Anonymous Wireless Address Matching (AWAM) Host Software

Installation, Configuration, and Operations Manual

Version 2013.4

Contents

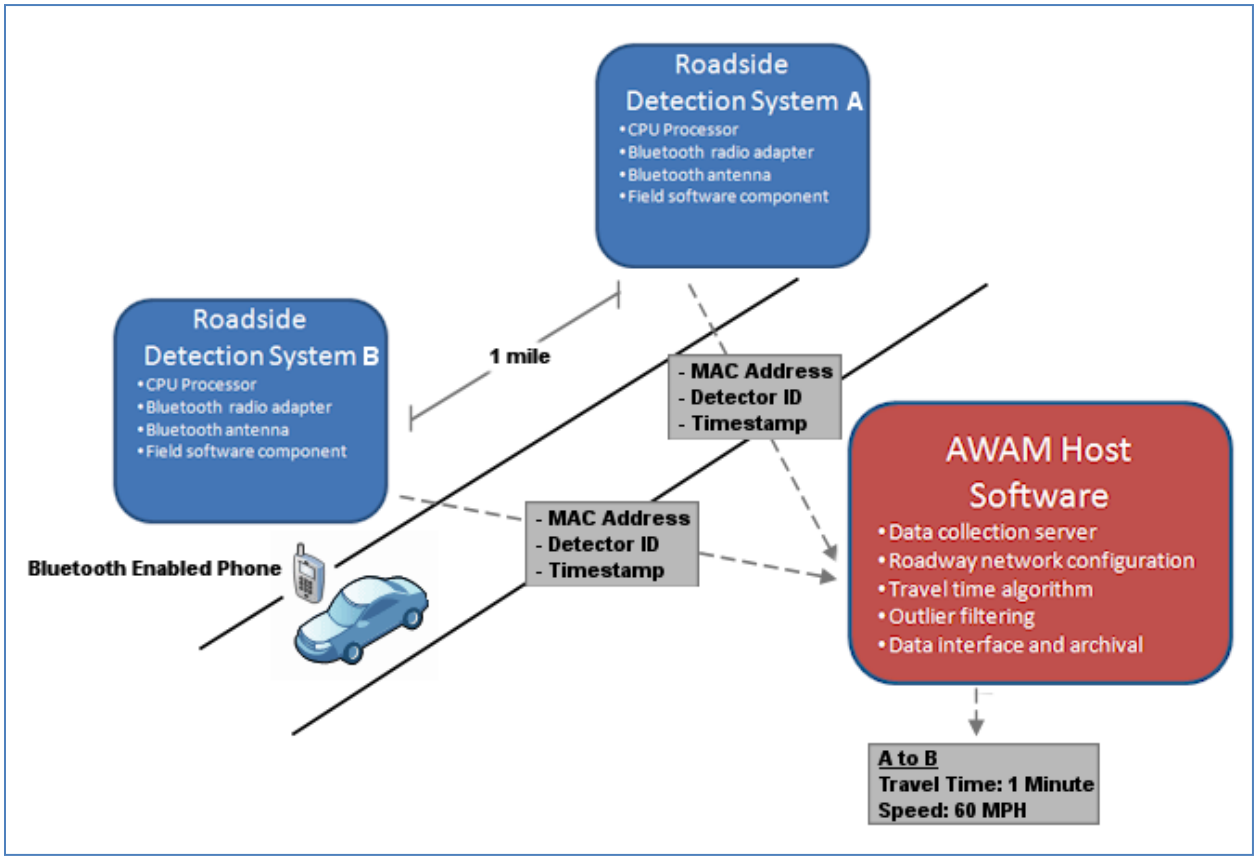
AWAM Traffic Monitoring Concept

The AWAM travel time monitoring technology is based on the use of *Bluetooth™*, a robust, low power, and low cost wireless communications method. *Bluetooth* technology is standardized and used worldwide, so that AWAM travel time monitoring technology may be deployed anywhere.

The AWAM system detects vehicles equipped with enabled *Bluetooth* networking devices, including cellular phones, mobile GPS systems, telephone headsets, and in-vehicle navigation and hands-free systems.

Every *Bluetooth* device has a unique 48-bit address, known as a MAC address, used to identify it to other network devices. Each AWAM reader senses MAC addresses emitted by enabled devices as they pass the reader station. The AWAM reader then transmits the time and location of the device to the AWAM host software. As addresses are detected at successive AWAM readers, the AWAM host system calculates average travel times and speeds for a roadway segment.

Figure 1. AWAM Traffic Monitoring Concept.



Software Overview

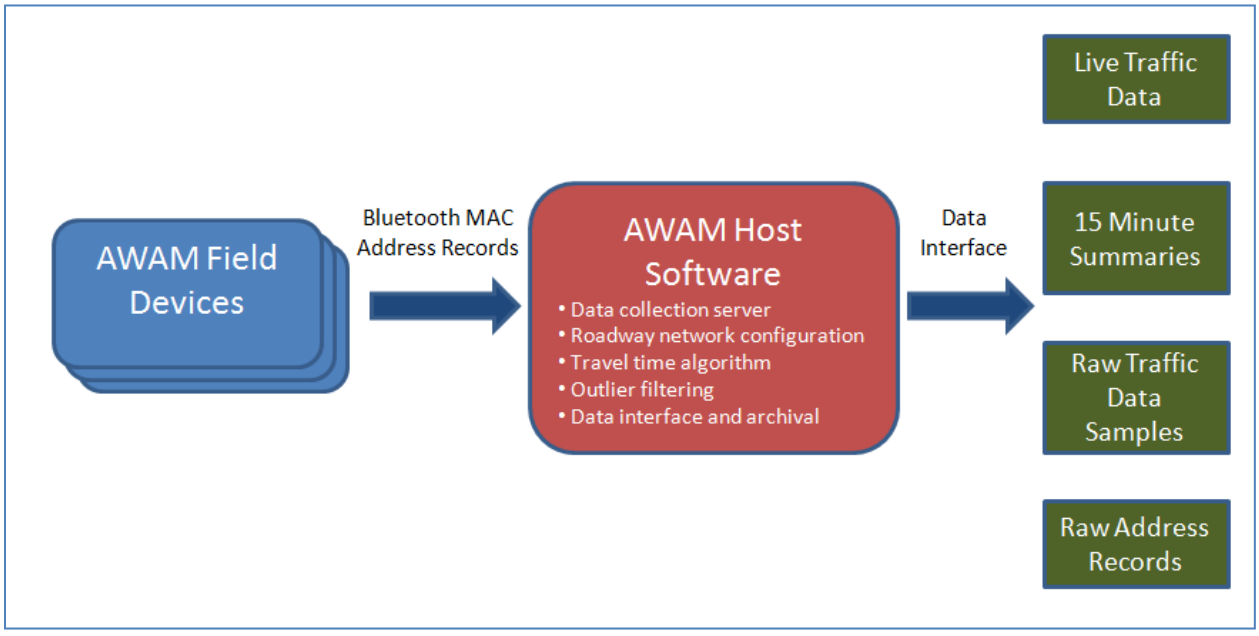
The Anonymous Wireless Address Matching (AWAM) Host software component accepts wireless address data in real-time from AWAM device readers and estimates travel times and speeds between configured roadway segments. The AWAM Host enables data from a network of AWAM device readers to be collected, processed, and stored at a central location. The basic functions of the AWAM Host are as follows:

1) Accept address data from each of the AWAM field devices via a standard network protocol.
2) Allow users to configure a network of AWAM field devices for creating travel time segments on a roadway.

3) Apply the proper algorithms for estimating the travel times between configured roadway segments as defined by the AWAM field device locations.
4) Apply filtering algorithms to travel time data samples and averages so that "outlier" data are not included in travel time estimations.
5) Create various output interfaces so that external applications can utilize the travel time and speed data generated by the software component.

When used with a network of device readers, the AWAM Host allows users to operate a robust system for collecting and processing travel time and speed data on a roadway network. Output generated from the AWAM Host can be used for traffic management, traveler information, planning, and origin-destination studies. With its rich data interfaces, the AWAM Host was designed with the intention of providing customers with an easy path to integration into their existing infrastructure. Additionally, the system design makes it easy for customers to develop their own interfaces and applications to enhance system management and monitoring.

Figure 2. AWAM Host Data Flow and Output.



Installation

Requirements

The AWAM Host software requires a Microsoft Windows operating system with the Microsoft Windows .NET Framework 3.5 or higher installed. Note that for the web-based charting interface (not described in this document), a Windows operating system with Internet Information Services 6.0 or 7.0 is also preferred. The software requires network accessibility between itself and the AWAM field devices. It hosts a User Datagram (UDP) socket interface for collecting data from the AWAM field devices. **You may need administrative or elevated rights to configure and run the program and configure the machine firewall.**

Files

The AWAM Host software runs on the Windows platform and can be run as a Windows service application or on the console for debugging purposes. The following files are included in the installation package and are required for operations.

Table 1. AWAM Host Software Package Contents.

File	Description
BluetoothHost.exe	The executable file for running the AWAM Host process.
AWAM Bluetooth Host Manager.exe	The executable file for running the graphical user interface for managing the AWAM Host process configuration.
AWAMReport.exe	The executable file required for running offline reports.
BluetoothHost.exe.config	The XML-based configuration file for controlling the AWAM Host process.
Bluetooth_segment_config.xml	The XML-based configuration file for defining the AWAM field device network.
Bluetooth_alert_config.xml	The XML-based configuration file for defining email based alerts for timely notification of AWAM field device outages.
Awam_route_config.xml	The XML-based configuration file for defining routes to calculate traffic data on.
AWAMCommon.DLL	Resource file necessary for the system to function.
BluetoothHostConsole.bat	Shortcut for executing the Bluetooth Host process on the console window.

Quick Installation Overview

1) Execute the installation package.

2) Configure the program settings using the AWAM Bluetooth Host Manager Interface.

3) Setup the roadway segments for monitoring using the AWAM Bluetooth Host Manager Interface.

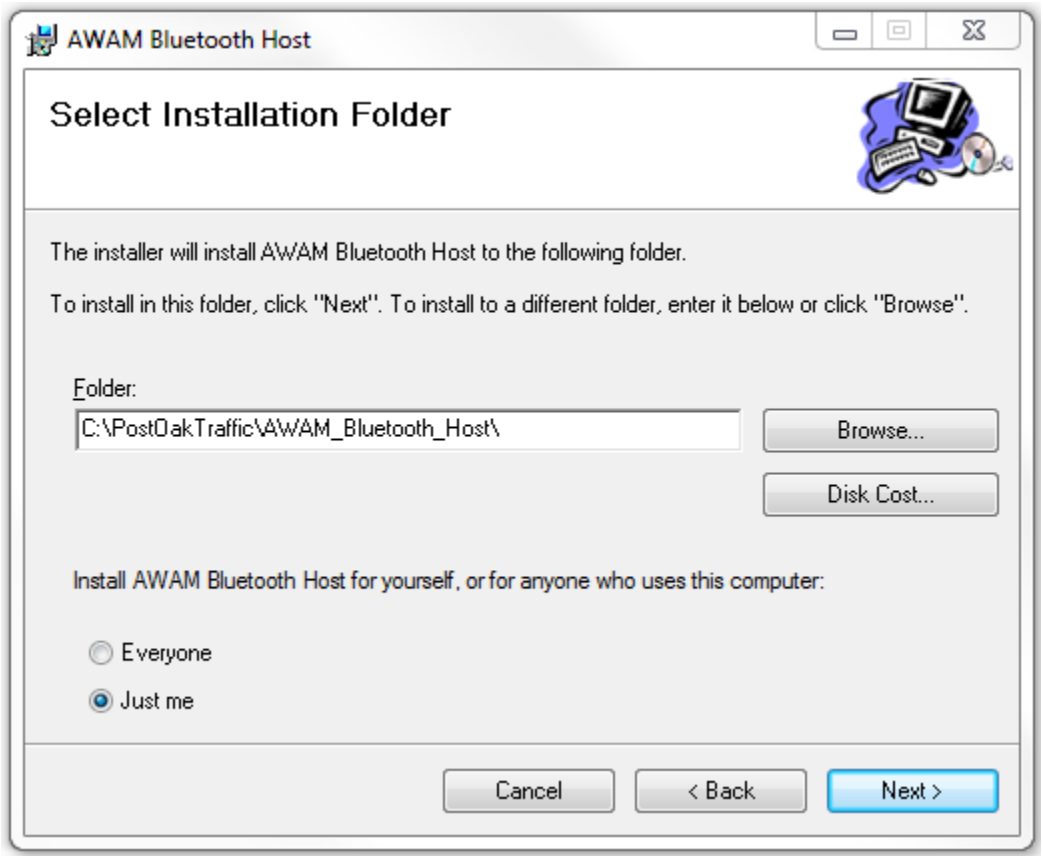
4) Setup device monitoring using the AWAM Bluetooth Host Manager Interface.

5) Configure the host process to run as a Windows service or on the console.

Detailed Step-By-Step Installation and Initial Configuration

Execute the installation package *AWAM Bluetooth Host Installer.msi* to begin the installation. The default installation directory is *C:\PostOakTraffic\AWAM_Bluetooth_Host*. Change the directory in the textbox to install the program files to a different location.

Figure 3. Software Installation Dialog.



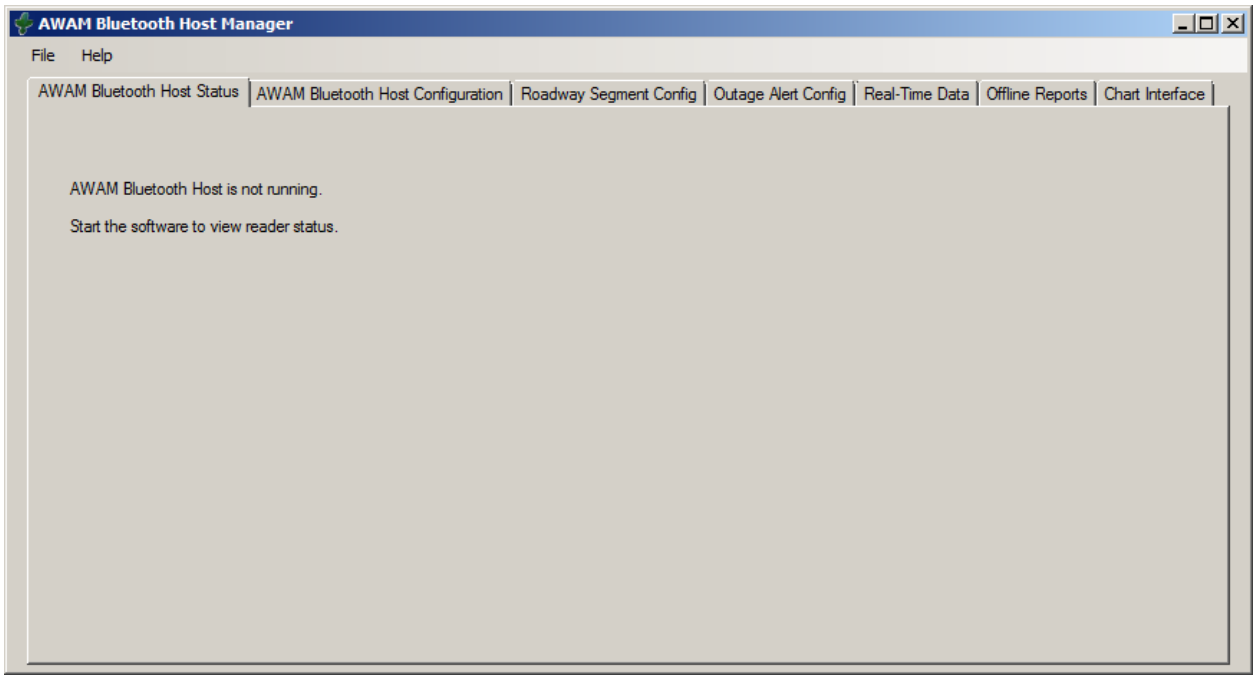
After this step is completed, the files listed in Table 1 will be installed in the directory you specified.

AWAM Bluetooth Host Manager Interface

Configuration of the AWAM Bluetooth Host process is controlled by the AWAM Bluetooth Host Manager graphical user interface. The AWAM Bluetooth Host Manager allows users to manage the configuration settings for the Bluetooth Host Process including program settings and roadway network configuration. The AWAM Bluetooth Host Manager can be used while the host software is already running to make changes to the configuration. Most setting changes will not require you restart the host software, however the AWAM Bluetooth Host Manager will notify you if this is necessary.

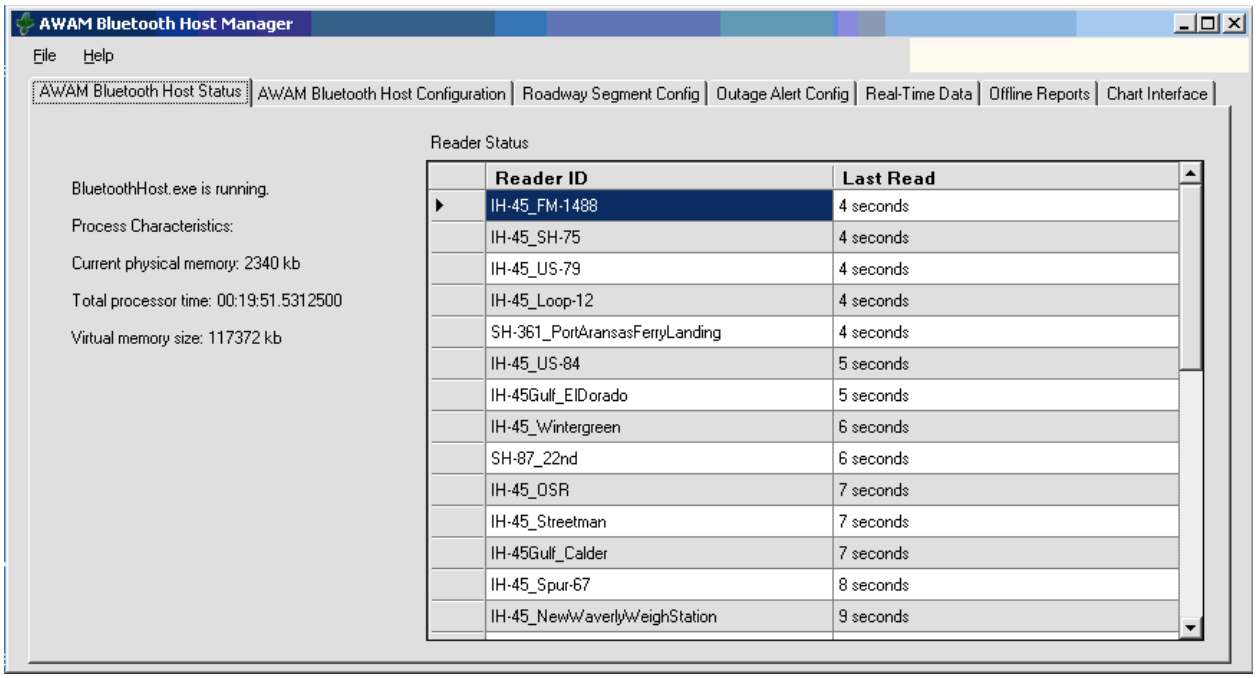
To begin configuring the AWAM Bluetooth Host, execute the AWAM Bluetooth Host Manager. Initially, before the system is configured, you will see a window similar to the one in Figure 4.

Figure 4. AWAM Bluetooth Host Manager.



When the AWAM Bluetooth Host is running, the Host Status screen includes diagnostic information about the host process as well as the last time each reader communicated with the Bluetooth Host. An example of this screen is shown in Figure 5.

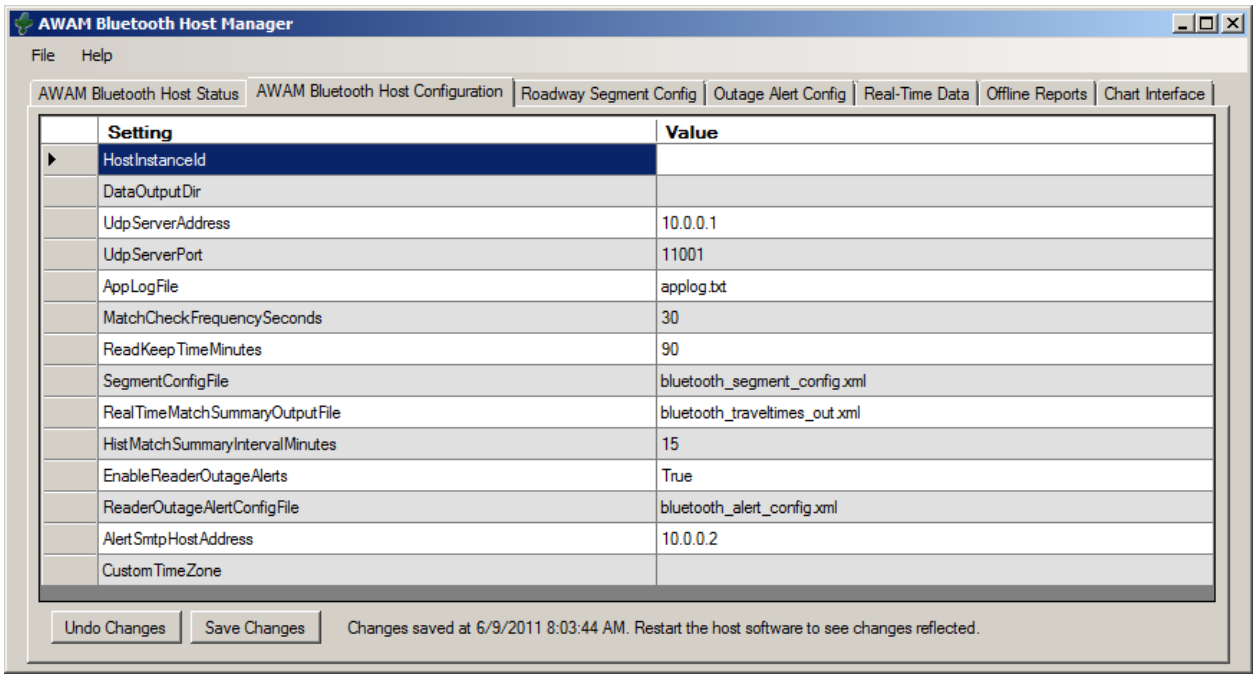
Figure 5. AWAM Bluetooth Host Manager With Reader Statuses.



AWAM Bluetooth Host Configuration

To begin configuration of the Bluetooth Host software, click on the AWAM Bluetooth Host Configuration tab along the menu at the top of the screen. You will see a screen similar to the one in Figure 6.

Figure 6. AWAM Bluetooth Host Configuration.



This form controls the program settings for the AWAM Bluetooth Host. Settings are listed on the left and their corresponding values are listed on the right. Each value will need to be configured for your environment. When you have completed the configuration, click the *Save Changes* button to save it. A list and description of each setting is shown in Table 2.

Table 2. AWAM Host Configuration Variables.

Setting	Data Type	Description
HostInstanceId	String	Text that uniquely identifies the user defined name of the instance of the AWAM Host. The name could refer to the geographic location of the region being served by the host—for example, *Houston*. The default value is an *empty string*.
DataOutputDir	String	The path to the output that will be generated by the AWAM Bluetooth Host including travel time and speed output files. The default value is an *empty string*.

UdpServerAddress	String	The IP address of the machine hosting the UDP socket for collecting data from the AWAM field software. The default value is *10.0.0.1*.
UdpServerPort	Integer	The numeric port of the UDP socket used for collecting data from the AWAM field software. The default value is *11001*.
AppLogFile	String	The path to the application log file. The application log file will log all diagnostic information output by the program. The default value is *applog.txt.* If running as a Windows service, the full path to this file should be entered here in order for it to be referenced correctly.
MatchCheckFrequencySeconds	Integer	The time in seconds that the software checks for new potential travel time and speed matches. The default value is *30.*
ReadKeepTimeMinutes	Integer	The time in minutes that the software stores each collected address in memory in order to search for travel time and speed matches. The time limit in this setting will be the maximum length of a travel time on a configured roadway segment. The default value is *90*.
SegmentConfigFile	String	The path to the roadway segment configuration file for defining the roadway network being monitored. The default value is *bluetooth_segment_config.xml.* If running as a Windows service, the full path to this file should be entered here in order for it to be referenced correctly.
RealTimeMatchSummaryOutputFile	String	The name of the XML file that will contain the real-time summary outputs from the software. The default value is

<table>
<tr><td></td><td></td><td>bluetooth_traveltimes_out.xml</td></tr>
<tr><td>HistMatchSummaryIntervalMinutes</td><td>Integer</td><td>The time in minutes to summarize travel time and speed data. This setting is used in the aggregate traffic summary output file. The default value is 15.</td></tr>
<tr><td>EnableReaderOutageAlerts</td><td>Boolean</td><td>True or False value that specifies whether to send reader outage alert emails. The default value is True.</td></tr>
<tr><td>ReaderOutageAlertConfigFile</td><td>String</td><td>The path to the file that contains the reader outage alert configuration. The default value is bluetooth_alert_config.xml. If running as a Windows service, the full path to this file should be entered here in order for it to be referenced correctly.</td></tr>
<tr><td>AlertSmtpHostAddress</td><td>String</td><td>The IP address of the SMTP server used for sending reader outage alert emails. The default value is 10.0.0.2.</td></tr>
<tr><td>CustomTimeZone</td><td>String</td><td>The named time zone of the roadway network being monitored. US and Canadian time zone strings are listed below.

<table>
<tr><th>Time Zone</th><th>String</th></tr>
<tr><td>Eastern Standard Time</td><td>(GMT-05:00) Eastern Time (US and Canada)</td></tr>
<tr><td>US Eastern Standard Time</td><td>(GMT-05:00) Indiana (East)</td></tr>
<tr><td>Central Standard Time</td><td>(GMT-06:00) Central Time (US and Canada)</td></tr>
<tr><td>Mountain Standard Time</td><td>(GMT-07:00) Mountain Time (US and Canada)</td></tr>
<tr><td>US Mountain Standard Time</td><td>(GMT-07:00) Arizona</td></tr>
<tr><td>Pacific Standard Time</td><td>(GMT-08:00) Pacific Time (US and Canada)</td></tr>
</table>

If this is left blank, the time zone of the</td></tr>
</table>

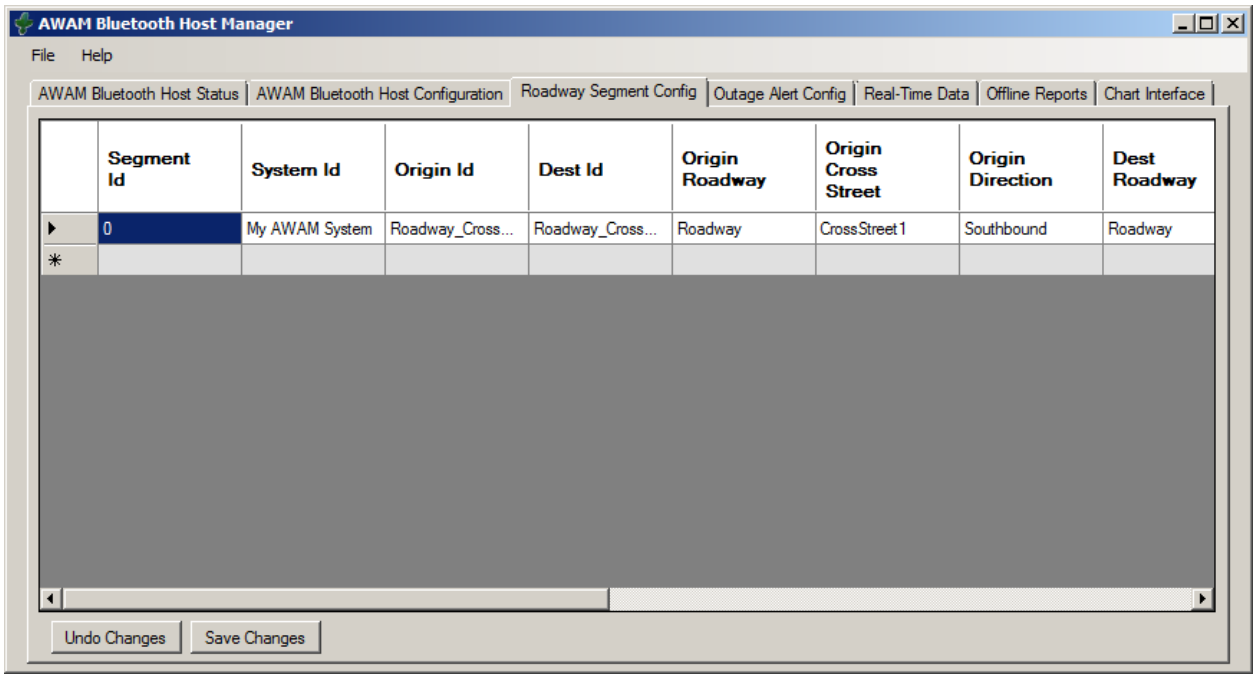
		machine running the software will be used. The default value is an *empty string*.
UseHostTimestamp	Boolean	True or False value that directs the host software whether or not to use the time of the host on the server to timestamp reads (offset by the *CustomTimeZone* setting above). If set to *False*, the timestamp sent by the address record is used to calculate speeds and travel times.
DistanceMeasurementUnit	String	Indicates the distance measurement unit for labeling distance and speed. Valid values are either *Miles* or *Kilometers*.
WebChartUrl	String	The URL of the web application that displays the charting interface to the data collected by the AWAM host. The default value is *http://localhost/awambluetoothweb*.
RouteConfigFile	String	The path to the configuration file for defining the routes being monitored. Routes consist of multiple segments for estimating traffic flow on. The default value is *awam_route_config.xml.* If running as a Windows service, the full path to this file should be entered here in order for it to be referenced correctly.
RouteTravelTimeOutputFile	String	The name of the XML file that will contain the real-time route summary outputs from the software based on the routes defined in the RouteConfigFile. The default value is *awam_route_traveltimes_out.xml*
LicenseKey	String	String containing the license key for the host software instance.

After the correct settings are in place and the appropriate firewalls are configured, the program is ready to accept address data from the field devices.

Roadway Segment Configuration

The AWAM Bluetooth Host software collects traffic data from multiple device reader stations on a roadway network. In order to estimate travel times and speeds on a roadway segment, the AWAM Bluetooth Host must be configured to match device reads between a pair of device readers. The roadway segments are defined in the XML file with the SegmentConfigFile attribute in the application configuration file. However, by clicking on the Roadway Segment Config tab, the AWAM Bluetooth Host Manager allows users to manage the settings in this file as shown in Figure 7.

Figure 7. Roadway Segment Configuration.



To collect travel time and speed data, each roadway segment's attributes will need to be entered into this form. For instance, to collect data between readers with IDs *Reader1* and *Reader2*, enter the appropriate attributes for both readers as a single record. All travel time and speed output generated by the AWAM Bluetooth Host Software is based on the information entered into this form. When you have finished entering the roadway segments into the form, click the *Save Changes* button to save them. A list of each of the form elements is listed in Table 3.

Table 3. Roadway Segment Configuration File Elements.

Element Name	Data Type	Description
Segment Id	String	An identifier given to the configured roadway segment to distinguish it from other segments. This element is not used in the AWAM Host software other than to allow the output

		to uniquely identify a segment.
System Id	String	An identifier given to the system of the roadway network being monitored. This allows a single instance of the AWAM Host to collect data from multiple, geographically separated roadway networks. This element is not used in the AWAM Host software other than to allow the output to uniquely identify a monitored roadway network.
Origin Id	String	The identifier assigned on the AWAM field device that uniquely identifies the origin location of the field device. This is used in combination with the dest_id element to determine travel times and speeds.
Dest Id	String	The identifier assigned on the AWAM field device that uniquely identifies the destination location of the field device. This is used in combination with the origin_id element to determine travel times and speeds.
Origin Roadway	String	The name of the roadway being monitored by the AWAM system at the location of the origin field device.
Origin Cross Street	String	The name of the closest cross street on the roadway being monitored by the origin field device.
Origin DIrection	String	The direction of roadway being monitored by the AWAM system at the location of the origin field device. For example, *Northbound*, *Southbound*, *Eastbound*, *Westbound.*
Dest Roadway	String	The name of the roadway being monitored by the AWAM system at the location of the destination field device.
Dest Cross Street	String	The name of the closest cross street on the roadway being monitored by the destination field device.
Dest Direction	String	The direction of roadway being monitored by the AWAM system at the location of the destination field device. For example, *Northbound*, *Southbound*, *Eastbound*, *Westbound.*
Segment Length (Miles)	Number	The length in miles of the roadway segment being monitored. For accuracy in calculations, the number should be rounded to the nearest tenth at a minimum. Greater precision is recommended.
Rolling Avg Minutes	Number	The time in minutes that the AWAM Host software should go back in time when determining the current average speeds and travel times for a roadway segment.
Max Segment Speed MPH	Number	The maximum speed that can be estimated on a roadway segment. Speeds greater than this will be considered erroneous and omitted by the filter.
Min Segment Speed MPH	Number	The minimum speed that can be estimated on a roadway segment. Speeds less than this will be considered erroneous and omitted by the filter.
Map Display	Boolean (true/false)	This is a flag that tells other programs whether to draw the roadway segment on a map. This element is not used in the

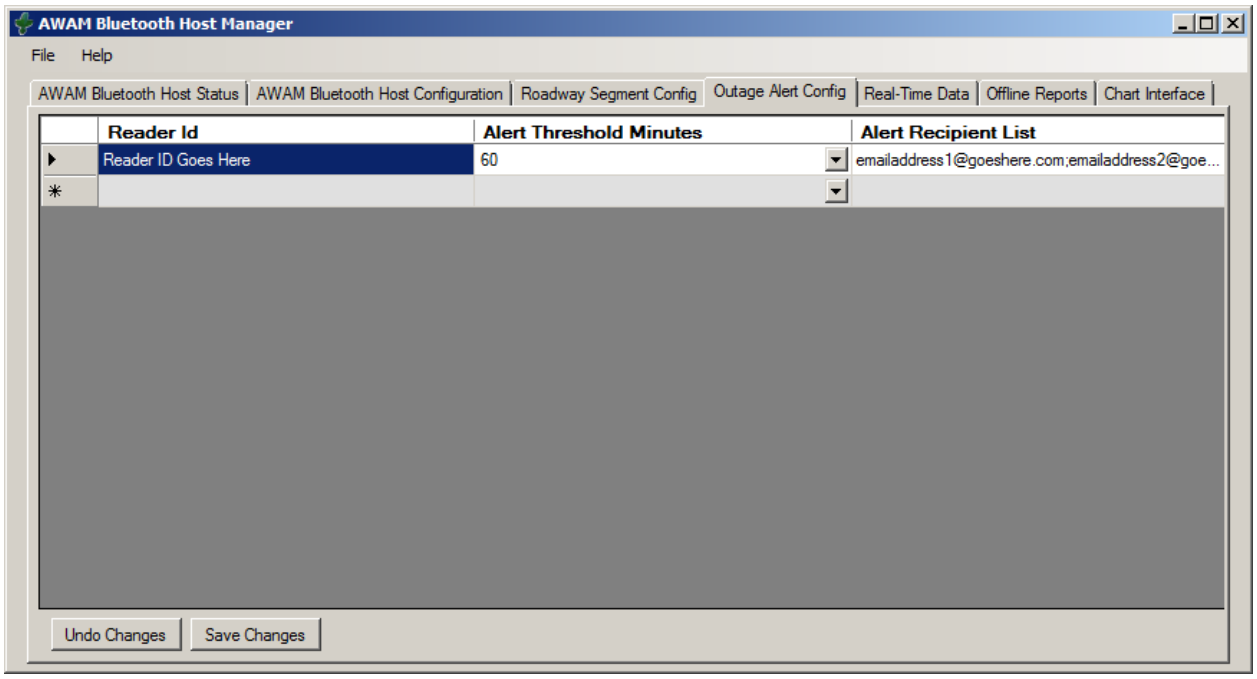
<table>
<tr><td></td><td></td><td>AWAM Host software other than to allow the output to contain the value.</td></tr>
<tr><td>Match Filter Id</td><td>Number</td><td>A value that represents the code for the algorithm to be used for determining outlier data and thus estimating travel times and speeds on a roadway segment. Valid values are:

<table><tr><th>Value</th><th>Description</th></tr><tr><td>25</td><td>Each new traffic data sample must be within +/- 25% of the previous sample's travel time.</td></tr><tr><td>45</td><td>Each new traffic data sample must be within +/- 45% of the previous sample's travel time.</td></tr><tr><td>125</td><td>New traffic data samples must be within 75% of the interquartile range of the previous 15 samples.</td></tr></table>
More detail is provided in the "Flexible Algorithm Configuration" section.</td></tr>
</table>

Outage Alert Configuration

In order to provide as much uptime as possible for field detectors and to ensure that data interruptions are kept to a minimum, the AWAM Host software can be configured to send email alerts when it detects a field site not sending data for a specified period of time. To accomplish this, the AWAM Host maintains a list of the last time each detector communicates with the host. Typically, the field devices are configured to send "heartbeat" messages at a regular interval so the thresholds need to be coordinated with that interval. If the last communication time exceeds the preset threshold, the host software sends an alert, in the form of an email, to personnel specified in the system configuration. Use of this feature requires a valid Simple Mail Transport Protocol (SMTP) server accessible to the machine running the AWAM host. The outage alert thresholds can be defined in the XML file specified in the ReaderOutageAlertConfigFile attribute of the application configuration file. However, the file contents can also be managed using the AWAM Bluetooth Host Manager interface in the Outage Alert Config tab as shown in Figure 8.

Figure 8. Outage Alert Configuration.



To configure the AWAM Bluetooth Host to send email alerts when a reader doesn't communicate within a certain threshold, enter the information into the form and click the *Save Changes* button when you are done. The data elements in the outage alert configuration forms are described in Table 5.

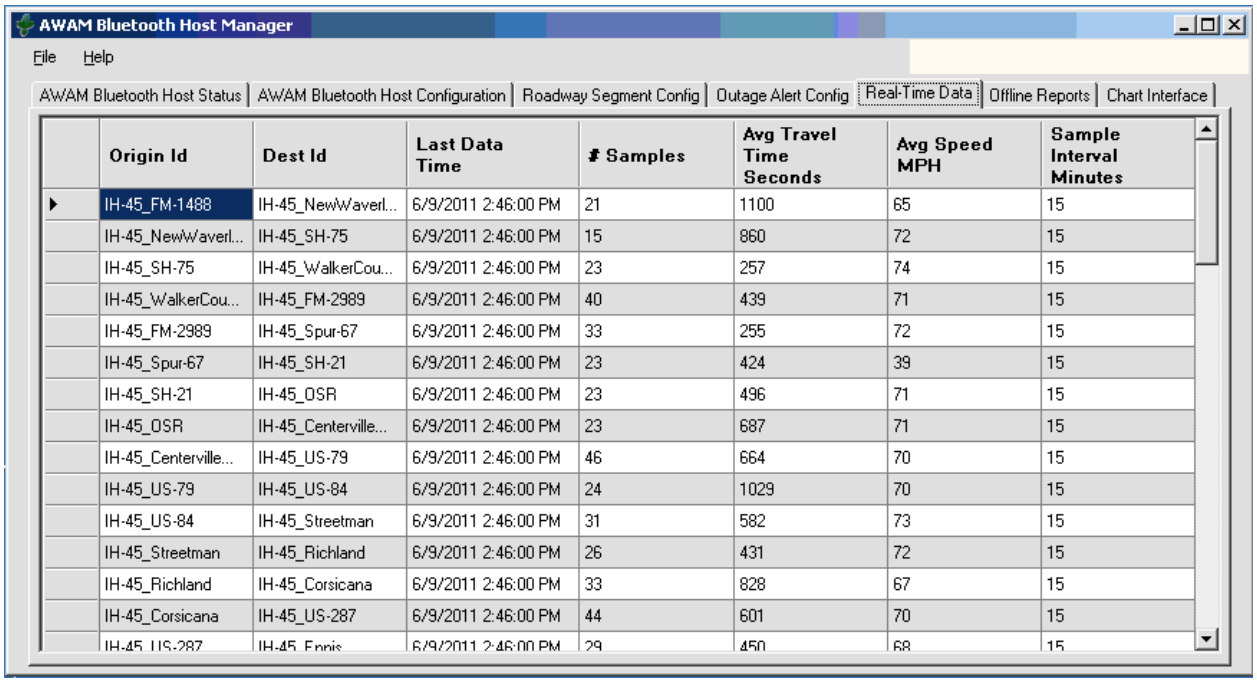
Table 4 . Reader Outage Alert Configuration File Elements.

Element Name	Data Type	Description
Reader Id	String	The identifier of the AWAM field device associated with the alert threshold.
Alert Threshold Minutes	Number	A number specifying the total number of minutes that must occur without receiving a message from an AWAM reader before sending out an alert.
Alert Recipient List	String	The email addresses of the recipients that should receive the alerts. Multiple addresses can be delimited by semicolons.

Real-Time Data View

The Real-Time Data tab is a read-only form that allows you to view the real-time speed and travel time data being collected by the AWAM Bluetooth Host. The Real-Time Data form is shown in Figure 9.

Figure 9. Real-Time Data View.



Origin Id	Dest Id	Last Data Time	# Samples	Avg Travel Time Seconds	Avg Speed MPH	Sample Interval Minutes
IH-45_FM-1488	IH-45_NewWaverl...	6/9/2011 2:46:00 PM	21	1100	65	15
IH-45_NewWaverl...	IH-45_SH-75	6/9/2011 2:46:00 PM	15	860	72	15
IH-45_SH-75	IH-45_WalkerCou...	6/9/2011 2:46:00 PM	23	257	74	15
IH-45_WalkerCou...	IH-45_FM-2989	6/9/2011 2:46:00 PM	40	439	71	15
IH-45_FM-2989	IH-45_Spur-67	6/9/2011 2:46:00 PM	33	255	72	15
IH-45_Spur-67	IH-45_SH-21	6/9/2011 2:46:00 PM	23	424	39	15
IH-45_SH-21	IH-45_OSR	6/9/2011 2:46:00 PM	23	496	71	15
IH-45_OSR	IH-45_Centerville...	6/9/2011 2:46:00 PM	23	687	71	15
IH-45_Centerville...	IH-45_US-79	6/9/2011 2:46:00 PM	46	664	70	15
IH-45_US-79	IH-45_US-84	6/9/2011 2:46:00 PM	24	1029	70	15
IH-45_US-84	IH-45_Streetman	6/9/2011 2:46:00 PM	31	582	73	15
IH-45_Streetman	IH-45_Richland	6/9/2011 2:46:00 PM	26	431	72	15
IH-45_Richland	IH-45_Corsicana	6/9/2011 2:46:00 PM	33	828	67	15
IH-45_Corsicana	IH-45_US-287	6/9/2011 2:46:00 PM	44	601	70	15
IH-45_US-287	IH-45_Ennis	6/9/2011 2:46:00 PM	29	450	68	15

After you have completed the configuration, you can exit from the AWAM Bluetooth Host Manager. It can be invoked at any time to change or modify the existing configuration.

Running the AWAM Bluetooth Host

Once the initial configuration is in place, the AWAM Bluetooth Host is ready to run and begin accepting MAC address data from the field readers. The AWAM Bluetooth Host is invoked by executing the BluetoothHost.exe file from the Windows command line in the directory that the software is installed in. The host can be run in one of two ways.

1) As a Windows Service application in an environment that automatically runs whenever Windows is running. If configured, this method allows the Bluetooth Host software to run without needing to have a user logged into the console.

2) As a console application. This method runs on the Windows desktop and can be used to view the MAC reads as they are being processed by the host software.

Both methods have the same functionality but differ in the way that they are invoked. Use the Windows Service method for an instance of the software that is expected to be "always on" regardless of whether a user is logged into the machine or not.

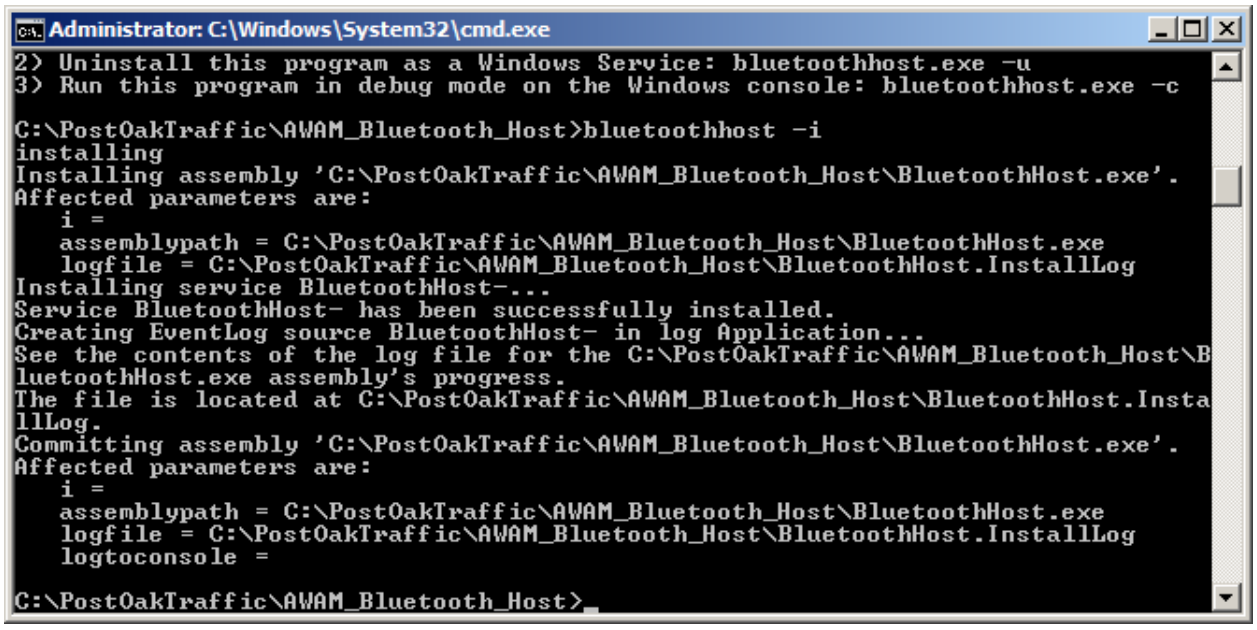
Running as a Windows Service

Initially, if you want to run the Bluetooth Host as a Windows Service, you will need to install the program as a service by executing the following command (You will need administrative rights on the command prompt to do so. This can usually be done by right clicking the cmd.exe icon and clicking "Run As Administrator").

```
bluetoothhost.exe -i
```

If the service installation is successful, you will see output similar to what is shown in Figure 10.

Figure 10. Windows Service Installation.



Once the program is installed as a service, you can manage its operations using the Windows Services Management Console which can be invoked using the command *services.msc*. The AWAM Bluetooth Host Service is installed with the name "Bluetooth Host". Right clicking on the service and selecting *Properties* allows you to control how Windows runs the service including choosing when the program starts and which account to use to run it.

To uninstall the AWAM Bluetooth Host service, execute the following command from a command prompt with administrative rights.

```
bluetoothhost -u
```

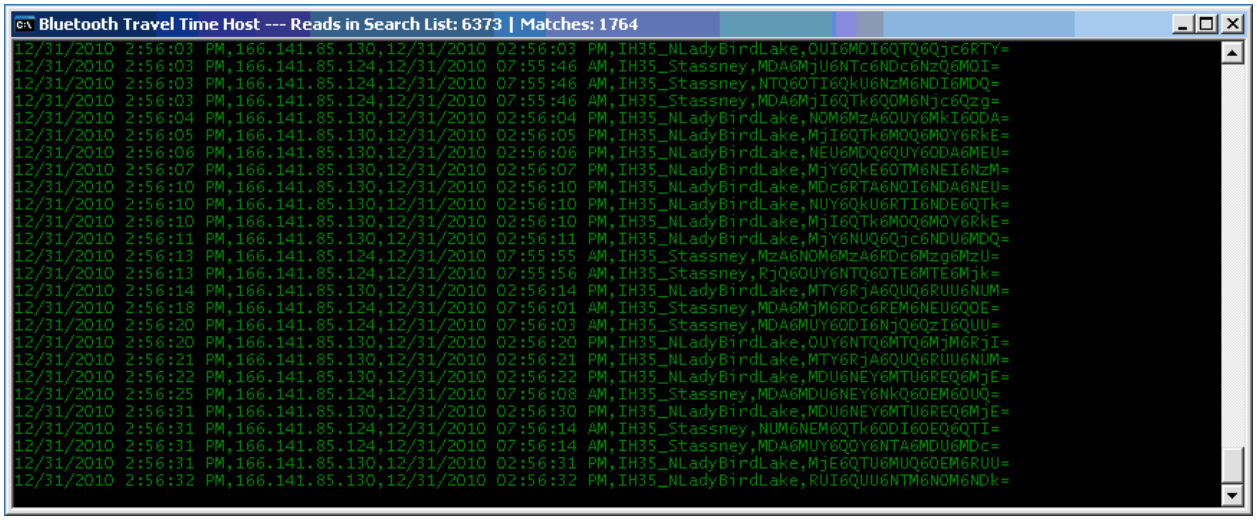
Running On the Console Window

By executing in console mode, all program output, including device reads and diagnostic messages, will be displayed on the AWAM Bluetooth Host console window. The console can be used for validating program operations, troubleshooting, and verifying reception of device reads from field units. To execute the program on the console, execute the following command from the command prompt.

```
bluetoothhost.exe –c
```

An example of the Bluetooth Host running on the console is shown in Figure 11.

Figure 11. AWAM Host Console.



Device Time Synchronization

Controlled by the UseHostTimestamp setting, by default, the AWAM host software timestamps each packet received with its current time. This is done to avoid having to coordinate time synchronization among all field devices. Using this method assumes that there is minimal delay (less than a second) between the time the packet is sent in the field and the time the packet is received by the host.

In an environment when network delay is high or unknown, it may be advantageous to utilize the timestamp placed on each packet by its respective field processor. This can be accomplished by setting the UseHostTimestamp setting to *False*.

Flexible Algorithm Configuration

The AWAM Host software incorporates algorithms to filter outlier data from the travel time calculations in order to determine the approximate average travel time over a defined period of time. Outlier filtering is necessary to identify the true average of the travel time data for a roadway segment and eliminate those matches representing longer (or shorter) than expected travel times. Since varied geometric conditions and other characteristics of roadway segments exist, the AWAM Host software allows users to specify the algorithm that is most effective in providing travel time and speed data for each individual roadway segment. A description of each algorithm is listed below.

Table 5. Filtering Algorithm Values.

Value	Description	Suggested Application
25	Each new traffic data sample must be within +/- 25% of the previous sample's travel time.	Use on roadway segments where there is little to moderate variance in travel time in the traffic stream. Most commonly used on freeway segments and arterial segments with few route deviation options and traffic signals.
45	Each new traffic data sample must be within +/- 45% of the previous sample's travel time.	Use on roadway segments where there is very little variance in travel time in the traffic stream. Most commonly used on freeway segments.
125	New traffic data samples must be within 75% of the interquartile range of the previous 15 samples.	Use on roadway segments where there is moderate to high variance in travel time in the traffic stream. Most commonly used on arterials with many route deviation options and traffic signals.

Data Interfaces and Output

The AWAM Host provides various output files that allow external applications to utilize the information provided by the system. The software provides an archival system, logging most data to files specific to individual days. Each output file is described in the sections below.

Real-Time Segment Status File

The contents of this XML-based file represent the real-time status of the current travel time and speed averages estimated by the system for each individual segment configured using the Roadway Segment Configuration tab in the user interface. The file can be used by applications looking to present the traffic data in a real-time environment such as a traffic congestion map interface. The XML elements in this file are listed in the table below.

Table 6. Real-Time Segment Status File Elements.

Element Name	Data Type	Description
system_id	String	An identifier given to the system of the roadway network being monitored. This allows a single instance of the AWAM Host to collect data from multiple, geographically separated roadway networks.
origin_id	String	The identifier assigned on the AWAM field device that uniquely identifies the origin location of the field device. This is used in combination with the dest_id element to determine travel times and speeds.
dest_id	String	The identifier assigned on the AWAM field device that uniquely identifies the destination location of the field device. This is used in combination with the origin_id element to determine travel times and speeds.
origin_roadway	String	The name of the roadway being monitored by the AWAM system at the location of the origin field device.
origin_cross_street	String	The name of the closest cross street on the roadway being monitored by the origin field device.
origin_direction	String	The direction of roadway being monitored by the AWAM system at the location of the origin field device. For example, *Northbound*, *Southbound*, *Eastbound*, *Westbound.*
dest_roadway	String	The name of the roadway being monitored by the AWAM system at the location of the destination field device.
dest_cross_street	String	The name of the closest cross street on the roadway being monitored by the destination field device.
dest_direction	String	The direction of roadway being monitored by the AWAM system at the location of the destination field device. For example, *Northbound*, *Southbound*,

		Eastbound, *Westbound.*
segment_length_miles	Number	The length in miles of the roadway segment being monitored.
timestamp	Date/Time	The time that the roadway segment was updated by the AWAM host. The format of the timestamp is *DD/MM/YYYY HH:MI:SS AM/PM*
travel_time	Number	The average travel time in seconds for the roadway segment as calculated by the AWAM host. A value of -1 indicates that no travel time data was available.
speed_mph	Number	The average speed in miles per hour for the roadway segment as calculated by the AWAM host. A value of -1 indicates that no speed data was available.
std_dev	Decimal	An attribute of *speed_mph* containing the standard deviation of the speeds that comprise of the average. This measures the average variation in the samples from the average. A value of -1 indicates that no standard deviation calculation was available.
summary_mins	Number	The interval in minutes that the averages are calculated from. For example, a value of 15 indicates the average travel times and speeds for the last 15 minutes.
summary_samples	Number	The number of individual traffic data samples included in the travel time and speed averages.
map_display	Boolean (true/false)	Flag that can be used to tell other programs whether to draw the roadway segment on a map.

Here is a sample of a real-time segment status file with a single roadway segment record expanded.

Figure 12. Real-Time Segment Status File.

```
<?xml version="1.0" encoding="UTF-8"?>
<match_summary_data distance_measurement_unit="Miles">
  - <match_summary>
        <system_id>virginia</system_id>
        <origin_id>IH-664_ArmisteadRd</origin_id>
        <dest_id>IH-664_25th</dest_id>
        <origin_roadway>IH-664</origin_roadway>
        <origin_cross_street>Armistead</origin_cross_street>
        <origin_direction>Northbound</origin_direction>
        <dest_roadway>IH-664</dest_roadway>
        <dest_cross_street>25th</dest_cross_street>
        <dest_direction>Northbound</dest_direction>
        <segment_length_miles>6.2</segment_length_miles>
        <timestamp>3/23/2012 4:36:09 PM</timestamp>
        <travel_time>463</travel_time>
        <speed_mph std_dev="8.28">48</speed_mph>
        <summary_mins>15</summary_mins>
        <summary_samples>19</summary_samples>
        <map_display>True</map_display>
    </match_summary>
  + <match_summary>
  + <match_summary>
  + <match_summary>
  + <match_summary>
  + <match_summary>
  + <match_summary>
  + <match_summary>
</match_summary_data>
```

Real-Time Route Status File

In addition to the individual segments, the AWAM host software also calculates average speeds and travel times on user defined routes, which can consist of any combination and percentage of multiple individual segments. The contents of this XML-based file represent the real-time status of the current travel time and speed averages estimated by the system for each defined route. A common use for routes would be to present a total travel time on a dynamic message sign. The XML elements in this file are listed in the table below.

Table 7. Real-Time Route Status File Elements.

Element Name	Data Type	Description
system_id	String	An identifier given to the system of the roadway network being monitored. This allows a single instance of the AWAM Host to collect data from multiple, geographically separated roadway

		networks.
route_id	String	The identifier given to the route. Typically, a descriptive element used for naming the route.
origin_roadway	String	The name of the roadway being monitored by the AWAM system at the origin location of the route.
origin_cross_street	String	The name of the closest cross street on the roadway being monitored at the origin location of the route.
origin_direction	String	The direction of roadway being monitored by the AWAM system at the origin location of the route. For example, *Northbound*, *Southbound*, *Eastbound*, *Westbound.*
dest_roadway	String	The name of the roadway being monitored by the AWAM system at the destination location of the route.
dest_cross_street	String	The name of the closest cross street on the roadway being monitored at the destination location of the route.
dest_direction	String	The direction of roadway being monitored by the AWAM system at the destination location of the route. For example, *Northbound*, *Southbound*, *Eastbound*, *Westbound.*
route_length_miles	Number	The length in miles of the route being monitored.
timestamp	Date/Time	The time that the route information was updated by the AWAM host. The format of the timestamp is *DD/MM/YYYY HH:MI:SS AM/PM*
travel_time	Number	The average travel time in seconds for the route as calculated by the AWAM host. A value of -1 indicates that no travel time data was available.
speed_mph	Number	The average speed in miles per hour for the route as calculated by the AWAM host. A value of -1 indicates that no speed data was available.
std_dev_avg	Decimal	An attribute of *speed_mph* containing the average standard deviation of the speeds that comprise of the average. This value measures the average variation in the samples collected. A value of -1 indicates that no standard deviation calculation was available.
summary_samples_avg	Number	The average number of individual traffic data samples for each segment defined in the route.
segment_report_pct	Number	The percentage of total segments reporting information for each segment configured in the route.

Here is a sample of a real-time route status file with a single route record expanded.

Figure 13. Real-Time Route Status File.

```
<?xml version="1.0" encoding="UTF-8"?>
- <route_summary_data distance_measurement_unit="Miles">
  + <route_summary>
  + <route_summary>
  - <route_summary>
      <system_id>virginia</system_id>
      <route_id>I-264 Eastbound from Downtown Tunnel to Virginia Beach</route_id>
      <origin_roadway>I-264</origin_roadway>
      <origin_cross_street>Effingham St</origin_cross_street>
      <origin_direction>Eastbound</origin_direction>
      <dest_roadway>I-264</dest_roadway>
      <dest_cross_street>Birdneck Rd</dest_cross_street>
      <dest_direction>Eastbound</dest_direction>
      <route_length_miles>18.45</route_length_miles>
      <timestamp>5/9/2013 9:57:33 AM</timestamp>
      <travel_time>1155</travel_time>
      <speed_mph std_dev_avg="2.89">58</speed_mph>
      <summary_samples_avg>6</summary_samples_avg>
      <segment_report_pct>67</segment_report_pct>
    </route_summary>
</route_summary_data>
```

Determining Data Quality

In order to assess the accuracy or fitness of the data being output by the AWAM Bluetooth Host for specific uses (for example, posting travel time messages to DMS), users should consider both the standard deviation of the speed samples and the number of samples comprising of the average. Confidence in the average should be heightened with a combination of a higher number of samples and a lower standard deviation.

AWAM Individual Address File

The AWAM individual address file contains each address record collected by the AWAM Host software. The address records alone are not traffic data but can be used to post process data by tracking individual addresses along a roadway network. The AWAM individual address record files are archived each day in the output directory location specified in DataOutputDir and are named with the following convention:

[AWAM Host Instance Name]_bt_[month-day-year].txt

The file is an ASCII comma delimited file with the following elements in this order.

Table 7. AWAM Individual Address File Elements.

Element Name	Data Type	Description
Host Read Time	Date/Time	The timestamp on the host when the address was received. By default, this is the timestamp used in travel time estimation. See the section entitled "Device Time Sychronization" for more information.
Field Device IP Address	String	The IP address of the device the record originated from.
Field Device Read Time	Date/Time	The timestamp of the field device when the address was received. By default, this is not used in travel time estimation. See the section entitled "Device Time Sychronization" for more information.
Reader Identifier	String	The identifier of the reader that the record originated from.
Device Address	String	The unique address of the device that was read by the field software. For security, this is an encoded version of the MAC address.

Here is a sample of a single record from an AWAM individual address file.

Figure 14. AWAM Individual Address File.

```
12/3/2010 12:00:00 AM,166.159.23.10,12/03/2010 12:00:12 AM,Woodway_ChimneyRock,MjU6MDA6Rjk6Mjk6NDI=
```

AWAM Individual Traffic Match File

The AWAM individual traffic match file contains each traffic data "match" generated by the host. Each match is a single traffic data record containing an individual vehicle's travel time and speed along a roadway segment. The AWAM individual traffic match files are archived each day in the output directory location specified in DataOutputDir and are named with the following convention:

[AWAM Host Instance Name]_btmatch_[month-day-year].txt

The file is an ASCII comma delimited file with the following elements in this order.

Table 8. AWAM Individual Traffic Match File Elements.

Element Name	Data Type	Description
Device Address	String	The unique address of the device that was read by the field software. For security, this is an encoded version of the MAC address.
Origin Reader Identifier	String	The identifier assigned on the AWAM field device

		that uniquely identifies the origin location of the field device.
Destination Reader Identifier	String	The identifier assigned on the AWAM field device that uniquely identifies the destination location of the field device.
Start Time	Date/Time	The time the address was read at the origin reader. The format of the timestamp is *DD/MM/YYYY HH:MI:SS AM/PM*
End Time	Date/Time	The time the address was read at the destination reader. The format of the timestamp is *DD/MM/YYYY HH:MI:SS AM/PM*
Travel Time Seconds	Number	The travel time in seconds from the origin to the destination reader.
Speed Miles Per Hour	Number	The speed in miles per hour between the origin and the destination readers
Match Validity	String	Value that indicates whether the AWAM host classified the traffic data sample as being valid or invalid based on the filtering algorithm and minimum/maximum allowable speeds applied to the roadway segment. Values are *valid* or *invalid*.
Filter Identifier	Number	The numeric code of the filtering algorithm used in the outlier filter for the roadway segment. See the section under "Algorithm Configuration" for more information.

Here is a sample of a single record from an AWAM individual traffic match file.

Figure 15. AWAM Individual Traffic Match File.

```
MUU6QUU6NDk6NzQ6OTU=,Westheimer_Hillcroft,Westheimer_ChimneyRock,12/15/2010 11:57:22 PM,12/16/2010 12:00:05 AM,163,33,valid,25
```

AWAM Aggregate Traffic Summary File

The AWAM aggregate traffic summary file contains aggregate travel time and speed summaries for each roadway segment defined in the roadway segment configuration file. The aggregate summaries are calculated and output based on the setting in the HistMatchSummaryIntervalMinutes attribute of the application configuration file. The default summary interval is every 15 minutes. The AWAM aggregate traffic summary files are archived each day in the output directory location specified in DataOutputDir and are named with the following convention:

[AWAM Host Instance Name]_btsummary_[Summary Interval]_[month-day-year].txt

The file is an ASCII comma delimited file with the following elements in this order.

Table 9. AWAM Aggregate Traffic File Elements.

Element Name	Data Type	Description
Origin Reader Identifier	String	The identifier assigned on the AWAM field device that uniquely identifies the origin location of the field device.
Destination Reader Identifier	String	The identifier assigned on the AWAM field device that uniquely identifies the destination location of the field device.
Origin Roadway	String	The name of the roadway being monitored by the AWAM system at the location of the origin field device.
Origin Cross Street	String	The name of the closest cross street on the roadway being monitored by the origin field device.
Origin Direction	String	The direction of roadway being monitored by the AWAM system at the location of the origin field device. For example, *Northbound*, *Southbound*, *Eastbound*, *Westbound.*
Destination Roadway	String	The name of the roadway being monitored by the AWAM system at the location of the destination field device.
Destination Cross Street	String	The name of the closest cross street on the roadway being monitored by the destination field device.
Destination Direction	String	The direction of roadway being monitored by the AWAM system at the location of the destination field device. For example, *Northbound*, *Southbound*, *Eastbound*, *Westbound.*
Segment Length in Miles	Number	The length in miles of the roadway segment being monitored.
Timestamp	Date/Time	The time that the roadway segment was updated by the AWAM host. The format of the timestamp is *DD/MM/YYYY HH:MI:SS AM/PM*
Average Travel Time in Seconds	Number	The average travel time in seconds for the roadway segment as calculated by the AWAM host.
Average Speed in Miles Per Hour	Number	The average speed in miles per hour for the roadway segment as calculated by the AWAM host.
Summary Interval in Minutes	Number	The interval in minutes that the averages are calculated from. For example, a value of 15 indicates the average travel times and speeds for the last 15 minutes.
Number of Samples	Number	The number of individual traffic data samples included in the travel time and speed averages.

Standard Deviation	Number	The standard deviation of the speed samples included in the summary.

Here is a sample of a single record from an AWAM aggregate traffic summary file.

Figure 16. AWAM Aggregate Traffic File.

```
Main_BuffaloSpeedway,BraesmainBT,Main,Buffalo Speedway,Northbound,Main,Braesmain,Northbound,1,10/13/2010 12:00 AM,104,35,15,4,2.22
```

AWAM Aggregate Route Summary File

The AWAM aggregate route summary file contains aggregate travel time and speed summaries for each route defined in the route configuration file. Routes consist of multiple segments or portions of segments as defined in the route configuration. The aggregate summaries are calculated and output based on the setting in the HistMatchSummaryIntervalMinutes attribute of the application configuration file. The default summary interval is every 15 minutes. The AWAM aggregate route summary files are archived each day in the output directory location specified in DataOutputDir and are named with the following convention:

[AWAM Host Instance Name]_route_summary_[Summary Interval]_[month-day-year].txt

The file is an ASCII comma delimited file with the following elements in this order.

Table 10. AWAM Aggregate Route File Elements.

Element Name	Data Type	Description
Origin Roadway	String	The name of the roadway being monitored by the AWAM system at the origin location of the route.
Origin Cross Street	String	The name of the closest cross street on the roadway being monitored at the origin location of the route.
Origin Direction	String	The direction of roadway being monitored by the AWAM system at the origin location of the route. For example, *Northbound*, *Southbound*, *Eastbound*, *Westbound.*
Destination Roadway	String	The name of the roadway being monitored by the AWAM system at the destination location of the route.
Destination Cross Street	String	The name of the closest cross street on the roadway being monitored at the destination location of the route.
Destination Direction	String	The direction of roadway being monitored by the AWAM system at the destination location of the

		route. For example, *Northbound*, *Southbound*, *Eastbound*, *Westbound.*
Segment Length in Miles	Number	The length in miles of the route being monitored.
Timestamp	Date/Time	The time that the route information was updated by the AWAM host. The format of the timestamp is *DD/MM/YYYY HH:MI:SS AM/PM*
Average Travel Time in Seconds	Number	The average travel time in seconds for the route as calculated by the AWAM host. A value of -1 indicates that no travel time data was available.
Average Speed in Miles Per Hour	Number	The average speed in miles per hour for the route as calculated by the AWAM host. A value of -1 indicates that no speed data was available.
Number of Samples	Number	The average number of individual traffic data samples for each segment defined in the route.
Standard Deviation	Number	The average standard deviation of the speeds that comprise of the average. This value measures the average variation in the samples collected. A value of -1 indicates that no standard deviation calculation was available.
Percent of Segments Reporting	Number	The percentage of total segments reporting information for each segment configured in the route.

Here is a sample of a single record from an AWAM aggregate route summary file.

Figure 17. AWAM Aggregate Traffic File.

```
I-264,I-64,Eastbound,I-264,Birdneck Rd,Eastbound,13.57,4/29/2013 12:00 AM,810,60,1,2.36,67
```

AWAM Reader Status File

The AWAM Reader Status file is an XML based file that contains the network address of each AWAM reader defined in the host software. Each record also contains the timestamp of the last time each reader reported its address to the host. Note that this file is updated in 5 minute intervals. The XML elements in this file are listed in the table below.

Table 11. AWAM Reader Status File Elements.

Element Name	Data Type	Description
reader		Records will be shown for each unique reader id defined in the roadway segment configuration, whether they are origin or destination ids.

id	String	The identifier assigned on the AWAM field device that uniquely identifies the location of the field device.
ip_address	String	The last IP address reported by the associated reader.
timestamp	Date/Time	The time that the roadway segment was updated by the AWAM host. The format of the timestamp is *DD/MM/YYYY HH:MI:SS AM/PM*

Here is a sample of several records in a reader status file.

Figure 18. AWAM Reader Status File.

```
<?xml version="1.0" encoding="utf-8" ?>
- <reader_network_addresses>
    <reader id="AldineMailRoute_Macnaughton" ip_address="10.51.40.51" update_timestamp="7/9/2013 9:01:33 AM" />
    <reader id="AldineMailRoute_Gloger" ip_address="10.51.40.67" update_timestamp="7/9/2013 9:02:14 AM" />
    <reader id="AldineMailRoute_Russ" ip_address="10.51.40.91" update_timestamp="7/9/2013 9:02:07 AM" />
```

Troubleshooting

AWAM Host is not receiving data from the AWAM field devices.

Ensure that the network firewalls on both your computer and any other network equipment allow incoming UDP traffic on the address and port specified in the UDPServerAddress and UDPServerPort settings of the application configuration file.

AWAM Host is displaying errors on startup.

Ensure that the settings in the application configuration file are valid. The AWAM Host will display the error message that pertains to the misconfigured setting.

AWAM Host is not generating any traffic matches for configured roadway segments.

Ensure that you are receiving addresses from both the origin and destination readers of the roadway segment.

AWAM Host is generating very few traffic matches for configured roadway segments.

In most environments, you can expect to match between 2-9% of the total traffic. Thus, roadways with lower traffic volumes, will collect fewer samples.

There is a wide variance in speeds and travel times on a configured roadway segment.

Many factors can influence the variance including roadway geometry, traffic patterns, and distance between field devices. For roadways with high variance, try using the more restrictive interquartile range algorithm.