Solar Shop Kelly's Telemetry

Combined Secondary Schools Team

This document explains the basic working of the telemetry installed in SS Kelly where data transfer from Kelly to the Lead Car and then by satellite to Adelaide can be monitored and used not only by the Kelly team on the spot but by schools etc in Adelaide and elsewhere thanks to Robway Cranes, Thebarton, South Australia.

The document was produced by TAFE SA staff and retired Electronics Engineers who worked in conjunction with TAFE SA and Energy Education Australia in preparing students for their role in the 2009 World Solar Challenge.

Our thanks go out to Geoff Barbour and Ian Rowley whose design and manufacture inspired others to make it happen.

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How it works

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Design Team

The following personnel have provided input to the design and it is envisaged that they will also be involved in the validation processes:-

Geoff Barbour	Electronic Monitoring and Electrical Drive System
Ian Rowley	Telecommunication and Telemetry Systems
Doug Tilbrook	Electronic Monitoring
Doug Tilbrook & Geoff Barbour	Software Design

Solar Car Telemetry (Sub)Project Overview

The aim of this Sub Project is to provide design and implementation thus ensuring reliable functionality of data telemetry and voice systems for each solar car team.

Performance Data:

- Collect and store all telemetry data for immediate and "after the event" analysis to maximise the performance of the solar cars, and
- Transfer the telemetry data from each solar car to the lead car for the immediate use by the strategist, and
- Transfer the data back to Adelaide by utilising Robway Crane Safety Systems' data logging hardware network, and
- Provide interactive performance data to the technical support team based at Regency Campus, and
- Provide a multimedia outlet to others including: schools, media and interested parties at Regency Campus - ensuring maximum visibility of TAFESA and its sponsors during the challenge.

Voice Communications:

- Provide effective and reliable interference free voice communications between the solar car, strategist and safety vehicles with a possible link to the Technical Interpretive Centre (TIC), based at Regency Campus, and
- Provide feedback to the mobile strategy team from the TIC at Regency TAFE.

Design Input and Validation

Design input and Validation has occurred through out the period preceding this document. It is envisaged that the validation process will continue through:

Design Reviews, and
Testing of hardware, and
Testing of software, and
Bench testing the complete system, and
Installation in "Kelly" for field trials.

Before the additional installation into Solar Spirit.

Project Risks

The following risks to this project have been noted:-

1= Low 2= Medium 3= High Risk = Occurrence x Consequence

Concern	Occurrence	Consequence	Risk	Mitigation
Loss of Key Personnel	3	3	9	Documentation kept to high standard, regularly reviewed and updated Stored on "S" drive. Regular briefings between Team Members.
Software Designer not found	2	3	6	Telemetry System becomes local data logger with increased power consumption on solar car. Neither capability for Satellite link nor capability for publicity of cars.
Components not able to be sourced	2	1	2	Telemetry system used in "best effort mode" Not critical to basic operation of vehicle.
Loss of Communication links – Telemetry & Video	1	3	3	UHF CB system as back up for field cars. Telemetry system for enhanced technical support / management and education.
Loss of Power supply to any portion of telemetry or primary voice systems	1	3	3	Mobile UHF CB system as back up for field cars. Telemetry system for enhanced technical support / management and education.
Loss of communications with Teams	2	1	2	Teams need to be self sufficient. Loss of media and educational exposure for TAFESA only.

Technical Design Overview

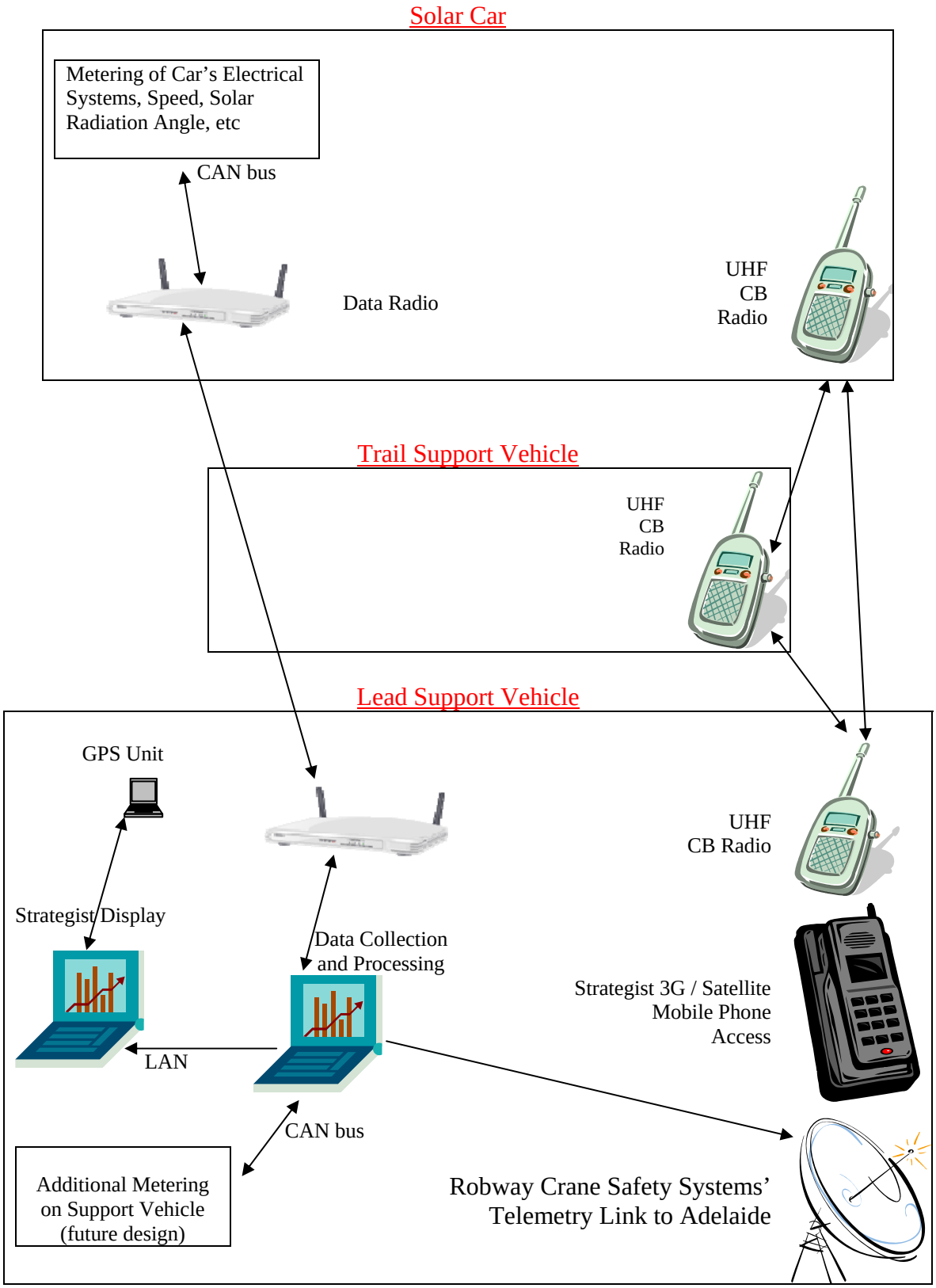
Inclusions:

- Creation of a "Team Interpretive Centre" (TIC) at TAFESA Regency Campus to provide over-arching technical support for both solar car teams as well as a public information interface for the purposes of educational gain and media exposure, and
- Provide internet web access to allow schools to monitor the telemetry for educational purposes, and
- Telemetry links from the solar cars and strategy vehicles, to the TIC at TAFESA Regency Campus, and
- Monitoring of the telemetry in the strategy vehicles, and at the TIC at TAFESA Regency Campus, and
- Interference free voice between the solar cars, strategy vehicles, chase vehicles with monitoring of the audio within the TIC at TAFESA Regency Campus, and
- The voice to strategy vehicles from the TIC, not necessarily in "real time".

Exclusions:

- Additional voice via any public terrestrial and satellite carrier networks (separate issue), and
- HF Radio equipment considerations (separate issue), and
- UHF CB communications with other team vehicles (separate scope), and
- Driver Controls – Wavesculptor Interface (separate scope), and
- Instrumentation & propulsion power supplies / solar arrays (separate scope).

Telemetry and Voice Block Diagrams – Mobile Component



Note:- For drawing clarity, only one car "team" shown.

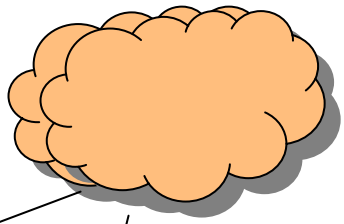
Telemetry and Voice Block Diagrams – Adelaide Component

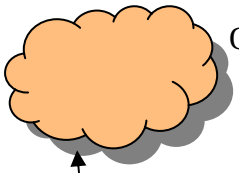
Robway Crane Safety Systems - Adelaide

Data from Lead Car

Robway's Server

www.robway.com.au





Other Web Sites

Selected web Pages

TAFESA Regency Campus

South Australian Schools

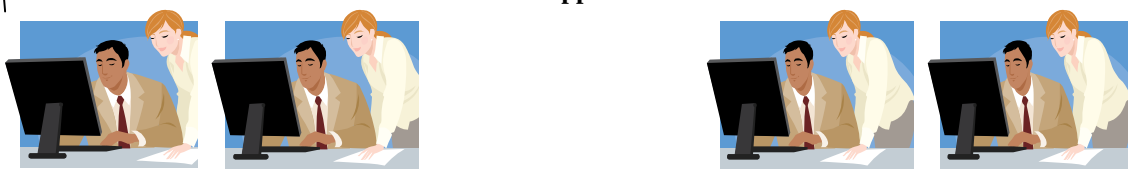
Updating of "Solar Spirit" Web Site

TAFESA's Team Interpretive Centre

"Solar Spirit"

"Kelly"

Technical Support Team



Public Interpretive Displays

Telemetry & Voice Hardware Requirements

Solar Car

Item	No. Rqd	Source	Contact
CAN Device Solar Array V&I	4	Regency	Doug Tilbrook
CAN Device to RS232	1	Regency	Geoff Barbour
CAN Device Accelerometer	1	Regency	Geoff Barbour
CAN Device Suspension height	1	Regency	TBA
CAN Device Tyre pressures	4	Regency	TBA
CAN Device Sun Marker	1	Regency	Doug Tilbrook
CAN Wavesculptor driver control	1	Regency	Doug Tilbrook
Digital Audio Bridge	1	Regency	Geoff Barbour
CAN232 Data Adaptor	1	Dontronics	Ian Rowley
2 Channel Data Radio	1	Trio Datacom	Ian Rowley
900 Mhz Antenna	1	Electric Bug	Ian Rowley
UHF CB (handheld)	1	Electric Bug	Ian Rowley
UHF CB GI Antenna	1	Electric Bug	Ian Rowley
			Sub Totals

Trail Car

Item	No. Rqd	Source	Contact
Digital Audio Bridge	1	Regency	Geoff Barbour
2 Channel Data Radio	1	Trio Datacom	Ian Rowley
900 Mhz Antenna	1	Electric Bug	Ian Rowley
UHF CB - Car Mounted	1	Electric Bug	Ian Rowley
UHF CB Antenna	1	Electric Bug	Ian Rowley
			Sub Totals

Lead Car

Item	No. Rqd	Source	Contact
GPS	1	Regency	Ian Rowley
CAN Device RS232	1	Regency	Geoff Barbour
CAN Device Solar radiation	1	Regency	Doug Tilbrook
Can Device Weather Instruments	1	Regency	Ian Rowley
Digital Audio Bridge	1	Regency	Geoff Barbour
CAN232 Data Adaptor	2	Dontronics	Ian Rowley
2 Channel Data Radio	1	Trio Datacom	Ian Rowley
900 Mhz Antenna	1	Electric Bug	Ian Rowley
UHF CB – Car Mounted	1	Electric Bug	Ian Rowley
UHF CB Antenna	1	Electric Bug	Ian Rowley
E-Log	1	Robway	Ian Rowley
E-Log Antenna – Terrestrial	1	Robway	Ian Rowley
E-Log Antenna - Satellite	1	Robway	Ian Rowley
Laptop Computers	4	Regency	Library?
Laptop Power Supplies 12/18	4	Dick Smith?	TBA
Misc Hardware (LAN associated)	1	Multiple	Ian Rowley
2nd car battery & DC Distribution	1	Multiple	Ian Rowley
Equipment Housing	1	Multiple	Ian Rowley

Sponsor Support

Inter-car Linking:

Digital radio equipment was sourced from Trio Datacom. Three units are required per solar car team. These radio terminals will carry the telemetry between the solar car and strategy vehicle

Satellite / 3G Data Link:

To link the data and voice back to the TIC, it is expected that a satellite and/or 3G terrestrial Telstra network will be made available. This capability and the associated hardware have been offered by Robway Crane Safety Systems. Without this support (sponsorship), the telemetry will only be available between the solar car and the strategy vehicle.

Robway Crane Safety Systems will provide 15 minute data updates as part of the sponsorship arrangement. Support from Telstra will be required for faster updates.

UHF CB Equipment:

It is mandatory that all key vehicles have UHF CB capacity during the challenge. Final configuration for the total equipment manifest has yet to be compiled (this includes “out of scope” vehicles).

Antennas are also required.

It is anticipated that this equipment could be sponsored by a local retailer. However, no approaches have been made to date.

Software Requirements

Overview

One software suite is required to perform the following functions independently as well as a combined function.

- CAN bus controller to poll and retrieve data from a CAN bus, at a user defined data and polling rate, then have the data stored to local hard drive.
- Transmit (via RS232) a CSV data string from that stored file to a third party device at a user defined output and rate.
- Provide graphical display of stored data on the hard drive and update automatically when the next CAN based data becomes available. This function to be possible via Ethernet network accessing a "shared" file.
- In "Challenge Mode" it is anticipated that the CAN Bus controller and CSV string generator would both be operational on one laptop with multiple laptops accessing the file, via Ethernet link, for the graphical display.
- Programming language used is not critical providing it interfaces seamlessly with Windows XP Operating system.

NOTE:- Existing software (commercial, shareware or freeware) can be considered providing that all above interfacing requirements and functionality requirements are met.

CAN Bus Controller

- The CAN bus is configured for a "master-to-slave" topology.
- All devices to be monitored will be connected to one CAN bus.
- The Can bus speed has yet to be decided and open to negotiation.
- Some devices will be controlled over a dedicated radio link and as such the radio link is seamless to the functionality of the CAN bus except for additional response times from the remote units. The delay to be advised.
- Polling of remote units to be set via a user software interface, in the range of 1 to 10 seconds per unit.
- All data captured to be saved to a common data file with remote read access for other applications running simultaneously. Time and date stamping within the file is acceptable however should not be passed to the SCV string during output.
- Technical monitoring screens to be provided for CAN controller diagnostic purposes but not expected to be used for end user monitoring.

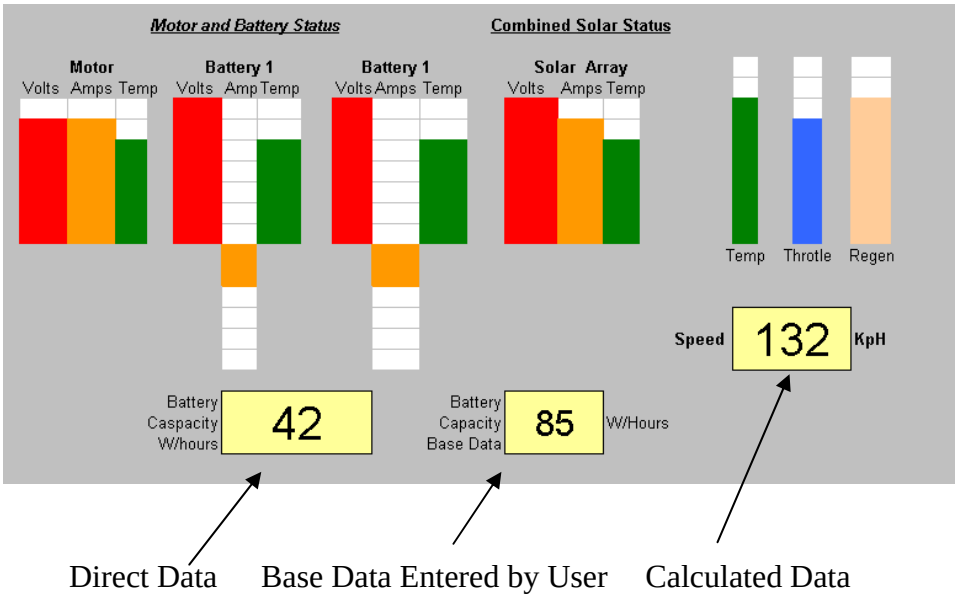
CSV String Generation

- The generation of a CSV string is required from the laptop to an E-Log "data logger" for forwarding to Adelaide via a satellite link.
- The CSV string to be provided by the Solar Car team (Ian Rowley) in conjunction with the supplier of the E-Log.
- The link between the two systems will be via RS-232 at 4800,n,8,1 using a direct cable connection with type of flow control to be decided.
- The data rate must be "user configurable" for other standard rates as required.
- The CSV string is expected to be transmitted to the E-Log every 10 seconds but must be "user configurable" between 1 second and 60 seconds in 1 second increments.
- Any date/time stamps generated within the laptop should not be sent as a component of the CSV string.
- The ability of the user to decide what data in the CSV string is sent is considered an advantage. Could this be via a "tick box" configuration screen?

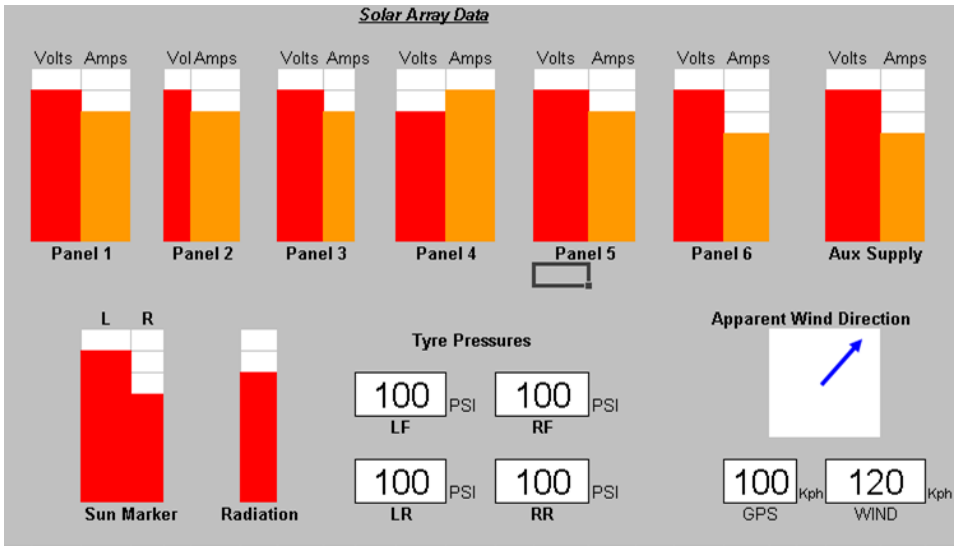
Graphical Display

- The user interface is required to display all the captured CAN data on "user selected" screens. That is to say, the critical data on the main screen with other screens being able to be selected to display less critical data when required.
- The displayed data to be updated every second regardless of the last update of the data file.
- Some displayed data will need to be calculated from the raw data. In some cases the display will need the user to provide some baseline data for the calculation to occur.
- Bar graphs, vectors and numeric displays are required on various screens.
- The layout of the screens needs to be "chunky" in appearance to allow the data to be interrogated whilst travelling at 130kph in the back seat of a vehicle on the open road.
- Layout concepts are being finalised and will be provided to the programmer when required.
- The possibility of re-reading data files "off line" at multiple sample rates is considered a major advantage but not critical.

Example Layout:-Main Screen:



Example Layout:- Secondary Screen:



TAFESA "Technical Interpretive Centre" - Regency Library

It is anticipated that the centre could be set up in the AV Room. The 15 Student PCs within the room can be re-tasked for the week of the challenge.

There is no expectation for additional major costs to the project as all the equipment will be sourced from TAN ICT or borrowed from existing class rooms / desks etc...

At this stage, no formal planning or requests have occurred to use this area. However, it is not envisaged that there would be any major concerns.

All information gathered will be sourced via the internet in the form of:

- Access to Robway Crane Safety Systems' server, and
- Automatic generated emails from Robway Crane Safety Systems, and
- Goggle Earth for car location displays, and
- Bureau of Meteorology, and
- Other sources of information as it becomes available during the project.

Some of the displays and information will be car specific as the TIC will have access to data from both "Kelly" and "Solar Spirit" as well as generic information for both solar cars.

With the assistance of TAFE student involvement, there is a possibility that information can be place on a TAFESA web site for the pubic to monitor and review as required.

Voice & Video from Solar Teams to TIC

As of 27th April, at a meeting with Robway Crane Safety Systems, it was confirmed that the system offered was not configured to carry voice and /or video back to Adelaide.

A fall back design is being considered. At this stage, it is to early to fully describe the concepts. The focus of any design will be to recover suitable video / audio, as close to real time as practical, for placement on the TAFE website and other WEB sites such as "U Tube". This would provide TAFESA maximum exposure during the challenge.

Annexure 1

Typical Screen Information from the Robway Crane Safety Systems' Server

Note:-

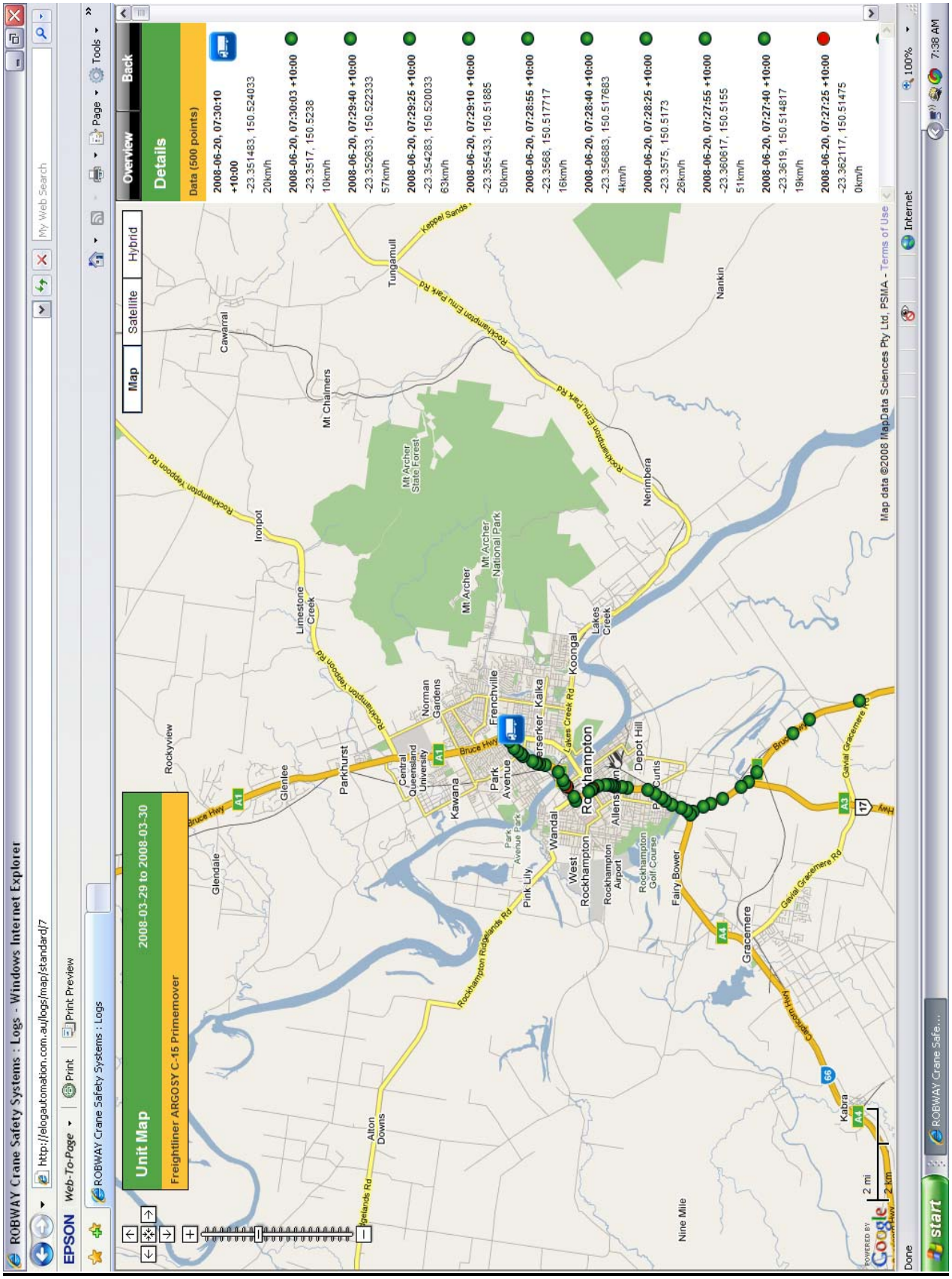
The data depicted is related to crane systems. The solar car data will be similar and custom designed as part of the sponsorship arrangement.

These screens would be made available direct to schools via the web server, thus promoting the educational value of this project.

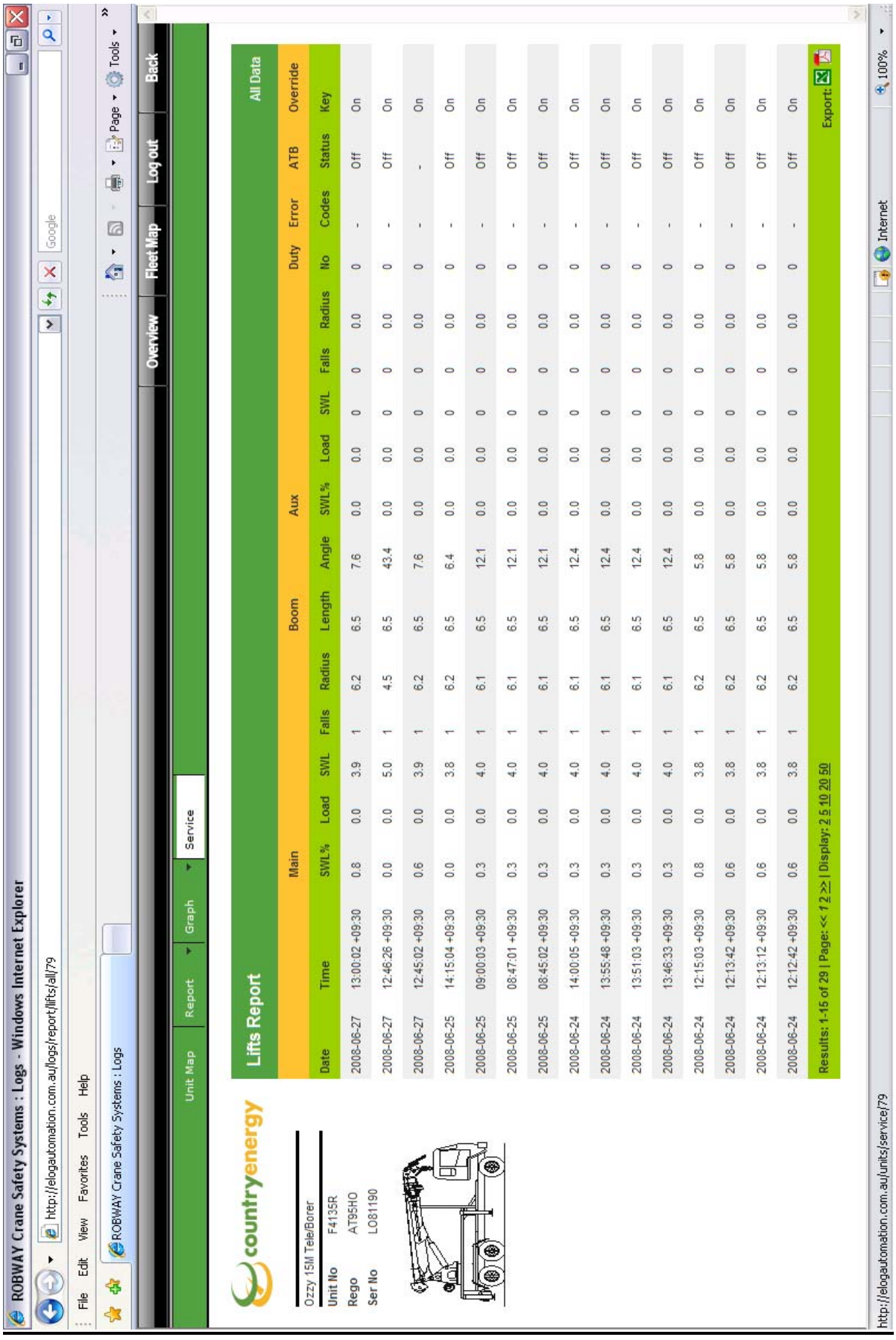
Graphics of equipment and corporate logos are manipulable.

All data captured is available for downloading for future reference.

Location of Vehicle



Tabulated Data



Date	Time	Main SWL%	Main Load	Main SWL	Main Falls	Boom Radius	Boom Length	Boom Angle	Aux SWL%	Aux Load	Aux SWL	Aux Falls	Aux Radius	Duty No	Error Codes	ATB Status	Override Key
2008-06-27	13:00:02 +09:30	0.8	0.0	3.9	1	6.2	6.5	7.6	0.0	0.0	0	0	0.0	0	-	Off	On
2008-06-27	12:46:26 +09:30	0.0	0.0	5.0	1	4.5	6.5	43.4	0.0	0.0	0	0	0.0	0	-	Off	On
2008-06-27	12:45:02 +09:30	0.6	0.0	3.9	1	6.2	6.5	7.6	0.0	0.0	0	0	0.0	0	-	-	On
2008-06-25	14:15:04 +09:30	0.0	0.0	3.8	1	6.2	6.5	6.4	0.0	0.0	0	0	0.0	0	-	Off	On
2008-06-25	09:00:03 +09:30	0.3	0.0	4.0	1	6.1	6.5	12.1	0.0	0.0	0	0	0.0	0	-	Off	On
2008-06-25	08:47:01 +09:30	0.3	0.0	4.0	1	6.1	6.5	12.1	0.0	0.0	0	0	0.0	0	-	Off	On
2008-06-25	08:45:02 +09:30	0.3	0.0	4.0	1	6.1	6.5	12.1	0.0	0.0	0	0	0.0	0	-	Off	On
2008-06-24	14:00:05 +09:30	0.3	0.0	4.0	1	6.1	6.5	12.4	0.0	0.0	0	0	0.0	0	-	Off	On
2008-06-24	13:55:48 +09:30	0.3	0.0	4.0	1	6.1	6.5	12.4	0.0	0.0	0	0	0.0	0	-	Off	On
2008-06-24	13:51:03 +09:30	0.3	0.0	4.0	1	6.1	6.5	12.4	0.0	0.0	0	0	0.0	0	-	Off	On
2008-06-24	13:46:33 +09:30	0.3	0.0	4.0	1	6.1	6.5	12.4	0.0	0.0	0	0	0.0	0	-	Off	On
2008-06-24	12:15:03 +09:30	0.8	0.0	3.8	1	6.2	6.5	5.8	0.0	0.0	0	0	0.0	0	-	Off	On
2008-06-24	12:13:42 +09:30	0.6	0.0	3.8	1	6.2	6.5	5.8	0.0	0.0	0	0	0.0	0	-	Off	On
2008-06-24	12:13:12 +09:30	0.6	0.0	3.8	1	6.2	6.5	5.8	0.0	0.0	0	0	0.0	0	-	Off	On
2008-06-24	12:12:42 +09:30	0.6	0.0	3.8	1	6.2	6.5	5.8	0.0	0.0	0	0	0.0	0	-	Off	On

Graphical Displays of Data