

# Remote Monitoring for the Next Generation of Traffic Controllers

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## Abstract

The Motus Traffic Remote Monitoring System (Motus RMS) was developed as an extension to the Motus TM-150-2 Controller Remote Web Interface. The Linux based platform in the controller CPU allowed for the creation of Ethernet and USB Modem interfaces to access web pages for quick analysis of the health of the controller, and the state of the intersection it was operating.

Having this connectivity on the controllers it made sense for Motus to create a web site to act as a portal to all the controllers on a user's network. A key part of this strategy was to ensure that users could log into the website without any special equipment, just a smart phone, PDA, Laptop or Computer running a web browser.

The key benefits are:

- User friendly "desktop" with Google™ maps for the users network
- Log in from any location where the internet can be accessed
- Quick overview of all controllers in the users network
- Simple set-up for controller alerts and monitoring
- Virtual Server for efficient back-up and disaster recovery



**TM-150-2 Controller**

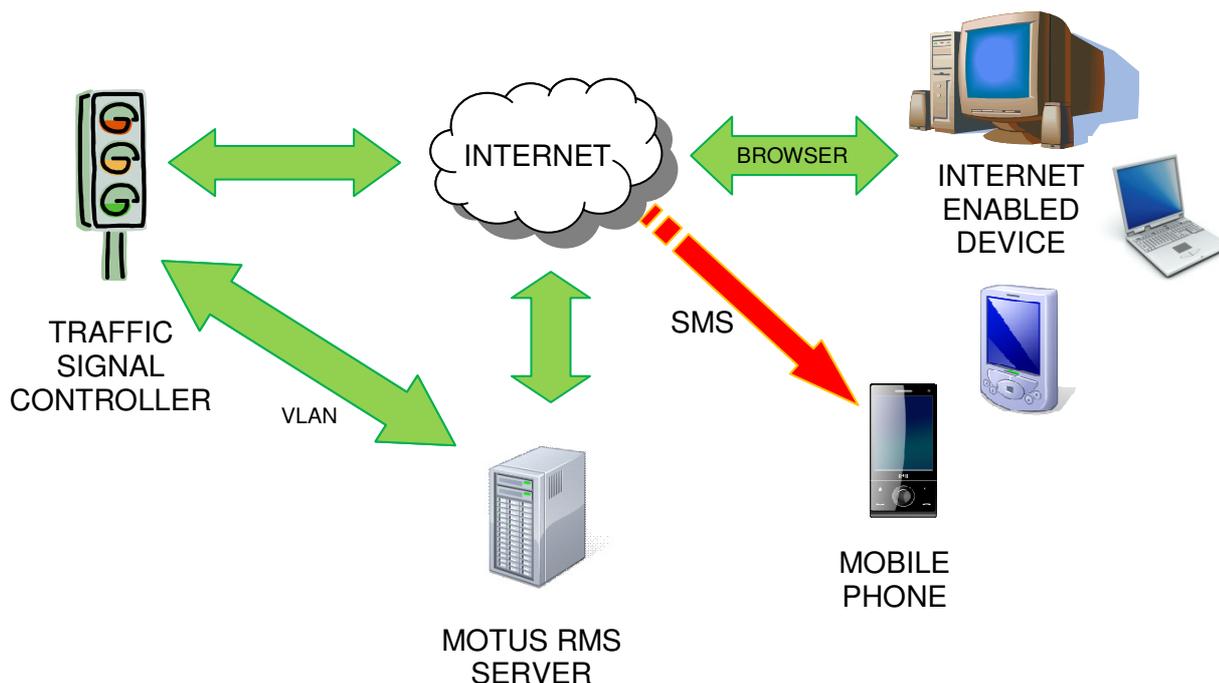
The Motus RMS gives the user two main views. A map view from Google™, with icons at the locations of all controllers in the network which change colour and shape according to controllers status. The icon can be clicked to access that controller's remote web pages. Secondly a list view is provided where controllers with faults rise to the top of the list. The controllers can be configured to send an email, text message, or both depending on the nature of the fault to a selection of contacts.

Motus are open to suggestions for future development of the controller and the Motus RMS system. Some ideas currently being explored are to make more use of the controller detector count facility, to allow some more intelligent VA logic. It would be possible for the Motus RMS to be adapted to send plan change data to the controller based on traffic counts received from the controller; this would be more flexible than simply changing max sets on a timetable.

## Introduction

The Motus RMS system is web based. Controllers simply need to be connected to a network accessible to the Motus RMS server. Currently Motus provide a SIM card, modem and aerial kit for GSM connection, utilising the Stream 3G network. Connections can be made via landline broadband with Fixed IP, via a suitable router. Connections to private networks can be made upon request.

Motus will assign each controller to the user's environment, and allocate a map icon for the controller. Motus take care of the connectivity of the controller to the network, server side, so the end user doesn't need to have any special software, or VPN accounts to connect to their controllers. If they can get to the Motus RMS web page, they can access their controllers. The general arrangement is given below:



**Motus RMS Overview**

## Basic Operation

The new Motus RMS brings an overview of the end users installed TM-150-2 controllers quickly and simply into the office. Only an internet connection is required for the user to connect. Built in a desktop like environment, end users will have no problems navigating the system. Each user has their own environment, and can only see controllers on their network.

The system is built on the widely used Google™ Maps system, with quick and simple tools provided to navigate a map or satellite image of the controller network. Each controller appears on the map with an icon, which changes colour and style according to status. Hovering over the controller icon generates a pop up window with basic controller information. Clicking on the icon takes the user directly to the controllers' integrated web interface. Controllers are also provided in a list format with non-responsive or faulty controllers always moving to the top of the list.

Alongside the mapping system is an alert system which can be configured for multiple contacts within the user environment. The RMS can send a SMS message or an email to user configurable contact details. The alert can be set up to only be active at certain times of the day or week by the user. Currently faults are categorised into Errors or Warnings. Errors are classed as those major faults that cause the signals to be

extinguished. Warnings are faults that occur but are not serious enough to cause the signals to be extinguished. An example of these would be general lamp faults or detector faults. Errors and Warnings are passed to the email or mobile number assigned to an alert contact, depending on the options ticked.

For example the user may wish to receive emails for Errors and Warnings, but only receive a text message for Errors. Fault clearance notices are also passed to the user in the same way as Errors and Warnings. If the fault was a Warning, the clearance would only be emailed to the contact in the above example.

The controllers operate a call back facility and will pass faults immediately to the RMS system on generation of a fault within the controller, not wait to be polled. The RMS system will poll the controllers once every four hours to monitor the connection to the network.

## Hardware Connections

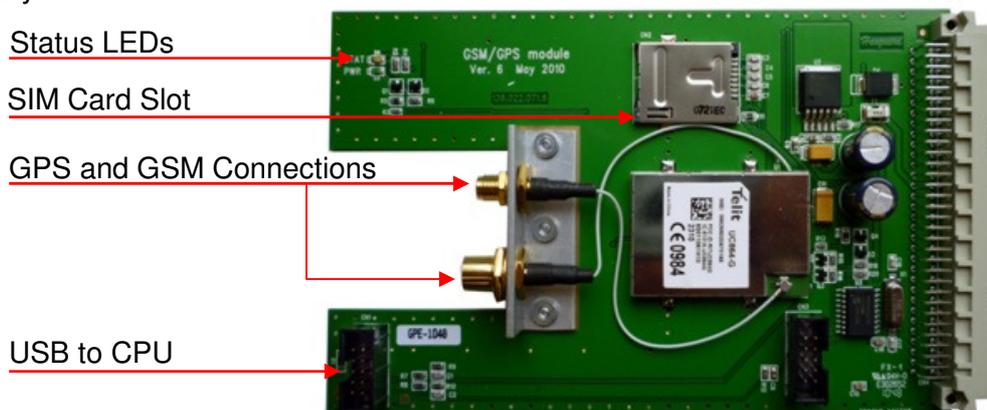
### Connecting via Ethernet

To connect the controller to a private network or to a router connected to a static broadband line, simply plug a standard patch lead (not cross-over) into the RJ45 socket underneath the controller. The router will need to be configured to port forward the relevant ports of the controller to the internet.

### 3G/EDGE and GPS Card

For the 16 and 32 phase controllers, the 3G/EDGE and GPS card is shown in Figure 3.1. It provides access to the GSM cellular telecommunications network and access to the Global Positioning System. The GSM module requires a 3G-enabled SIM card before it can provide internet access to the Remote Monitoring System. The GPS module receives data from a satellite network so that the TM-150-2 can retrieve the current time and date when (re)synchronising its Real Time Clock.

The card plugs into the backplane in one of the available I/O Card slots. It is also connected to the Main CPU card via a 10-way ribbon cable, which forms a USB link. Separate antennas designed for GSM and GPS use must be connected to the sockets on the bracket via impedance matched coaxial cable and mounted externally.



**3G/EDGE and GPS Modem Card**

### External Modem



**Telit GT 863-3GG Modem**

The Modem is a Telit GT 863-3GG panel mount device, with separate power adapter. The input is rated at 6-30Vdc. Motus supply this modem with a Meanwell 12Vdc 1.5A encapsulated power supply. The modem has connections for the combined GSM/GPS antenna, power in, USB mini B socket, and SIM card slot. The modem connects to the TM-150-2 controller via a standard USB mini B to A plug or 10pin IDC cable depending on whether the connection is to pedestrian or rack mount version of the controller.

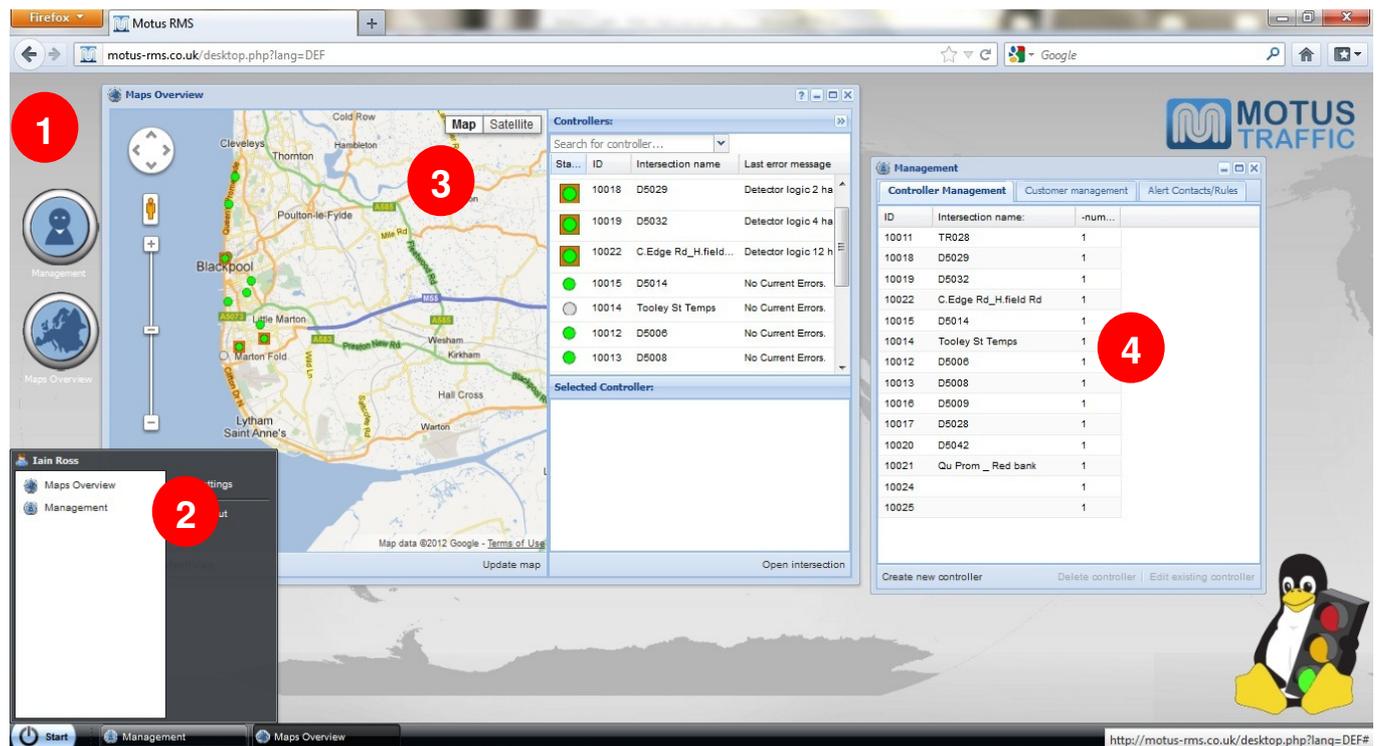
## Aerials

Cabinet mount or pole mount antennas can be used with the modems.

## Overview of the Website

The Motus Remote Monitoring System is built on a Virtual Server running Linux hosted in a dedicated data centre. Being a virtual server in a professional data centre means that there are proper disaster recovery plans in place with backups taken regularly. In the event of a hardware failure the virtual server can be migrated to another physical server very quickly to minimise down time.

Once logged in, the web desktop is built like an ordinary desktop, with windows, and a start menu.



**Desktop Overview**

The main parts of the desktop are:

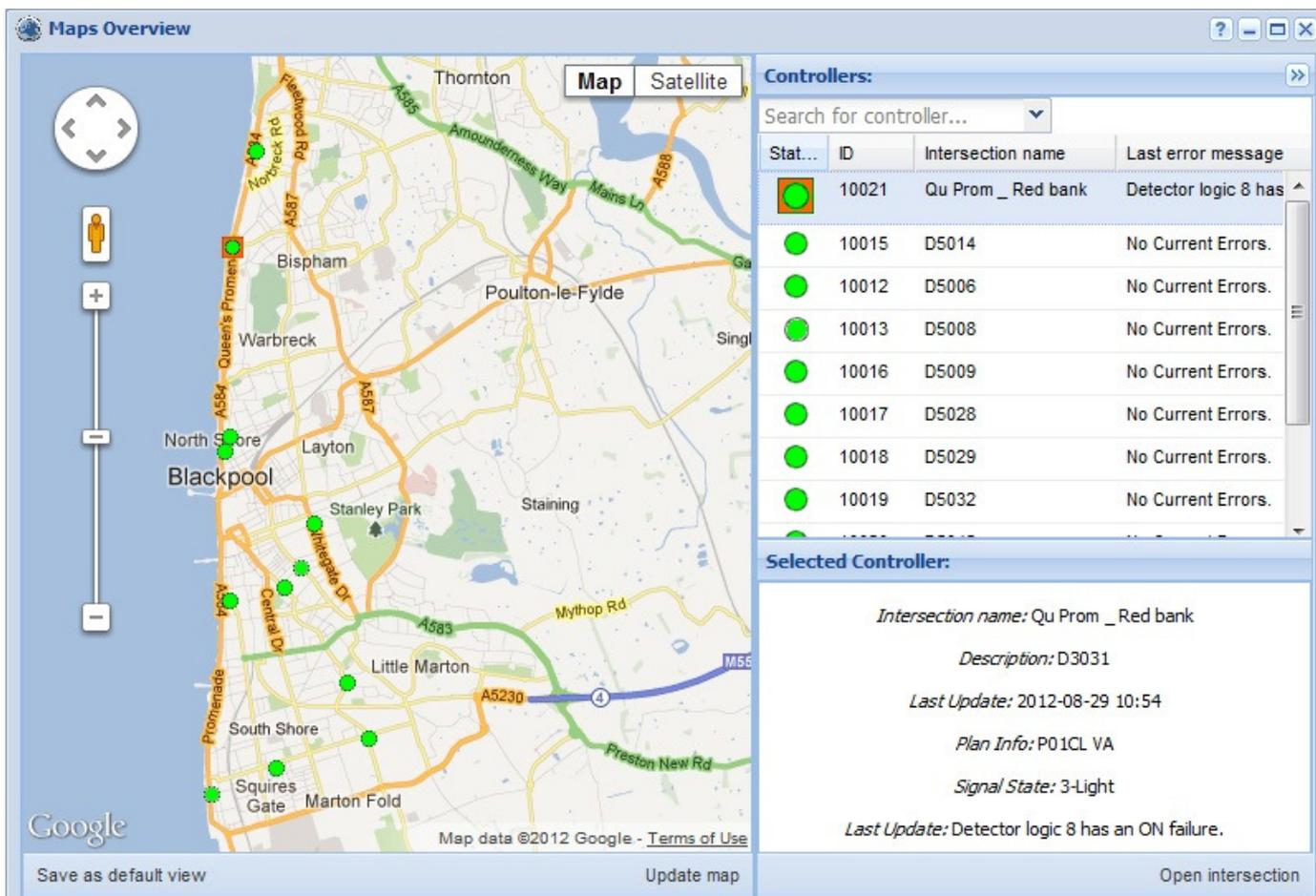
- (1) Icons - Click on an icon, to open the desired window – currently either management or maps.
- (2) Start menu - Click in an icon to open a window, change user settings or log out of the system.
- (3) Maps window - Get a quick overview of controller in the network
- (4) Management window - Manage contacts and alerts here.

## Maps Window

The maps window is the heart of the Motus RMS. Here users get an overview of the controllers in their network. The Maps Window is divided into three main parts; map view, list view and selected controller information.

### Controller Map View

The function of the map is to give the user a quick and simple status overview the network. To navigate around the map, use the navigation buttons to the left, or simply click and drag the map into desired position. Scroll with the mouse wheel to change zoom level or use the scroll bar with the navigation buttons.

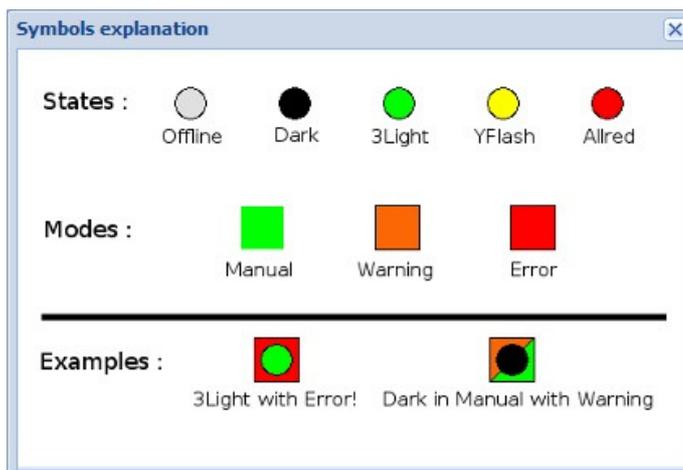


### Map View of Blackpool

Each controller is represented on the map by a status icon. Possible controller states are given by the '?' symbol in the title bar. Normally a controller would be represented by a circular icon.

If the controller has no errors and is connected the icon will be green. Other colours represent different status. Offline controllers are grey, dark (e.g. Part time or Lamps Off by control panel) is black, Manual All Red is a red icon.

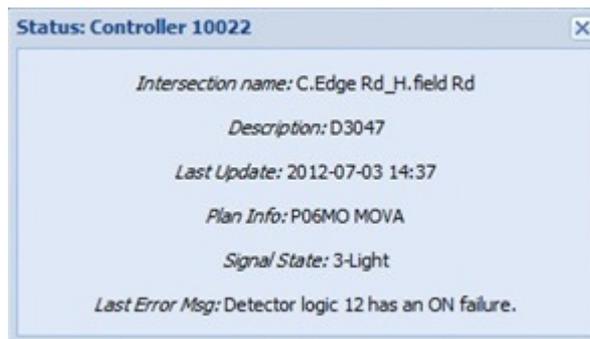
If the controller has an Error, Warning or is not in Normal Mode, the icon changes to a square. The colour of the square can be green when not in Normal mode, but no Errors or Warnings, orange for a Warning or red for an Error.



**Map Icons**

To get more detailed information about a controller's status, hover the mouse cursor above a controller icon on the map, and a status window will pop up. The following information is displayed:

*Intersection Name* From controller configuration  
*Description* Created in RMS  
*Last Update* Never more than 4 hours old  
*Plan info* Current controller plan/mode  
*Signal State* The signal status of the controller  
*Last Error Msg* Last error message (if any)



**Controller Status Pop-up Window**

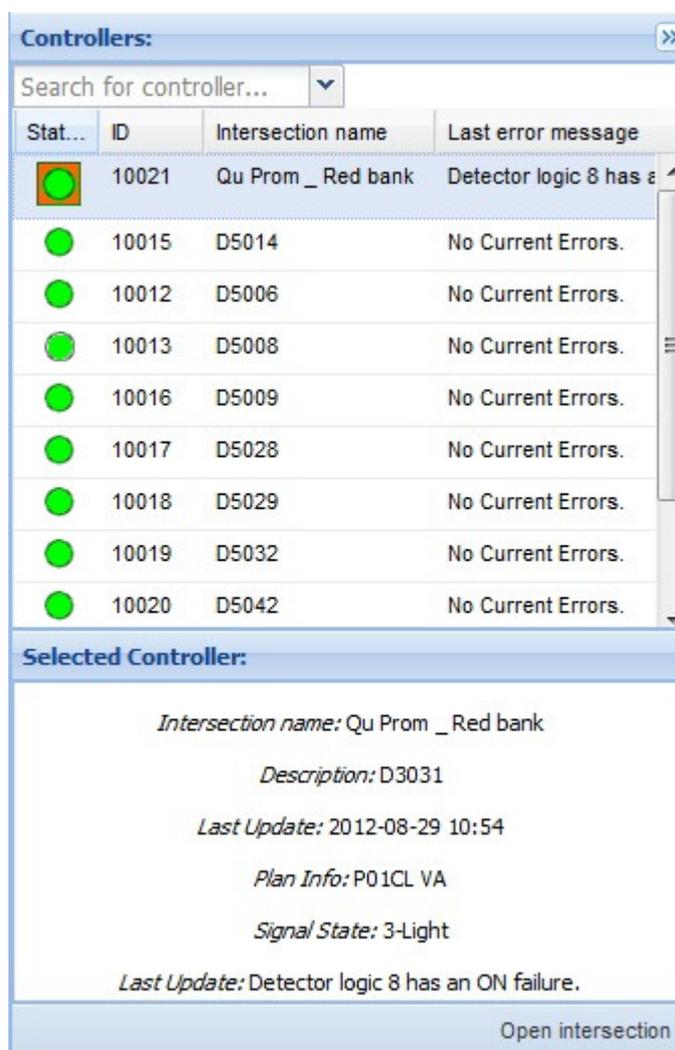
### Controller List View

The maps window also provides a list of all the controllers. This is particularly useful if there are a lot of controllers very close together as the map view can get crowded. The list is sorted so controllers with faults or are offline will be on top.

If the list is very long, there is a search facility to quickly find the controller of interest.

To get detailed information simply click on a controller in the list, and the selected controller area at the bottom will be updated with detailed information as displayed in the pop up window. The map will also change to centre the controller in the map window and zoom to a suitable level.

If desired, the selected controller integrated web pages can be opened up by clicking the open intersection button below the status window. This will open up a new window in the desktop environment to display the web pages. A user can open up as many windows as they want, with each one appearing on the task bar at the bottom of the web page for simple navigation between them.

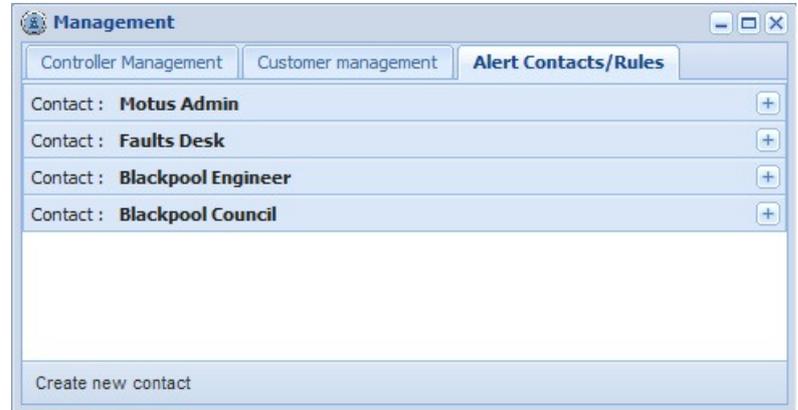


**List View and Controller Status Window**

## Management Window

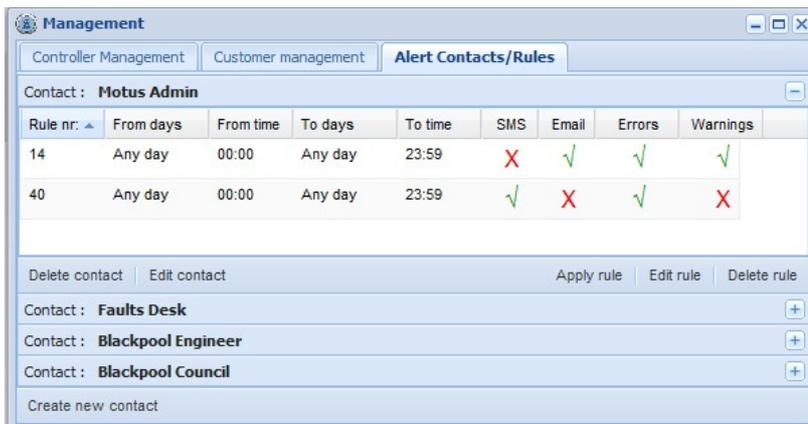
In the management section, it is possible to manage controllers and users of the system. To open the management section, click the management icon on the desktop, or press 'Start' and choose 'Management'. Currently, only authorised Motus personnel may log into the Motus RMS with Administration rights to add/delete controllers and users. This will be evaluated on a user by user basis.

The most useful tab in the Management Window is the Alert Contacts / Rules tab. Here the user can define contacts for fault messages to be passed to. There can be many different contacts, with their own preferences for when, what and how fault messages are passed. The contact information can store a unique name, email address and a mobile telephone number. These are required if the contact is to receive emails or SMS text message alerts from the system in the event of a fault or fault clearance.



**Management Window Alert Contacts/Rules Tab**

Clicking on a contact expands the rules for that contact. A number of different rules can be created, for different times of the day or week. Currently a rule will cause the Motus RMS system to alert the user to any faults on any of the controllers in the users' network.



In the figure above, there are two rules for the contact "Motus Admin". Rule 14 has the following properties:

- Active 24 hours a day, 7 days a week
- Email on Errors and Warnings

Rule 40 has the following properties:

- Active 24 hours a day, 7 days a week
- SMS Text on Errors only

### Contact Alert Rules

Fault clearances are only sent according to the rules created. Therefore in the situation above, if a fault generates a Warning, the fault clearance will only be sent by email to the contact, as SMS text messages are only created for faults that generate an Error.

## Integrated Web Pages

The integrated web interface for a controller is accessed from the maps window by pressing the 'Open Intersection' button, or double clicking the controller icon on the map. A login box will appear the first time that user logs into the controller. The website remembers the login credentials for subsequent logins under that username. The controller home page will be displayed, which is an overview of the intersection. Some of the most useful pages are described in the following sections.

## Overview Tab

The Overview tab is shown below provides a composite view including a map with real-time information about the signal phases, a virtual clone of the text-based LCD on the control panel and an error log window.



**Overview Display**

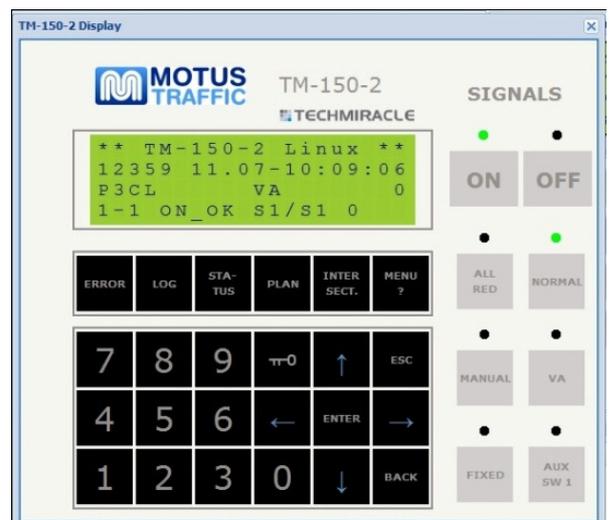
The overview page is designed to present as much useful information as possible without appearing to be cluttered. The LCD screen in the control window is updated approximately once per second, providing real time information about the controller status. The police function keys in the control window are read-only, and you can see which buttons are active as they are coloured blue, whereas the inactive buttons are grey.

Just below the top menu tabs, the name of the intersection and the owner of the configuration are displayed for reference.

There is an optional map window, which can display a site layout map, with coloured icons showing the real time status of the signals. If the signals are off, the map will display but there will be no icons visible.

Below the map display is a space for current errors to be displayed. This error log can contain up to 64 entries. A scroll bar will appear if necessary. The log can be refreshed by pressing the **Reload Log** button, or exported to a **.txt** file for archiving.

Underneath the real time LCD display is a button which can bring up a graphical representation of the control panel, shown on the right. The black buttons can be pressed to manipulate the display to show the user various parameters. The mode buttons and signal **ON/OFF** buttons are greyed out because they are inactive over the remote network. As with most RMS systems, Level 2 commands can be executed via this panel.



**Remote Panel Display**

## Log Tab

The Log tab is shown below.

At the top of the page there are two sub menus:

- *Log Viewer*
- *Temp & Mains Log*

At the bottom of the page there are tabs that select the detailed logs:

- *Detector log*
- *Event log*
- *Lamp log*
- *Plan log*

Click on the small arrow to reload the log.

To the right of the log selection tabs, there is an export tab. Hovering over the **Export** button will reveal some text that explains how to export the data to another program.

Date/Time	Mode	Code	Message
2011-07-11 09:29:40	+	00-001-00	Error reset. Intersection 1. Startup (Warm).
2011-07-11 09:29:27	+	00-001-00	Error reset. Intersection 1. Startup (Warm).
2011-07-11 07:29:45	+	00-000-00	Error reset in intersection 1. Startup (Cold).
2011-07-11 07:29:17	+	00-001-00	Error reset. Intersection 1. Startup (Warm).
2011-07-11 07:28:18	+	00-001-00	Error reset. Intersection 1. Startup (Warm).
2011-07-11 07:17:56	+	00-001-00	Error reset. Intersection 1. Startup (Warm).
2011-07-11 07:16:59	+	00-001-00	Error reset. Intersection 1. Startup (Warm).
2011-07-11 07:14:00	+	00-002-00	Error reset. Intersection 1. A restart of the controller has been performed according to parameter F0N36.
2011-07-11 07:13:03	+	00-001-00	Error reset. Intersection 1. Startup (Warm).
2011-07-11 07:11:59	+	00-001-00	Error reset. Intersection 1. Startup (Warm).
2011-07-11 07:10:47	+	00-002-00	Error reset. Intersection 1. A restart of the controller has been performed according to parameter F0N36.
2011-07-11 07:09:47	+	00-001-00	Error reset. Intersection 1. Startup (Warm).
2011-07-11 06:51:15	+	00-002-00	Error reset. Intersection 1. A restart of the controller has been performed according to parameter F0N36.
2011-07-11 06:51:10	*	25-001-00	Phase 1 reports that a conflict has been monitored against the phase.
2011-07-11 06:51:10	+	00-001-00	Error reset. Intersection 1. Startup (Warm).

**Log Viewer Tab Display**

## Traffic Analysis Tab

The Traffic Analysis tab contains information about the lamp status, phase timings and traffic count.

### Lamp Status

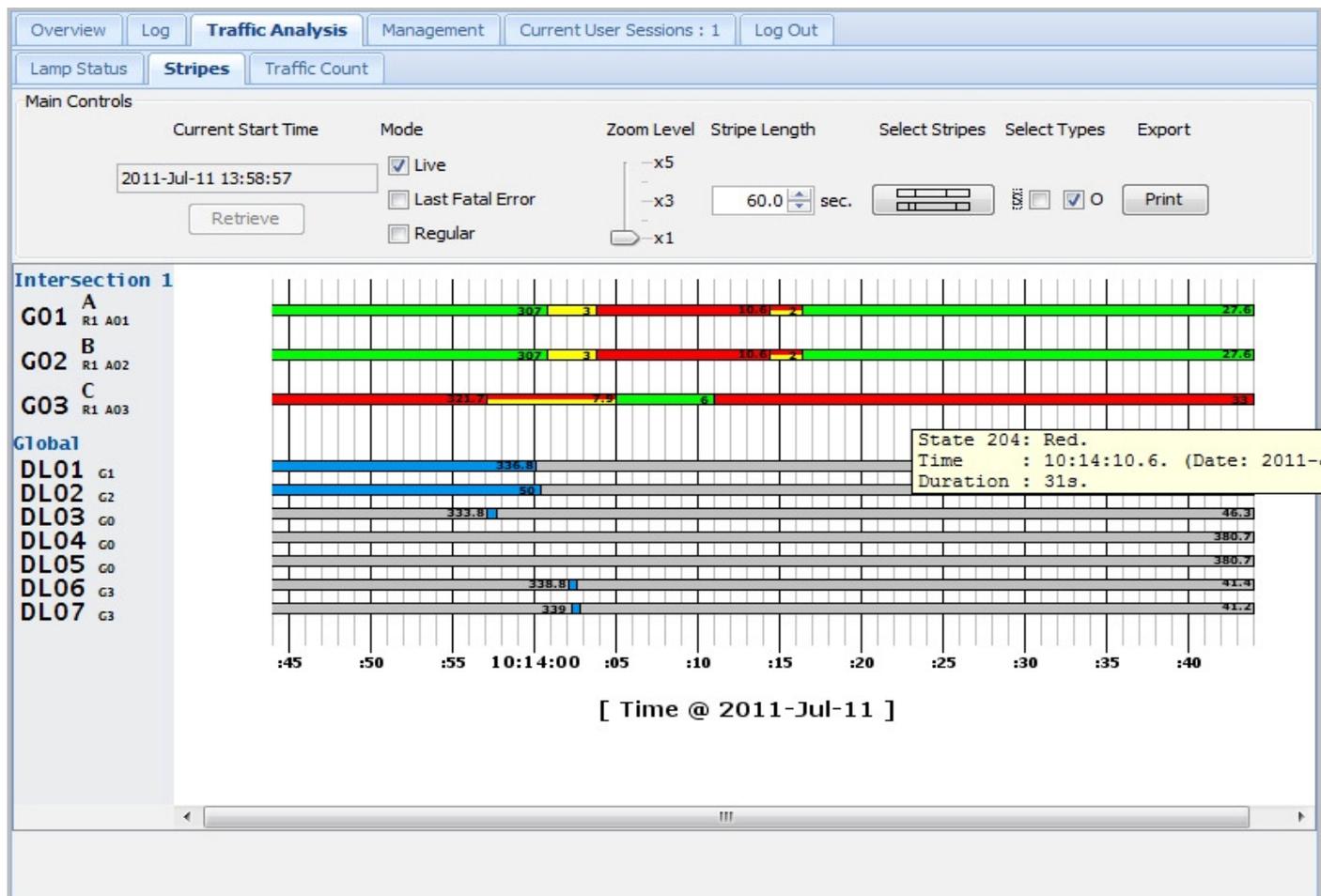
At the top of the Lamp Status page, there is a summary of the controller plan and lamp status. Underneath this information, all monitored phases are displayed. For each phase it is possible to view load levels and reference levels for lamp monitoring. There is a slight delay from what is happening on street to what is displayed here, of around one second.

Phase:1 - A						Phase:2 - B						Phase:3 - C					
R1	Load	Ref	Lvl 1	Lvl 2	Max	R1	Load	Ref	Lvl 1	Lvl 2	Max	R1	Load	Ref	Lvl 1	Lvl 2	Max
R1	027	026	024	022	000	R1	027	026	024	022	000	R1	018	018	000	000	000
A01	027	028	026	024	000	A02	027	027	025	023	000	A03	012	000	000	000	000
	027	029	027	025	000		029	026	024	022	000		031	030	000	000	000
A01 Min. load: 001						A02 Min. load: 001						A03 Min. load: 001					

**Lamp Status Tab**

## Stripes

The second tab under the Traffic Analysis tab is called Stripes.

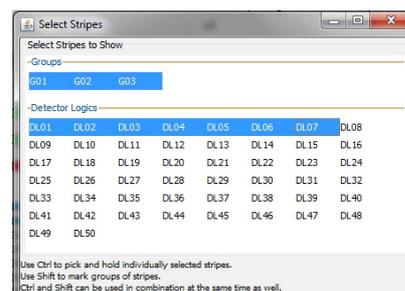


**Stripes View**

“Stripes” is an excellent tool for a real-time view of selected phases and detectors. At the top of the page there are various options. The first is to select the point in time to start viewing the signal data with stripes. The default is live view, with options for last fatal error, or a given time in the past. Historical data is recorded for a maximum of two weeks. A zoom level can be selected. The time window displayed is by default 60s, stripe length sets this value.

One of the most useful features is the option to select the type of signal output viewed through stripes. There are two options: The default is signal logic “S” categorising the signal phase into min, max, past-end green etc. If a simpler view is required, tick the “O” check box which will display the signal phase output colour i.e. red, amber, green, starting amber, or Off. Along the stripe itself the time in seconds that a particular state has been maintained is written. It is possible to view both types of stripe at the same time by checking both boxes.

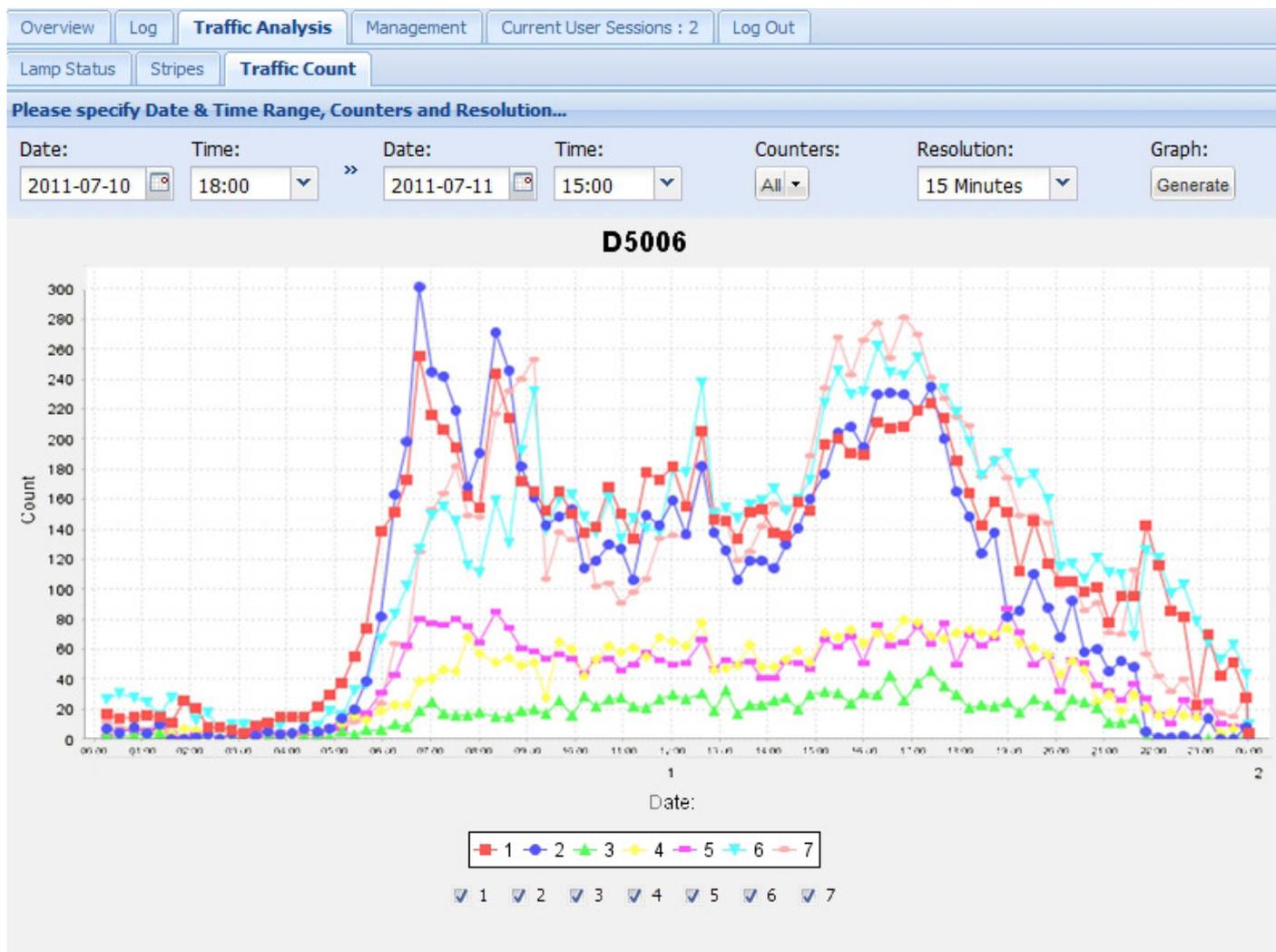
Using the Select Stripes button:  brings a window up to select the displayed signal phases, and detector logics. Left Click to select an individual groups (phases) or detector logics. To select a range in series, hold the **SHIFT** key down and select the first and last group or detector logic in the desired range. To select multiple groups or detector logics not in sequential order, hold the **CTRL** key down and left click the desired items. The selected items are displayed with an active one coloured blue, and inactive coloured grey.



**Select Stripes**

## Traffic Count

With this analytical tool, counters can be assigned to detector logics, so that each time the input to that detector logic is activated, the controller stores the time of the event. This allows the user to monitor specific detectors on a site for analysis later.



### *Traffic Count Display*

This can be useful for ascertaining how busy a particular traffic approach is, or working out whether the selected DFM off times on a pedestrian crossing are long enough, for example, by monitoring the use of the crossing over a weekend.

Motus used this method to assist Ritherdon and RO Electrical with their Motus Intelligent Temporary Traffic Controller installed for TfL to assess tidal flow of pedestrians across the temporary signals.

The detector counting facility is built into the controller, and is very simple to set up. From the Traffic Count page the following can be selected:

- The start and stop time
- Which counters are displayed
- The time resolution in minutes

Press the 'Generate' button to draw the graph. It is possible to remove a counter from the graph by de-selecting it from the tick box below.

## **Future Developments**

### **Improvements to current system**

Currently the system is being trialled by several local authorities and companies who use the Motus Controllers. Improvements are organic; as users ask for functionality to be added or altered to better suit their needs, the system becomes more feature-rich.

Motus are looking to add more features to the alerts system to give the user more control over what controller actions generate an alert within the system.

The way that a network of controllers is managed by users is being examined to improve flexibility and user control, without compromising security and confidentiality.

### **Traffic Count Data**

The method of communication used between the Motus RMS and the connected controllers lends itself to more sophisticated use. It is possible to send data to the controllers from the system. Some ideas currently being explored are to make more use of the controller detector count facility, to allow some more intelligent VA logic. It would be possible for the Motus RMS to be adapted to send plan change data to the controller based on traffic counts received from the controller; this would be more flexible than simply changing VA maximum sets on a timetable.

### **Common Database Integration**

Currently the controllers can use an adapted RMS interface to communicate directly with the Envitia Cutlas Common Database for automatic fault reporting. This is used on the Blackpool PFI. Motus are exploring integrating the controller into other common databases.

### **Fault Management System (FMS) Integration**

Motus are exploring integrating directly into a widely used FMS system.

## **Summary**

The Motus TM-150-2 Controller has a proven track record for exceptional reliability, flexibility and use of cutting edge technology. The TM-150-2 Integrated Web Interface has been operational for several years now and proved to be a very useful feature for Clients and Engineers alike.

The Motus RMS is a natural progression from the Integrated Web Pages and has been live for a few months now, and already there are over 30 controllers operating on the system. The initial feedback has been good, with some updates already made and others planned. Motus prides itself on being flexible to users' requirements and always open to suggestions for future development of the controller and the RMS system.