidelines.

In addition, for systems that emulate a trap using a single detector, the detector should be placed on a section of roadway over which the vehicles are moving at a constant speed because accelerating or decelerating vehicles may introduce errors in speed measurement.

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Installation and Wiring of Remaining Components

Figure 8 illustrates how various components are connected to complete system installation. Chapter 2 provides detailed descriptions of these components. Note that the breakout panel is not needed if the system is to be installed in a TS-1 cabinet. Furthermore, in case of video-based advance detection, the video processor will replace the inductive loop amplifier shown in Figure 8.
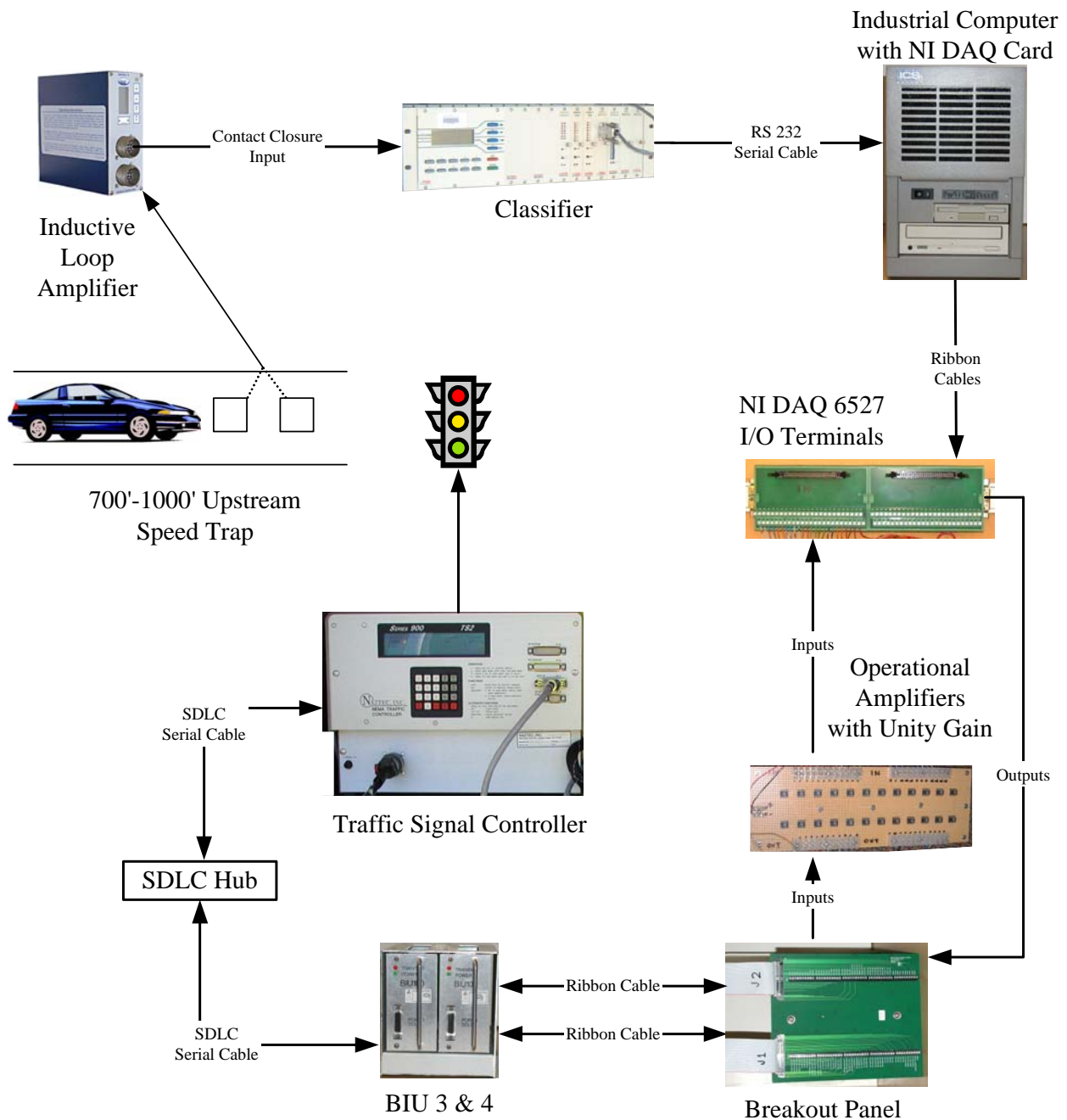
Figure 8. System Connection Diagram for a TS-2 Cabinet.

As illustrated in Figure 8, the PIA software resides on an industrial PC that can withstand extreme temperatures and other field conditions. This PC also houses the digital I/O card. A PC with the following specifications is recommended:

- 500 MHz or better CPU,
- 20 GB or larger hard disk drive (useful when user desires to log operational data),
- 256 Megabytes of RAM, and
- Windows® 2000 operating system.

The PIA software needs phase and detector status inputs from the controller cabinet. Thus, the phase and detector status contact-closure connections on the controller's back panel (or breakout panel) need to be wired and mapped to the proper channels on the digital I/O card used by the PIA system to access these inputs from the controller cabinet. In addition, the low-priority preemption outputs from the PIA system need to be wired to the proper contact-closure connections on the controller back panel. Researchers recommend that preempt number 3 or higher be used. The next steps are to wire loop lead-ins to proper classifier input channels and to connect the classifier to the computer using a serial cable. The final step is to set the timer relay. Using a value slightly larger than the maximum preempt time (described below) set in the PIA software will ensure that the relay does not override normal operation.

SYSTEM CONFIGURATION

System configuration requires programming preempt parameters in the controller and setting up the PIA software. These steps are described below.

Controller Setup

The controller should be programmed to provide a snappy operation. If the controller operation is sluggish, it will also make the PIA system sluggish because the PIA software has been designed to work within the constraints of controller operation. The following guidelines will ensure a more responsive preemption operation:

- Set preemption delay to zero. Delay is the amount of time the controller waits before activating a preempt signal.
- Set the controller to skip conflicting phases in the presence of a preemption signal. The PIA software provides an enhanced capability to skip selected phases. This feature is better than the all or nothing selection for this data in the controller.
- Set the value of preemption extension to zero. The controller should not extend signal preemption beyond the signal from the PIA software.
- Set the preempt lockout to the smallest value possible without forcing the controller to service all conflicting phases. The PIA software provides a programmable lockout option.
- Set preemption to call the priority through phase only. This will allow the controller to time any concurrent phase with a call on its detector.

In addition to the above, researchers also recommend that other parameters in the controller be programmed with values to provide a snappy operation as well. These parameters include: gap

(passage) settings for phases, minimum times for phases, and detector options. For instance, if through and right movements share a lane, a delayed call on the detector will improve operation.

PIA Software Setup

The appendix provides examples of screens, along with descriptions of data on these screens. Data described below are important for setting up optimal operation.

Algorithm Parameters

These parameters are specified on the Edit Parameters screen (Appendix). Except for Detector Distance, Max Preempt, and Preempt Lock Duration, all values should be left at their default values. Class Distance specifies the distance between the stopbar and the speed trap. This value is dependent on trap installation. The other two parameters should be selected based on field observations.

Phase Configuration Data

Identify which conflicting phases are not to be skipped when demand is present on corresponding movements. These phases are referred to as Unprivileged Phases. On the Phase Configuration data, check the box for each identified unprivileged phase. This will ensure that vehicles arriving on these phases during preemption are serviced before the software issues another preemption signal.

INITIAL OPERATION

To ensure desired — safe and efficient — operation, it is important to observe the operation of the system for a variety of prevalent traffic conditions. Such observations will more than likely identify parameters needing adjustments.

APPENDIX: PIA SOFTWARE

PIA Main Screen

The PIA main screen displays the current system activity such as the vehicles classified and detected by the system, various calculated values that the PIA system uses to determine if a platoon is detected or not, low-priority preemption status (on/off), and if a preemption is allowed during the current cycle or not. The main screen also provides the user with a set of menus that enables him/her to configure the PIA system and display other interface screens.
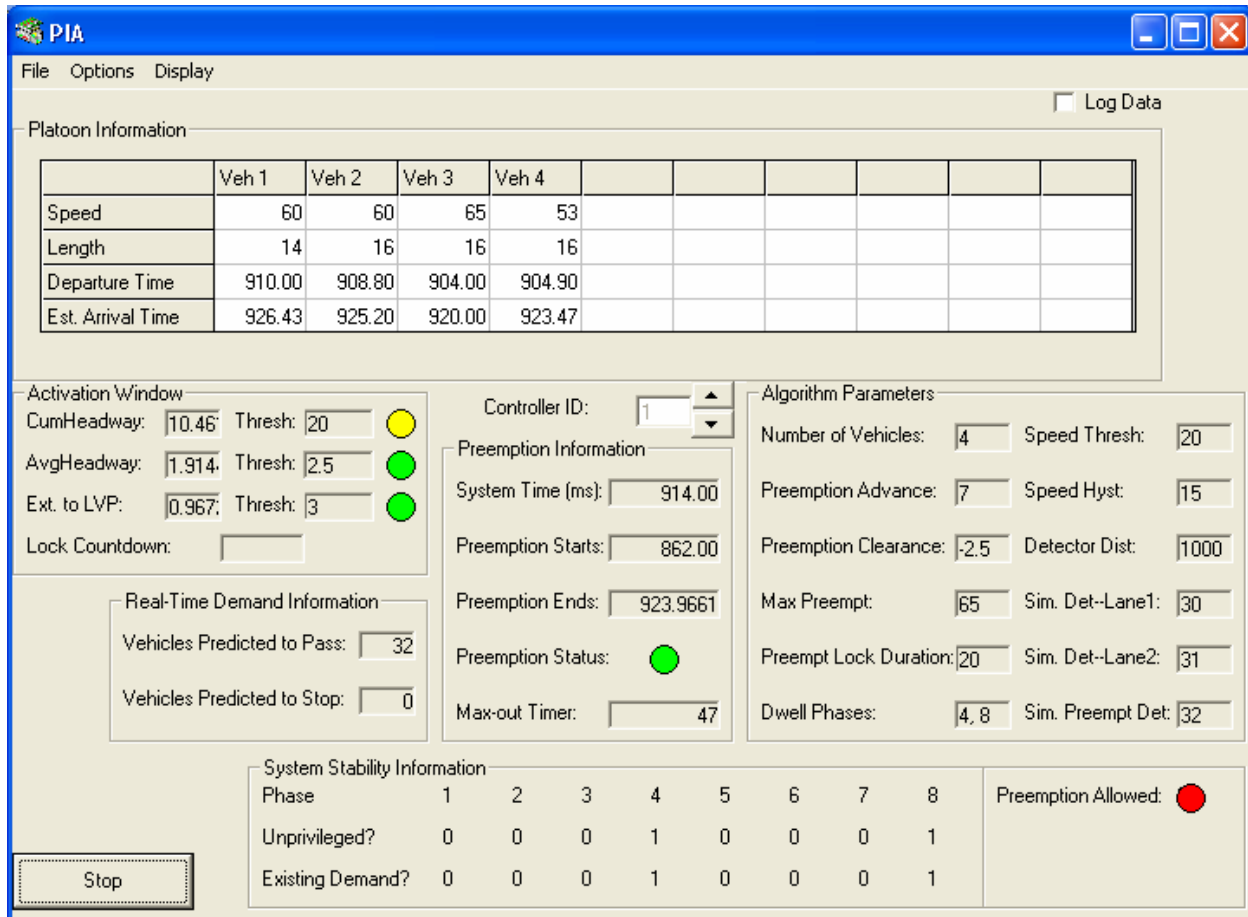
PIA File Menu

The PIA system relies on a configuration file to remember the user settings from one session to another. The PIA File menu provides the user with the options of loading the default PIA system parameters or saving the current PIA system parameters into a configuration file that will be used the next time the system is started. The PIA system provides the user with a number of screens that enable him/her to customize the system configuration to a specific intersection.
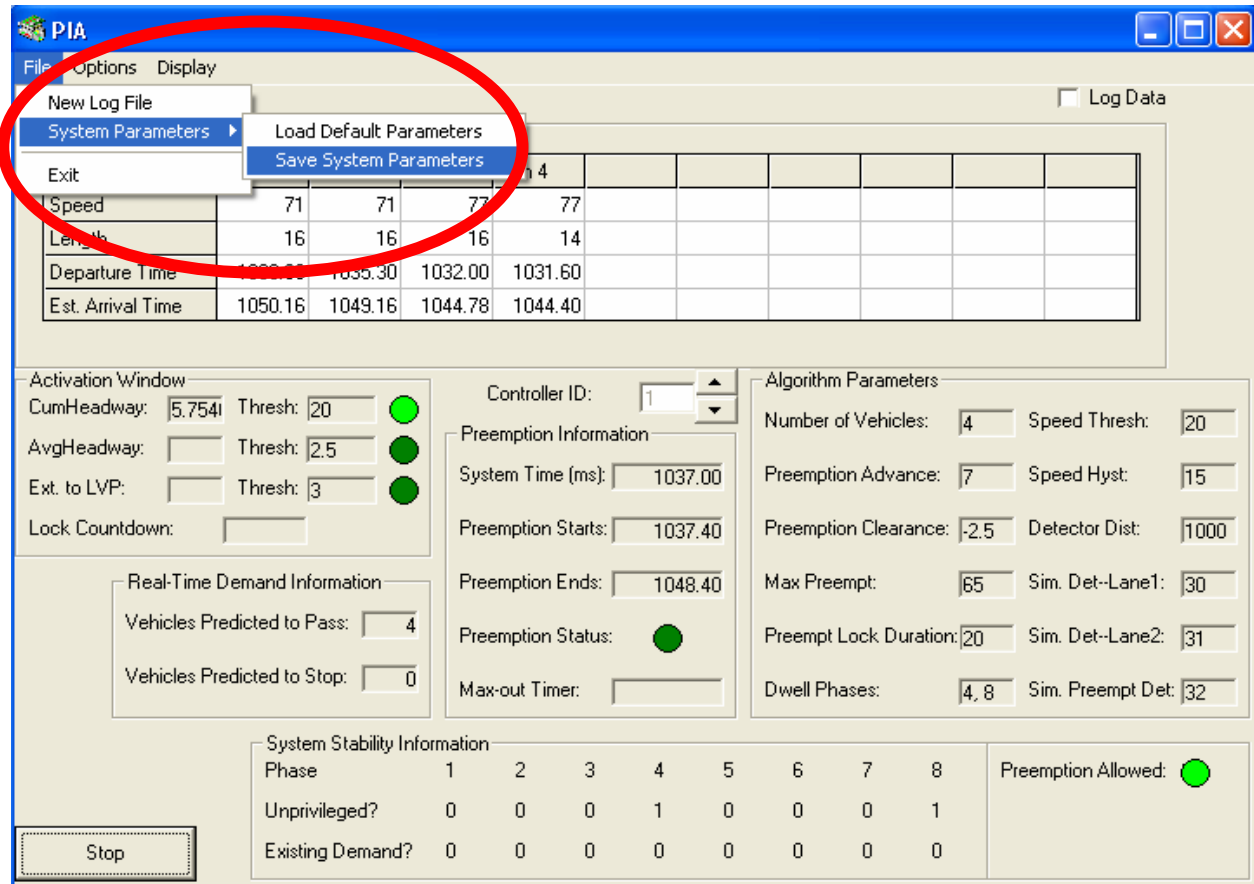
PIA Options Menu

The PIA Options menu allows the user to edit and set the PIA system parameters through a series of user interface screens that include the Platoon Phase, Edit Parameters, Edit Phases, Edit Preempts, Edit System Parameters, and Edit CommPort Settings screens. The following figures explain these screens.
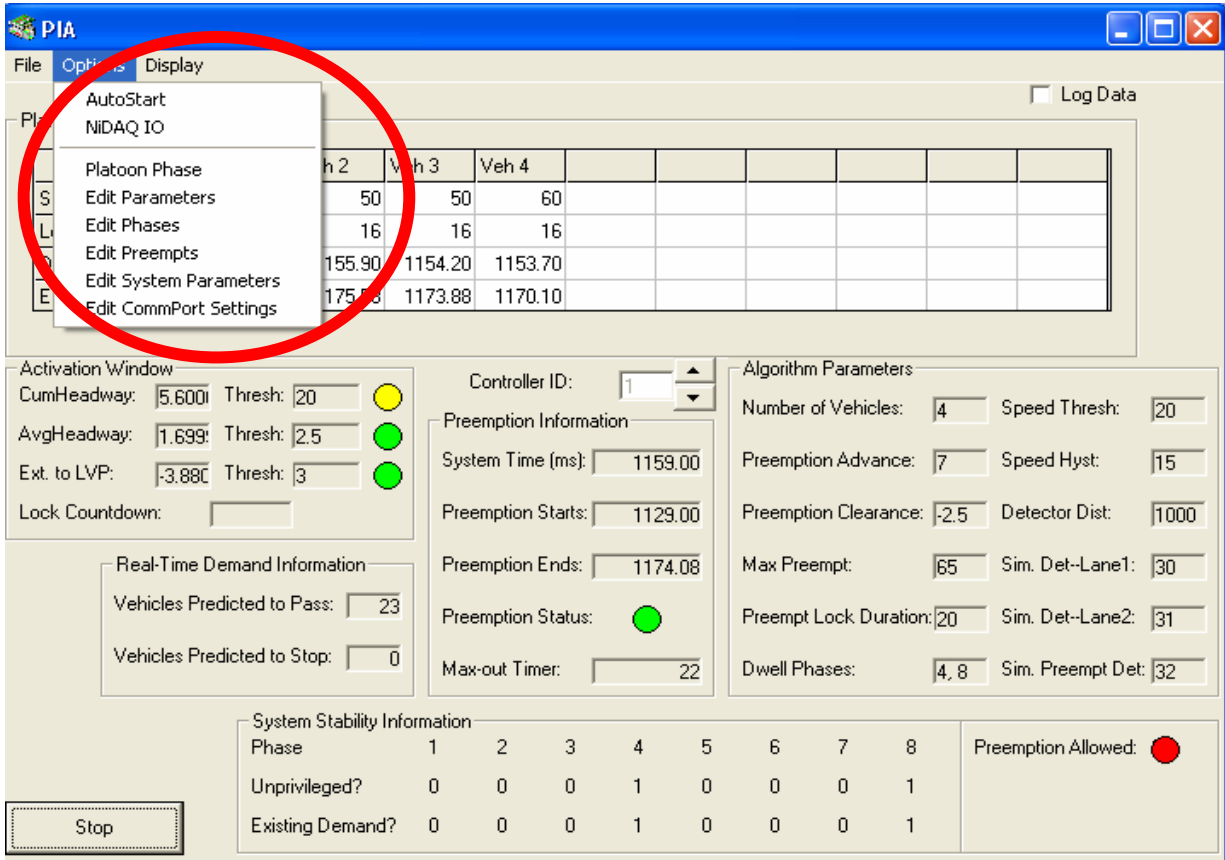
Platoon Phase Screen

In the Platoon Phase screen, the user specifies the main street phase or approach for which platoons need to be detected.

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Edit Parameters Screen
The Edit Parameters screen allows the user to change some or all of the PIA parameters. Post-Preemption-Dwell-Phases setup is an optional feature provided to dwell on user-defined phases until the next platoon is identified. This is an advanced feature where the user, for example, can opt to provide green to the side street until a platoon is identified on the main street. The number of vehicles defined as a platoon in such a case could be as small as one vehicle.

Edit Phases Screen

The Edit Phases screen provides the user with the capability of setting the direction of each phase, especially the main street phases and other parameters that are used to provide the user with a display showing the status of each phase (green/yellow/red) and each stopbar detector (on/off). The Edit Phases screen also allows the user to set the unprivileged flag for each phase, the SBDetector (stopbar detector) flag for phase, and the SBFunctional flag (that tells whether the stopbar detector for that phase is functional or not). The PIA algorithm uses these flags in making a decision whether to allow a low-priority preemption or not, even if there is a platoon. The Edit Phases screen is used also by the user to configure the mapping between the digital I/O card channels and the phases these channels are connected to.

Edit Preempts Screen

The Edit Preempts screen allows the user to map low-priority preemption contact-closure connections on the controller's back panel to the corresponding channels they are connected to on the digital I/O card that is being used by the Controller Interface subsystem to activate the low-priority preemption based on requests from the PIA algorithm.
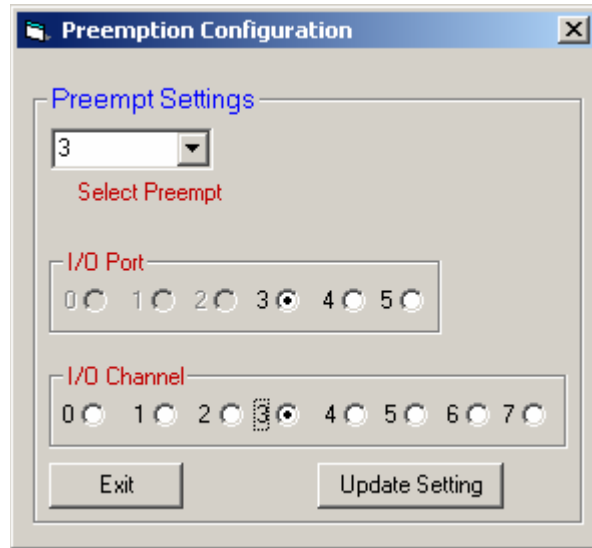
Edit System Parameters Screen

The Edit System Parameters screen allows the user to specify the port on the digital I/O card including which channels are being used to get the phase status, detector status, and the ring-status bits. The user can also set the ports that are being used to send signals to activate the phase hold and low-priority preemption.
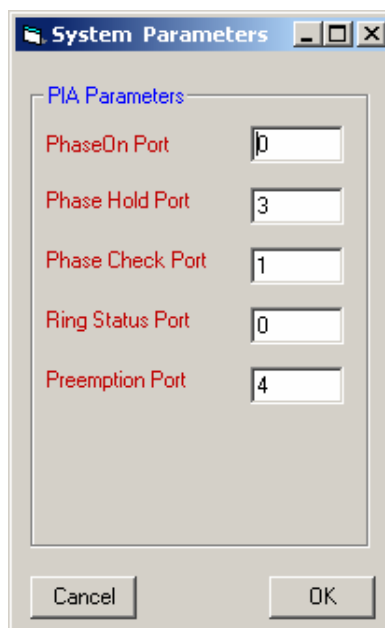
Edit CommPort Settings Screen

The Edit CommPort Settings screen enables the user to specify the serial port number on the PC to be used by the PIA algorithm to communicate with the Peek ADR-2000 classifier. The classifier provides the PIA algorithm with length and speed of vehicles detected by the upstream speed trap detectors. The screen also allows the user to set the baud rate for communicating with the classifier.

Display Menu

The Display menu provides the user with access to other user interface screens to monitor the status of main-street and side-street phases, stopbar detectors, and classifier output.

Intersection Display Screen

The Intersection Display screen provides the user with the ability to monitor the status of main-street and side-street phases in addition to stopbar detectors and the status of the low-priority preemption activated by the PIA algorithm.