

Viion Systems

Wrong Way Driver Incident Management System

Overview

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1 INTRODUCTION

1.1 OVERVIEW

Viion’s Wrong way driver detection system is used to detect when vehicles are driving in the wrong direction on highway ramps or other roads. Incidents are detected using a radar system that tracks vehicles moving in the opposite direction of traffic flow. When an incident is detected, warning beacons are activated on the road. There are also two camera units that record video segments centered on the time when the event occurred. Once the video has been recorded, the video along with other images and meta-data are sent to a central management workstation. All system components are shown below.

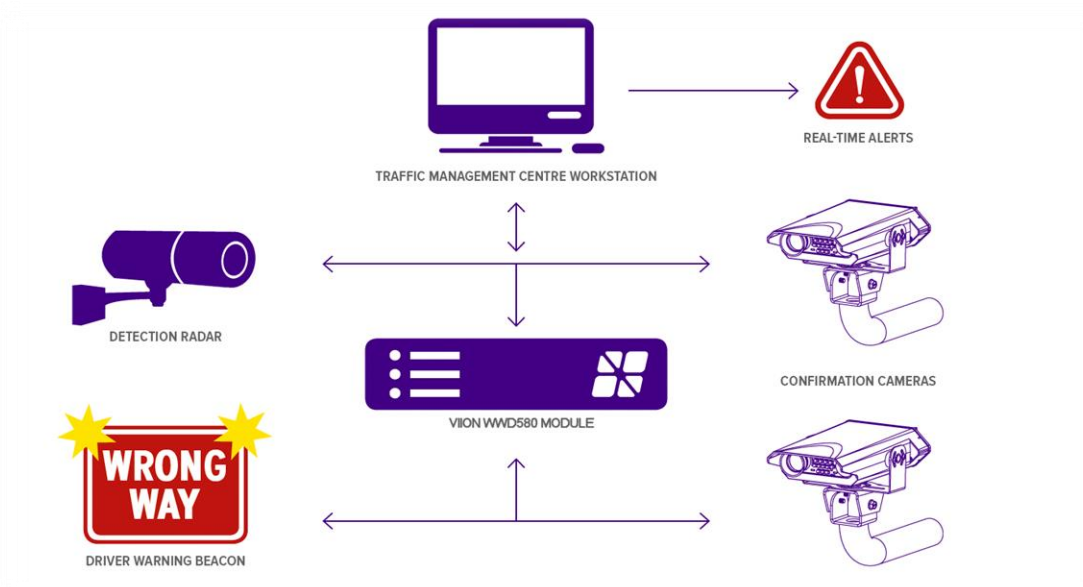


Figure 1: Wrong-way driver system components

The following summarizes each of the items shown in Figure 1.

1.2 CONFIRMATION CAMERAS

Two of these are used to record video when an event occurs. Video segments are begun some time interval before the event, and extend to sometime interval after the event. These time intervals are configurable, but we are typically recording 15 seconds before the detection event, and 15 seconds from after the event into a single .mp4 video.

Once a video has been recorded, each camera creates a .zip file (referred to as a Trigger Data Packet – or TDP) containing images, the video files, and an .xml file containing other meta-data from the event. These TDP files are then sent to the Central Traffic Management Workstation where the data is stored for review, and alarms are raised.

1.3 DETECTION RADAR

This unit generates vehicle tracking data that is used to infer when a wrong-way driver event has taken place. Tracking data is sent to the Viion WWD580 module.

1.4 WWD580 MODULE

This rack-mounted unit accepts data from the Detection radar unit and implements an algorithm to detect when an actual wrong-way driver event has occurred. If an event is detected, the WWD580 module sends messages to both Confirmation camera Units. It is also used to activate Warning Beacons that are installed beside the road-way to alarm drivers.

1.5 TRAFFIC MANAGEMENT WORKSTATION

This is a Windows based computer that is connected so that all field devices have network access. It runs a Windows service (WWD_Service) which receives data sent from all cameras and WWD580 units. This application runs a web server that is configured to receive two types of data posted from the cameras and WWD580 units.

The Traffic Management Workstation is assigned a fixed IP address of 172.29.240.11. Data is posted (via cURL) to the following two web-server addresses:

```
http:// 172.29.240.11:8082/bin/diag  
http:// 172.29.240.11:8082/bin/tdp
```

Data posted to “/diag” is diagnostic data that comes from the two cameras and from the WWD580 unit. It is used to keep track of overall system health.

Data posted to the “/tdp” location is the Trigger Data Packet data that is generated each time a wrong-way driver event is detected.

There is also a viewer application that runs on the workstation (CentralWWD.exe). This application allows one or more users to view part WWD events and to access live feeds from cameras.

1.6 IP-ADDRESSES

Note that for each install location, the following devices will all be assigned a unique fixed IP address as part of the installation process.

- Traffic Camera1
- Traffic Camera 2
- WWD580 Module
- Radar Unit

The Traffic Management Workstation will also be assigned a fixed IP address as outlined above

2 CENTRAL WWD APPLICATIONS

There are two applications running on the Traffic management Workstation. The first is a Windows service that is started each time the machine is booted (WWD_Service.exe). This service manages all data received from the field equipment. The second application (CentralWWD.exe) is a viewing tool that allows one or more users to gain access to the stored data and live feeds. All executables and data are stored in D:\Viion.

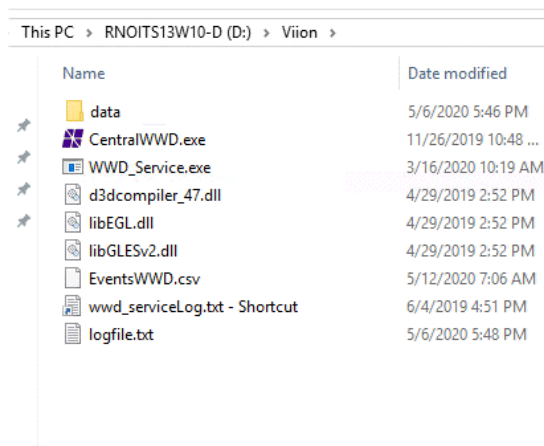


Figure 2: Contents of install folder

Inside the data folder an SQLite database (<https://www.sqlite.org/index.html>) is contains all the tables that will be used by the application. The tables will be empty following a fresh install.

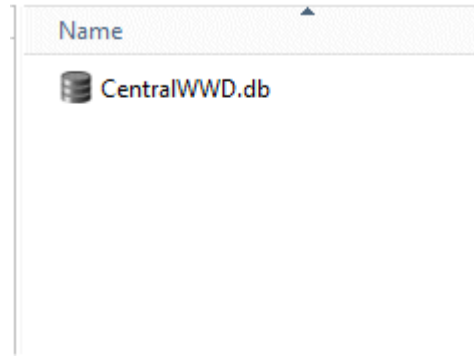


Figure 3: Contents of the data folder following installation.

2.1 DATABASE

Viion recommends installing DB Browser for SQLite (<http://sqlitebrowser.org/>) as a tool for viewing and entering data that will be used by the CentralWWD app.

2.1.1 Database Tables

The SQLite database file contains the following tables

- DevicesWWD
- DiagnosticSummary
- DiagnosticSummaryTS2
- EmailRecipients
- SettingsCentralWWD
- TriggerEvent

The details of all fields contained in these tables is provided in section 3.

2.2 TDP FOLDER

Once Trigger Data Packets (TDP) are received, a folder is created where all associated .zip files are stored. This folder is located inside the data folder shown in Figure 2 and is labeled TDP.

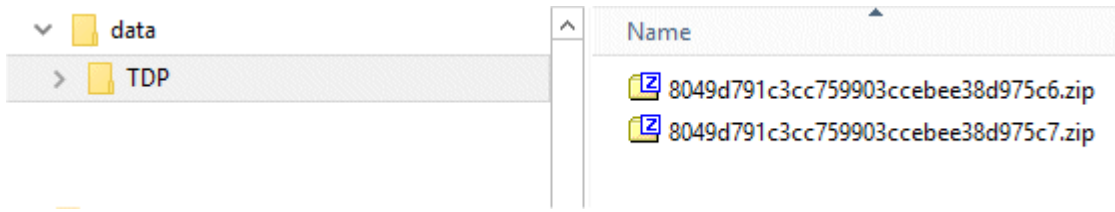


Figure 4: Trigger data packets are contained in a sub-folder (TDP) contained in the data folder.

Each Trigger Data Packet is stored as a zip archive in the TDP folder. Records for each TDP are also stored in the SQLite database in table TriggerEvent. The name of each TDP is assigned based on an MD5 hash that is stored in the reportMD5 field of this table. Some of the other fields in the TriggerEvent table are described as follows:

- cameraMacAddress – the mac address of the device where the TDP was generated
- timestamp – the Unix Epoch timestamp from when the TDP was generated
- latitude/longitude –the GPS location of the camera
- reportMD5 – the unique string that defines the .zip filename
- colorVideoFilename – the .mp4 file located within the .zip archive that is the video clip for this event.

2.3 TDP EVENT LOGGING

Each time a WWD event is detected, a record is added to a file located in the root folder named:

EventsWWD.csv

This is a standard .csv file that may be opened with Excel. The file contains data in the following form:

```
NB McCarran,2018-Dec-20 08:28:53,Camera Validated,D:\Viion\data/TDP/03164225505e807e359c94ddd65c24ed.zip,D:\Viion\data/TDP/03164225505e807e359c94ddd65c24ed.zip
SB McCarran,2018-Dec-20 10:46:36,Radar Detect,D:\Viion\data/TDP/27e6a7e7fd31d5218acc87fd3fbf338c.zip,D:\Viion\data/TDP/27e6a7e7fd31d5218acc87fd3fbf338c.zip
NB McCarran,2018-Dec-20 11:39:50,Radar Detect,D:\Viion\data/TDP/c07f3b6f3aec455521f2a561cf86c64f.zip,D:\Viion\data/TDP/c07f3b6f3aec455521f2a561cf86c64f.zip
```

The fields are from left to right as follows:

Location – the location where the event occurred

Date/time

Event Type – there are 3 event types as listed below

TDP location 1 – the path to the TriggerData Packet .zip file from Camera 1

TDP Location 2 - the path to the TriggerData Packet .zip file from Camera 2.

2.3.1 Event Types

The 3 types of events are as follows:

Button Test – this is not an actual WWD Event. Each WWD580 unit in the field has a test button that allows user to test that data is getting through to the server. If this button is pressed the event type will be recorded as Button Test.

Radar Detect – this indicates that a WWD event was detected but only by the radar unit. It was not validated by a camera unit.

Camera Validated – this indicates that a WWD event was first detected by a radar unit, and then it was confirmed by a camera. For these cases, an e-mail will be sent to a select set of recipients, and the message will contain information pertaining to the WWD event including the location, date/time, and visual information.

2.4 USER INTERFACE

The CentralWWD Application interface as the following appearance

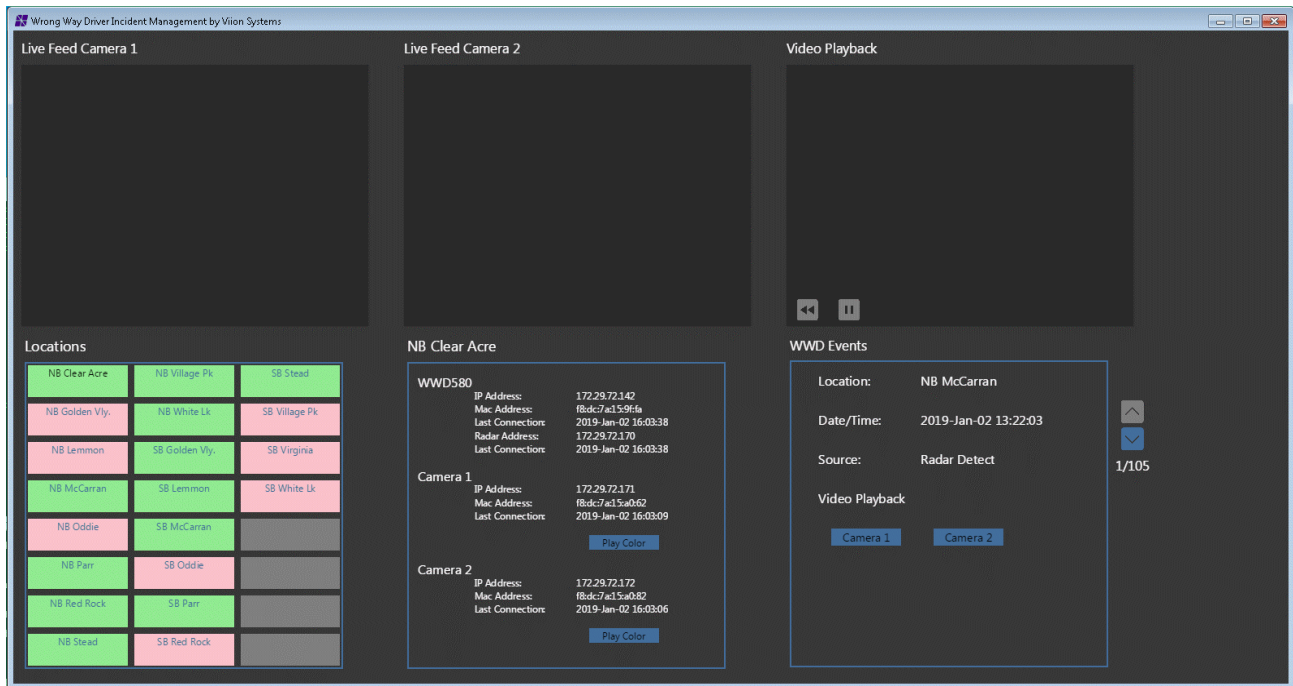


Figure 5: CentralWWD Application User Interface

The interface is divided into three columns and two rows as follows.

Live Feed Camera 1	LiveFeed Camera 2	WWD Video Playback
Locations	Location Details	WWD Event Details

The **Locations** panel of the interface has a set of coloured buttons – one for each location. Buttons colored green indicate that all equipment at that location is working correctly. Buttons that are red indicate that there may be an issue with at least one piece of equipment at that location. By pressing on a button (red or green) the details for all devices at that location are displayed in the **Location Details** panel. In the above example, we see all devices listed for the NB Clear Acre location.

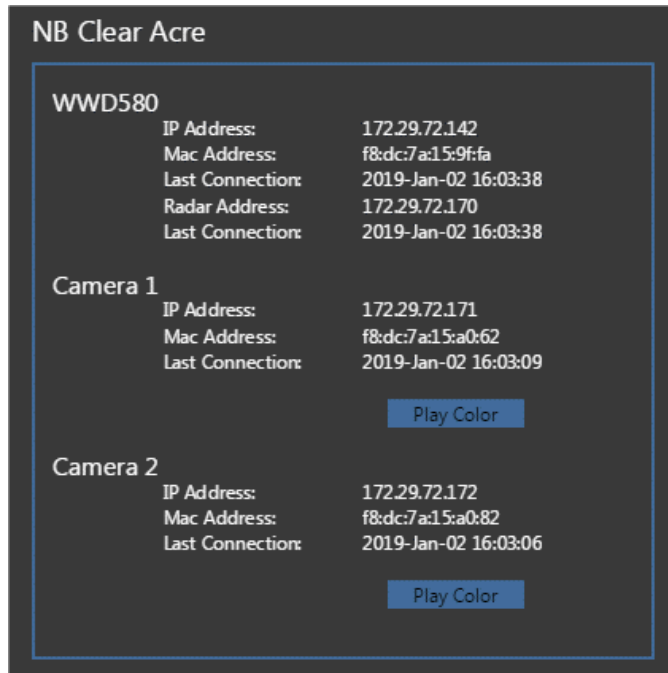


Figure 6: Location details for NB Clear Acre showing all devices healthy. The Last Connection date/time in each case is white.

There are 3 headings – WWD580, Camera 1, and Camera 2. Inside the WWD580 section, you will also find information pertaining to the Radar (MS-Sedco Intersector) unit. In the above example, all devices are working correctly as indicated by white text beside each Last Connection item. You will also find other device specific information for each unit such as its IP Address and Mac Address (for all units except the Radar units).

If a device has not checked in for some time, the Last Connection values become colored red as shown below.

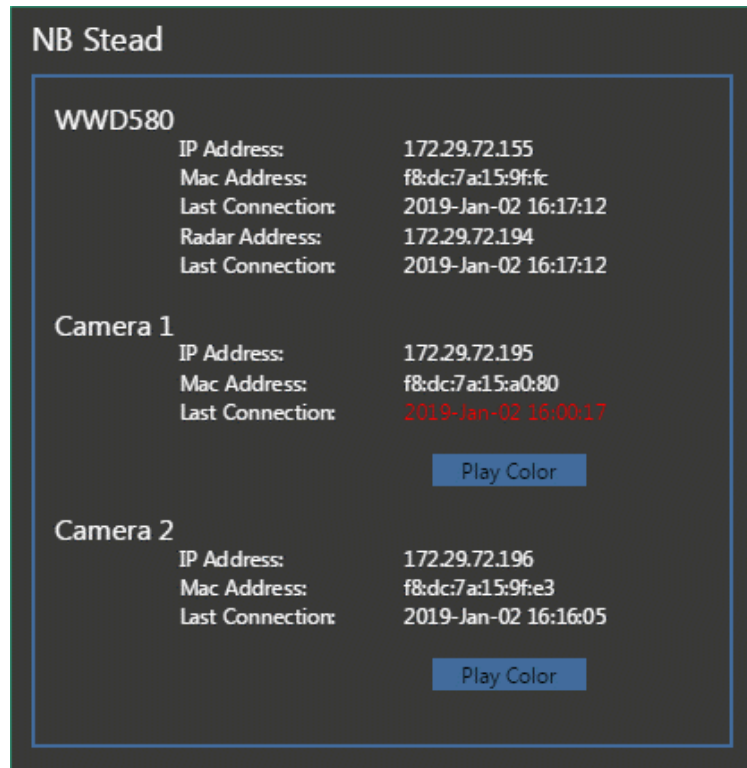


Figure 7: Location details for location NB Stead. Camera 1 has not checked in since Jan 2 at 16:00

In some cases, devices may not have ever been seen on the network. In these cases, the word **never** will appear in red as shown below.

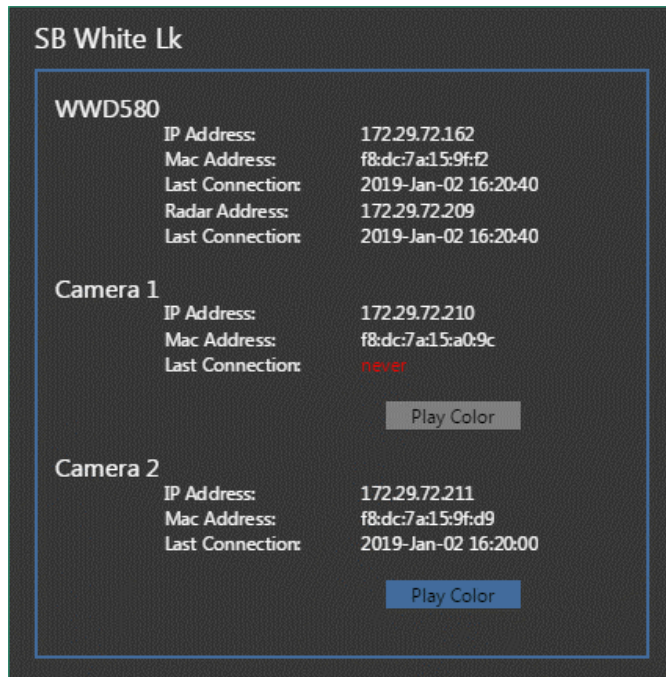


Figure 8: Location details for SB White Lake where data from Camera 1 has never been received at the server.

2.4.1 Live Feeds

To access the live feeds from a given camera, first select the Location from the colored location buttons. The Location Details will then appear in the lower central panel. Note that there are two buttons in this panel – one for playing the Color feed from camera 1, and the other for playing the feed from camera 2. These buttons are only enabled if the associated device is on-line.

When a Play Color button is pressed the corresponding feed will appear in one of the upper Live Feed camera windows. An example is shown below.



Figure 9: Live feeds from NB Clear Acre cameras 1 and 2

Note that Camera 1 is the one that is used to validate that a WWD event has taken place following an initial radar detection. It is usually facing up the ramp, and will under regular (non WWD) conditions show vehicles driving towards the camera. Camera 2 is facing down the ramp and under normal conditions will show vehicles driving away from the camera.

2.4.2 Reviewing VWWD Events

The CentralWWD interface permits the viewing of all past WWD events that have been detected. There is a set of up/down buttons with a counter located on the right-hand side as shown below.



Figure 10: Up/down buttons for navigating between previous WWD events. In this example we have selected event 1 out of 105, where 1 is the most recent, and 105 is the oldest.

These buttons are used to navigate between the various WWD events that have been recorded by the system, and the corresponding details are displayed in the WWD Event Details panel to its left.

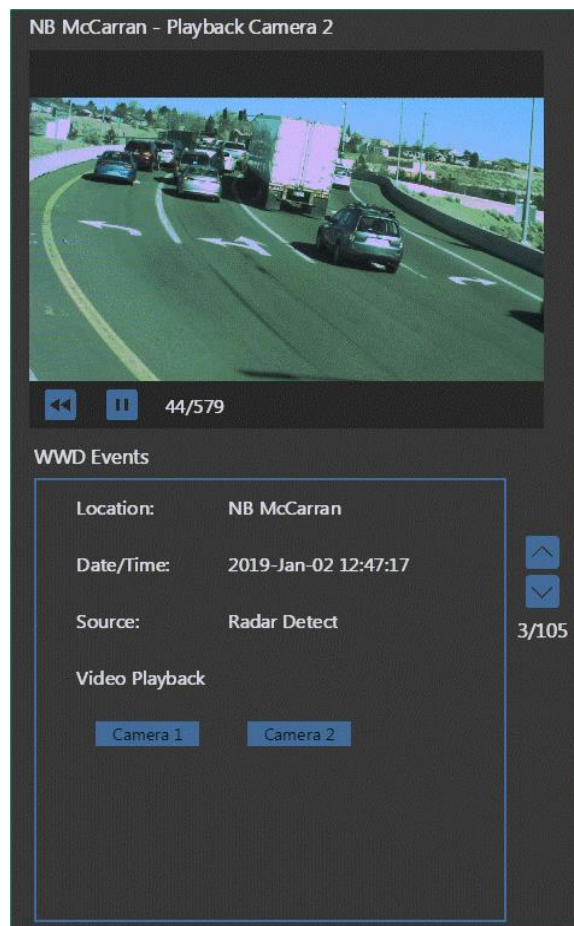
The WWD Events details panel shows that following details:

Location – where the even occurred

Date/Time – when the event occurred

Source – one of the 3 Event types outlined above (see section 2.3.1)

There is also a pair buttons under Video Playback. These are used to play the recorded videos from Cameras 1 or 2. If you press one of these, the video gets played in the upper right panel (WWD Video Playback). The example below shows a video playback for NB McCarran from Camera 2. This is an example of a situation where the radar system detected a WWD event that was not confirmed by video.



The video may be paused and re-wound to the beginning using the



Figure 11: Video playback controls for pause and rewind. the counter shows the current approximate position in the video sequence.

When a new WWD event is detected the system displays a visual alarm in the form of a red outline around the WWD events panel as shown below.

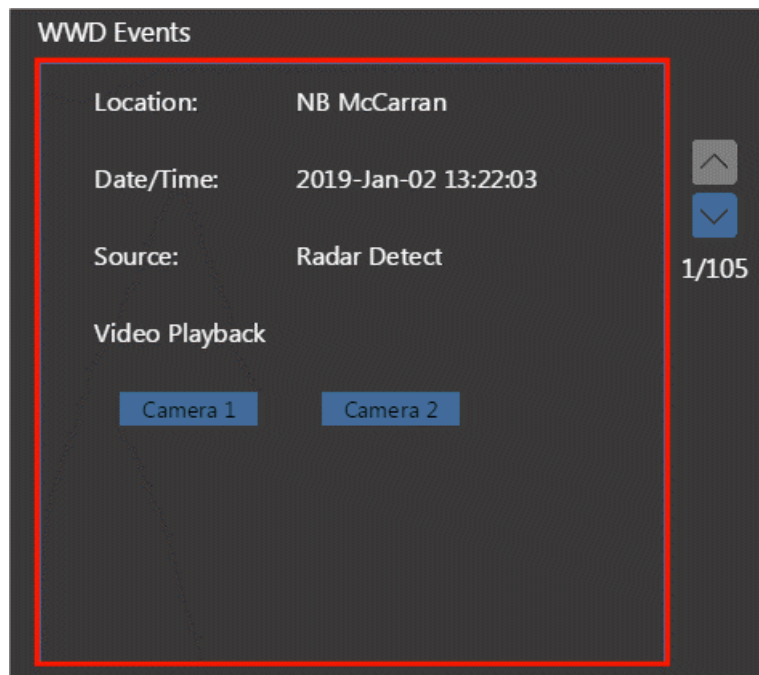


Figure 12: The WWD Events panel is highlighted in red when there is a new WWD event. Note that the counter automatically skips to the most recent record (in this case 1/105).

2.5 INSTALLING COMPONENTS

Installing the all required components on a new Windows machine is done by copying the two executables WWD_Service.exe and CentralWWD.exe into an appropriate folder where all WWD data will reside. In the following examples, we use the folder C:\ViionWWD for illustration purposes.

Install the Windows service by opening a command prompt (as administrator) and entering the following:

```
create "WWD Service" binPath= C:\ViionWWD\WWD_Service.exe
```

Following this you may edit the properties of the service through Windows Task manager, and selecting the Services tab. The WWD Service may be set to automatic start, or it may be started and stopped manually.

Once the service has run, the log file for the WWD Service may be found in

```
C:\ProgramData\Viion\wwd_serviceLog.txt
```

After first running the service, it will automatically create the “data” folder inside the root folder, and will create an empty instance of CentralWWD.db. This file may be edited or replaced as required in order to populate the devices and other tables. You will also be prompted by Windows to grant access to the service so that it may communicate with other devices on your network.

The first time that viewing app (CentralWWD.exe) is run it will automatically install a set of .dll files in the root folder, and will also begin generating a log file (logfile.txt) that will also reside in that folder.

2.6 NETWORK ACCESS PORTS

A summary of required network ports was previously provided and is summarized in Figure 13 below.

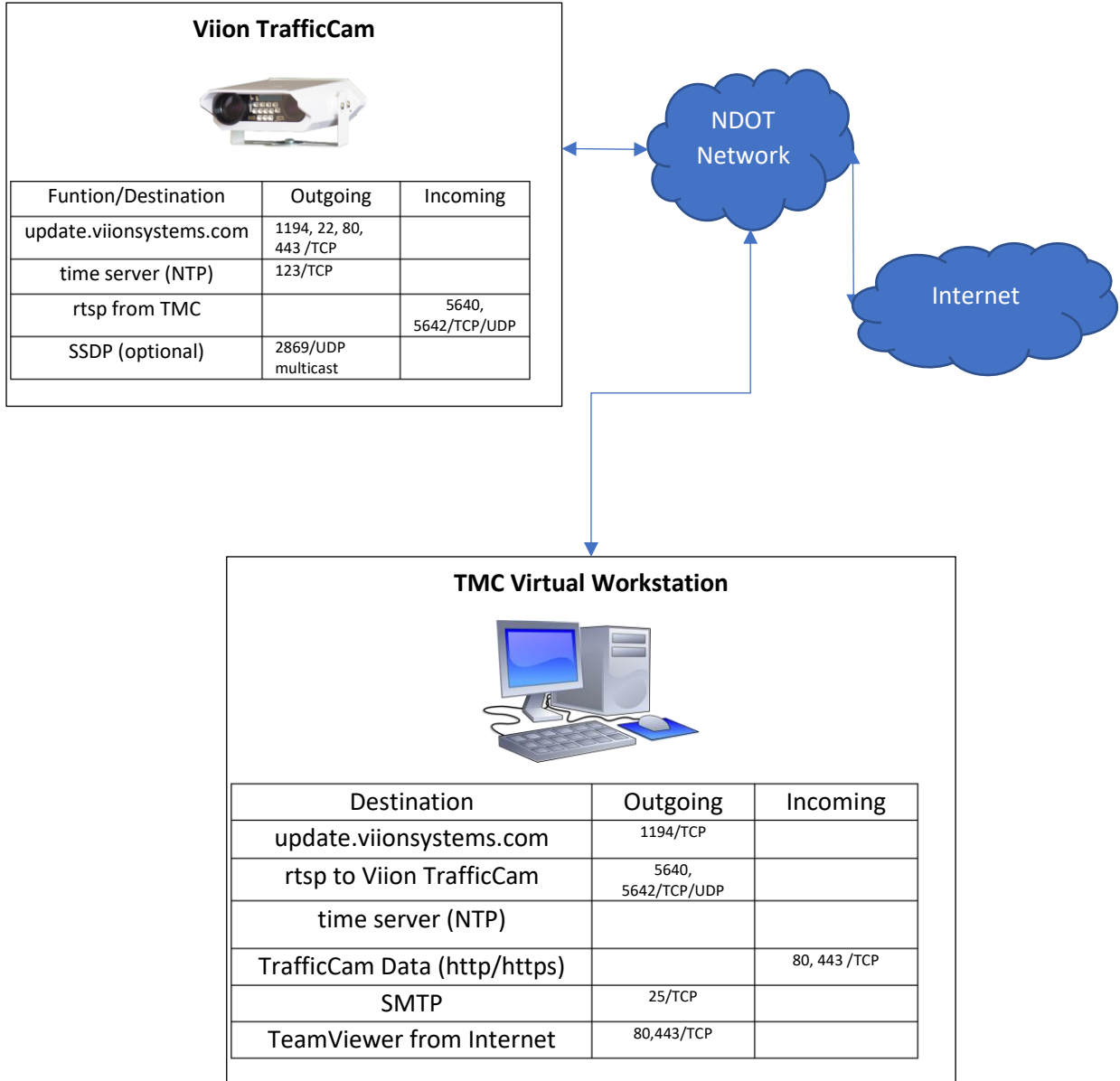


Figure 13: Port requirements

3 DATABASE DETAILS

The SQLite database file contains the following tables

- DevicesWWD
- DiagnosticSummary
- DiagnosticSummaryTS2
- EmailRecipients
- SettingsCentralWWD
- TriggerEvent

Each of these tables is described below.

3.1.1 DevicesWWD Table

This table is used to identify all field equipment, and to group equipment based on location. Some examples are given below.

Table: DevicesWWD

	id	macAddress	ipAddress	lastDiagnosticID	deviceType	location	notes
	Filter	Filter	Filter	Filter	Filter	Filter	Filter
1	7	f8:dc:7a:15:9f:ea	192.168.5.101	-1	TrafficCam1	NorthBnd Goldn Valley	none
2	8	f8:dc:7a:15:9f:e4	192.168.5.102	-1	TrafficCam2	NorthBnd Goldn Valley	none
3	27	f8:dc:7a:15:9f:f2	192.168.5.103	-1	TS2	NorthBnd Goldn Valley	none
4	49	NULL	192.168.5.104	NULL	Intersector	NorthBnd Goldn Valley	none
5	3	f8:dc:7a:15:a0:0d	192.168.5.105	-1	TrafficCam1	NorthBnd McCaren	none
6	4	f8:dc:7a:15:9f:cd	192.168.5.106	-1	TrafficCam2	NorthBnd McCaren	none
7	25	f8:dc:7a:15:9f:e9	192.168.5.107	-1	TS2	NorthBnd McCaren	none
8	50	NULL	192.168.5.108	NULL	Intersector	NorthBnd McCaren	none

Figure 14: Example of data from DevicesWWD table

The data shown in Figure 14 is given only as an example.

Each camera and WWD580 device is identified by a unique Mac address which is displayed on the outside of the device. These should be entered into the DevicesWWD table along with the fixed IP addresses that are assigned to each device. Devices are grouped by location based on the location field. Note that the Radar (Intersector) units do not have an assigned Mac address.

3.1.2 DiagnosticSummary Table


This table may be used to log diagnostic messages from camera units. It is not used under regular operating conditions.

3.1.3 DiagnosticSummaryTS2 Table

This table may be used to log diagnostic messages from WWD580 units. It is not used under regular operating conditions.

3.1.4 EmailRecipients Table

This table defines a list of all recipients who will receive e-mail messages under various conditions. An example is given below.

Table:  EmailRecipients

	id	emailAddress	groupID	notes
	Filter	Filter	Filter	Filter
1	3	ToTechDL@...	3	NULL
2	4	awolfson@d...	1	NULL
3	5	jbahmiller@...	1	NULL
4	6	crsylvester...	1	NULL
5	7	chagen@dot...	1	NULL
6	8	emacgill@d...	1	NULL
7	9	FTydeman@...	1	NULL
8	10	D1CommTe...	3	LasVegas
9	11	berlor@rtcs...	3	LasVegas
10	12	ToTechDL@...	3	LasVegas
11	13	D2CommTe...	3	NULL

Figure 15: EmailRecipients table example.

For each recipient there is an emailAddress provided along with a groupID and notes. The group ID defines when a recipient will receive an e-mail message as follows:

GroupID	Send email for events
1	Camera validated
2	Camera validated, and radar detect
3	Camera validated, radar detect, and button press (all events)

Additional recipients may be added, or other edits may be made using DB Browser for SQLite to open the database.

In the example above note that in the “notes” field there are three instances where LasVegas is included. This is a special condition that was added to accommodate a system that was installed in Las Vegas and that is getting monitored by individuals other than those monitoring the Reno systems. Recipients with LasVegas in the notes field will only get e-mails when there is an event on the Las Vegas system.

3.1.5 EventGroup Table

Each time there is an event, this table gets populated with data from the devices at that location.

Table: EventGroup New Record Delete Record

	id	eventIDcamera1	eventIDcamera2	locationName	timestamp	triggerSource	eventIDcamera3	triggerID
	Filter	Filter	Filter	Filter	Filter	Filter	Filter	Filter
91	4496	8671	8669	WB Exit 1	1584280530647	Camera Valid...	8670	1584280530
92	4497	8674	8672	WB Exit 1	1584280591245	Camera Valid...	8673	1584280589
93	4498	8676	8675	WB Garson Rd	1584282870536	Radar Detect	-1	1584282868
94	4499	8679	8678	WB Exit 1	1584285698037	Radar Detect	8677	1584285697
95	4500	8681	8680	WB Verdi	1584313311030	Radar Detect	-1	
96	4501	8683	8682	WB Verdi	1584319930588	Radar Detect	-1	
97	4502	8685	8684	WB Garson Rd	1584321655249	Radar Detect	-1	1584321654
98	4503	8687	8686	LasVegas	1584330230285	Radar Detect	-1	
99	4504	8690	8689	WB Exit 1	1584348734095	Camera Valid...	8688	1584348733
100	4505	8693	8691	WB Exit 1	1584357251025	Radar Detect	8692	1584357250
101	4506	-1	8694	WB Keystone	1584369662571	Radar Detect	-1	
102	4507	8696	8695	WB Keystone	1584369682217	Radar Detect	-1	
103	4508	8698	8697	WB McCarran	1584370546831	Radar Detect	-1	
104	4509	8701	8700	WB Exit 1	1584372276366	Camera Valid...	8699	1584372276

Figure 16: An example of data from the EventGroup table.

The first 2 field contain ids that correspond to entries in the TriggerEvent table (see below). The next 3 fields are self explanatory. The field “eventIDCamera3” is used in some cases when there is a 3rd camera in a given location. The last field TriggerID is an optional value that may be provided.

3.1.6 SettingsCentralWWD Table

This table contains a set of parameters that are used to control how the WWD service will operate. The parameters are as follows:

Parameter	Description
keepDiagnosticRecords_days	Not used
keepTdpRecords_days	Specifies the number of days that event records will be kept for. Records older than this value will be deleted.
timeZoneOffsetSec	The offset for the local time relative to UTC in seconds.
resetLiveFeedsEachEvent	Not used
resetLocationEachEvent	Not Used
resetGroupViewEachEvent	If 1 then the display will update to show the latest event
sendEmails	If 1 then send emails. If 0 then no emails sent.

smtpServer	The server that should be used for sending emails.
smtpPort	The port used for sending emails
senderAccount	The email account that messages will be sent from
senderAccountName	The sender name

3.1.7 TriggerEvent Table

This table contains a new record each time there is an event received from a camera unit. Many of the field are not relevant to this application, however, the following fields are noteworthy.

Field	Description
cameraMacAddress	Will correspond to a Mac address of one of the devices in devicesWWD
timestamp	The epoch time (in milliseconds) when the event occurred
reportMd5	A unique hash that is created for each data set and which is used to identify the TDP zip archive where the data is stored
triggerSource	One of three ways the event was triggered – either radar Detect, Camera validated, or Button Test.