



Resource Extraction Monitoring

69a Lensfield Road,  
Cambridge CB2 1EN, UK  
Tel: +44 (0) 1223 314 589  
Fax: +44 (0) 1223 359 048  
mail@rem.org.uk  
[www.rem.org.uk](http://www.rem.org.uk)

# Tools for Implementation of Forest Governance (TIFG)

**Output 3:** New law enforcement and monitoring tools proposed and field-tested

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## Context and Concept development

Following many years of Independent Monitoring in the forest sector, it has become evident that the policy objectives of sustainable forest management are not being met. While there are many interconnected reasons for this, this document's objective is not to identify and map all of them.

One of the most serious one and that'd we'd like to focus on is that the rotational forest management systems for large-scale concessions are not being respected. This has been identified as a major and recurring infraction throughout the fifteen years of independent monitoring of forest law enforcement and governance in the Congo Basin and elsewhere. We refer here specifically to the rotation system of cutting within a limited proportion of a concession each year e.g. 1/25th or 1/30th of the allocated area, within the prescribed timeframe.

This introduces two important elements requiring closer scrutiny:

- 1) Time/Date of felling
- 2) Location of felling

We have attempted to address this core reason for the entry of illegally produced timber into the trade chain by developing a Live Monitoring System to track vehicles used for forest exploitation, adapted to a tropical forest environment and which provides accurate information on both elements.

## Operational Considerations

It is not necessary at this point for logging companies to record the exact location or time of felling of each tree and record this information in an accessible format for law enforcement purposes. Certification is also voluntary so may not serve to tackle those operators that are not willing or technically capable of respecting the law.

There is a power imbalance between the law enforcement agencies in weak governance environments and the logging companies. The law devolves responsibility for managing forest areas to concession holders, yet the concessionaires know that the responsible law enforcement agencies do not have the resources, nor in some cases the political will, to undertake their task of monitoring and controlling respect for the applicable laws. The question of how to determine and record the date and location of forest operations on a systematic and ongoing basis has to be considered.

Having local law enforcement agents in the field at the felling of every tree recording all actions is neither practical nor feasible, especially in contexts open to bribery and collusion. If monitoring of the production itself cannot be reasonably undertaken, other options have to be considered, which led us to consider monitoring the means themselves used for timber production.

Our assumption is that all industrial logging require capital equipment items to drag logs from the felling site to focal collection points for transport, processing and export.

It is not possible to transport a log weighing several tones without heavy machinery, which should be possible to monitor.

Fleet tracking systems are commonplace in more economically developed countries around the world. This is often done on a voluntary basis by the private sector to better manage the vehicles they have. The question we asked ourselves is whether the Time and Location of vehicles could be monitored in the operational environment of a logging concession in the Congo basin, i.e. in the absence of a mobile phone network and other support structures.

## The process

### Identifying a test country partner

DRC was privileged as a choice given REM's ongoing support to the mandated Independent Monitoring of Forest Law Enforcement and Governance in-country, namely Congolese and Cameroonian CSOs OGF and FLAG.

Although there was some resistance on the part of the Ministry in DRC to participate in the trial, we believe that this was essentially due to the novelty of the proposed concept and the difficulty to present the real potential of this new tool without seeing it working in real time.

The Ministry however agreed for us to proceed to engage with private sector partners, since direct implication of the ministry was not necessary for the concept stage of the work. REM committed to present results. This was done in a meeting with the head of the Division of Control and Internal Verification (DCVI) in February 2015 held at the DCVI office in the presence of OGF. The concepts and results were presented together with a live demonstration of vehicle tracking in the CFT concession (See below). The Ministry's interest in the monitoring increased following this presentation.

Given the government's agreement for REM to proceed with trials, there was no reason at the current stage to approach the Cameroonian government.

### Private sector partner for field testing

The *Compagnie Forestière et de Transformation s.a.r.l* (CFT) was approached by REM for the field-testing phase in view of their expressed interest in ensuring the legality of their operations. Following discussions, they accepted to participate in the trials of the tracking units. In exchange, access to all the data collected was provided to the company and this in turn enabled CFT to explore the potential of the system and consider using it in their future management and monitoring operations.

REM intended that the testing of the tracking units be carried under real operating conditions so that if the feasibility of the system was proven, the results could be easily repeatable. It was thus important for the test that the installation of the tracking units caused as little disruption as possible to the routine operations of the company, including logging and transport.

An MoU was established with CFT explaining the access that would be required to the ongoing logging activity and the objectives of the current phase of the project.

## Results

### Phase 1: Review the overall functioning system as a whole

A geo-locating device capable of reporting exact longitude and latitude location data, along with other specific information was to be customized to operations in tropical forest areas and attached to heavy equipment responsible for the extraction of timber. Vehicles would include any logging truck, bulldozer, barge or other such equipment involved in the transport or extraction of timber. The device would then communicate its geo location information and other data to a central server via either a land based data network (GSM), a satellite data link or RF (Wi-Fi) connection, depending on availability. The central server would capture and store this data, presenting it to the user through the live monitoring user platform in a visible, intuitive and user-friendly format. The user, any individual, organisation or independent monitoring body, would thus have access to real time 'live' (approx. 20-90min delay) data and insight as to what was happening on the ground without the need of physically being present.

Due to the vast areas and large scale nature of logging operations, it is inherently difficult to reflect or report on the exact movements and activities carried out by operators of individual pieces of equipment. In contrast, the proposed Live Monitoring System aimed to provide real time visibility of all operators, all of the time.

Having considered the overall basic design requirements of the system, the objectives of phase 2 of the system were established.

### Phase 2: Attempt to build a basic working prototype

Phase 2 was to test the functionality of the individual components of the system in real conditions. Then, where possible, integrate these individual systems to deliver a basic working prototype of the Live Monitoring System as a whole within a set timing and budget. This working prototype would allow for a greater understanding of the benefits and/or limitations of the available technologies, as well as the benefits and/or limitations of such a system to the forestry sector. It is important to note that the focus of this phase was on rapid prototyping, thus a learning and experimental phase. As such, this phase, in no way, shape or form, offers a complete solution.

Phase 2 centred on the following elements in order to satisfy and ultimately deliver the basic working prototype:

- Device / Hardware
- Data transmission
- Data capturing
- Data monitoring user interface
- Integration into a working system

After testing and field trialling, the final Prototype device make-up and configuration included the following features:

- GPS module with integrated antenna capable of providing accurate 1.8 m CEP (95) positional information data with time and date stamp;
- self-powered, self-contained independent unit that can function for up to 2 years;
- satellite transmission module capable of transmitting captured data via iridium satellite constellation without the need for land based communication such as GSM or RF;
- protective enclosure resistant to dust and water;
- on board logic/processor capable of programming and accepting external inputs where necessary/possible;
- sensors to identify tampering or removal of the unit;
- magnetic attachment of the device to vehicle.

After exploring numerous options and technologies, we determined that with the large number of variables associated with no standard log transporting equipment and the current available technologies, the development of a custom payload sensor would be prohibitive for this phase of the project.

### **3rd Party Data Integration – outline and final integration into the prototype user interface (UI)**

In order to further enhance the effectiveness of the solution as a whole and to deliver additional/essential information to the user, basic external data set integration was evaluated.

The following data sets (along with the ability to add and test additional data sets in KML and GeoJSON format) were converted where necessary and integrated into the prototype UI, all agreed upon and supplied by REM. All 3rd party data used is copyrighted to the respective copyright holders.

- Concession data set - World Resources Institute
- Hydropower - Moabi DRC
- Agricultural – Moabi DRC
- Indigenous Lands – Moabi DRC
- Logging Concessions – Moabi DRC
- Oil Concessions - Moabi DRC
- Protected Area - Moabi DRC
- Road Rehabilitation - Moabi DRC
- Transmission Lines - Moabi DRC

### **Data Monitoring User Interface**

A fundamental element within the system as a whole is the delivery of the data recorded by the device and presented to the user platform. It is imperative that this data is presented in a format that is both useful and intuitive to the user. This is also

where the system's automatic monitoring features are set, controlled and reports generated. As such, the core of the prototype monitoring system is the user interface.

In order to deliver an effective prototype solution rapidly and within the constraints of both budget and time, a suitable pre-existing framework was identified. This framework was then developed with significant customisation to suit the specific needs of the prototype solution and its user requirements.

The framework was then deployed as a web based portal allowing users with appropriate credentials to log in from any location on any computer through a dedicated website.

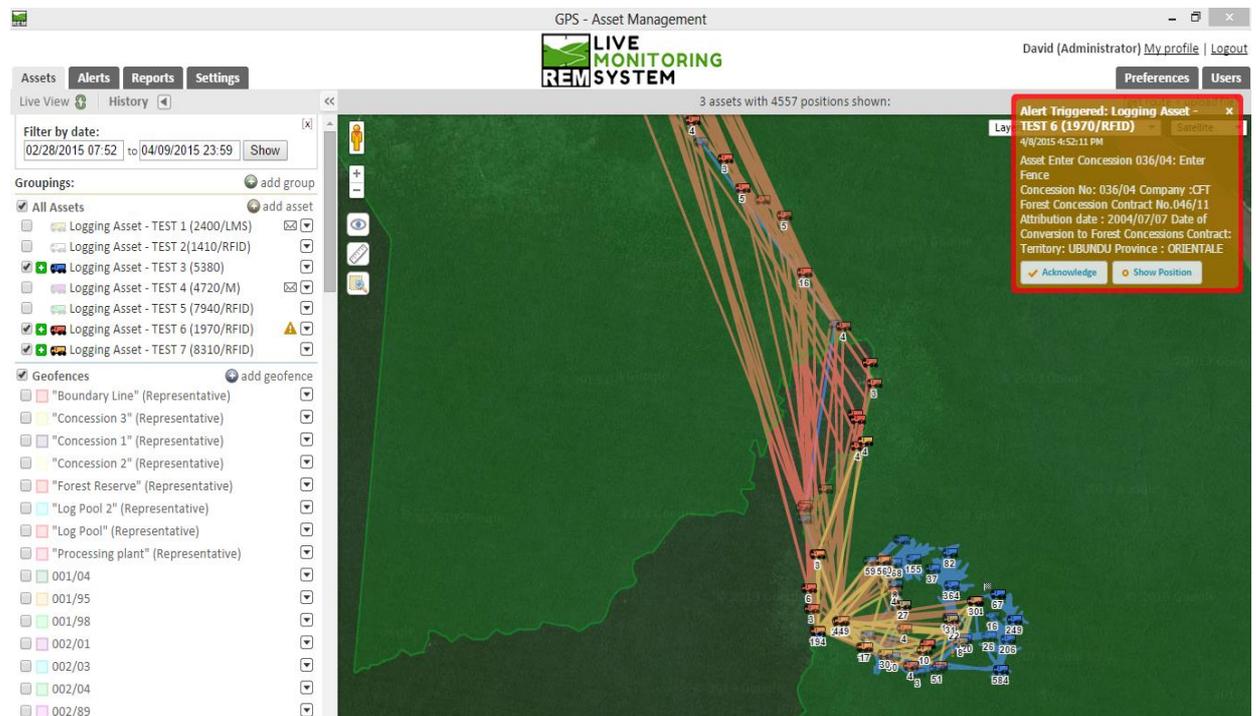
### Live Monitoring System – features and functionality working prototype

In order to better understand the system as a whole, below is an annotated series of diagrams to explain the prototype features and functionality of what the final system might contain.

#### Live Monitoring System dashboard

The Live Monitoring System dashboard, an example of which can be seen below, would sit at the heart of the system. Displaying a wide range of data, the user could quickly and easily identify information, system changes, along with notifications and violation updates immediately upon login. A fully customisable interface would allow the user to choose exactly which data sets they would like presented.

The user could decide which assets, geofences and places they wish to display by simply selecting the appropriate data sets displayed on the left.



## Assets

All assets attached to the system are listed and presented either as a group or a single asset depending on the setup.

Clicking on a particular asset displays its location on the map along with additional assets details aimed at assisting the user and provide them with quick access to working data.

The screenshot displays a software interface for managing assets and geofences. On the left, there are two main sections: 'All Assets' and 'Geofences'. The 'All Assets' section lists seven logging assets, each with a checkmark, a plus icon, a truck icon, a name, a location, and a dropdown menu. The 'Geofences' section lists various geofences, each with a checkmark, a colored square, a name, and a dropdown menu. On the right, a map shows the location of the selected asset. A 'Position Information' popup window is open over the map, displaying details for 'Logging Asset - TEST 3 (5380)'. The popup includes the date and time (4/9/2015 6:35:19 AM), address (Congo (DRC)), latitude and longitude (0.159718, 25.359773), speed (1.2 mph), and geofence information (Concession No: 036/04). Below the popup, there are expandable sections for 'General Information', 'Asset Details', 'Contracted To', and 'Asset Owner/Operator'. A photo of a logging truck is also visible in the 'General Information' section.

**All Assets** add asset

- Logging Asset - TEST 1 (2400/LMS)
- Logging Asset - TEST 2(1410/RFID)
- Logging Asset - TEST 3 (5380)
- Logging Asset - TEST 4 (4720/M)
- Logging Asset - TEST 5 (7940/RFID)
- Logging Asset - TEST 6 (1970/RFID)
- Logging Asset - TEST 7 (8310/RFID)

**Groupings:** add group

**All Assets** add asset

- Logging Asset - TEST 1 (2400/LMS)
- Logging Asset - TEST 2(1410/RFID)
- Logging Asset - TEST 3 (5380)
- Logging Asset - TEST 4 (4720/M)
- Logging Asset - TEST 5 (7940/RFID)
- Logging Asset - TEST 6 (1970/RFID)
- Logging Asset - TEST 7 (8310/RFID)

**Geofences** add geofence

- "Boundary Line" (Representative)
- "Concession 3" (Representative)
- "Concession 1" (Representative)
- "Concession 2" (Representative)
- "Forest Reserve" (Representative)
- "Log Pool 2" (Representative)
- "Log Pool" (Representative)
- "Processing plant" (Representative)
- 001/04
- 001/95
- 001/98
- 002/01
- 002/03
- 002/04
- 002/89
- 002/92

**Position Information**

Logging Asset - TEST 3 (5380)  
4/9/2015 6:35:19 AM  
Address: Congo (DRC)  
Lat/Lng: 0.159718, 25.359773  
Speed: 1.2 mph  
Geofences: Concession No: 036/04

**General Information**

Photo: 

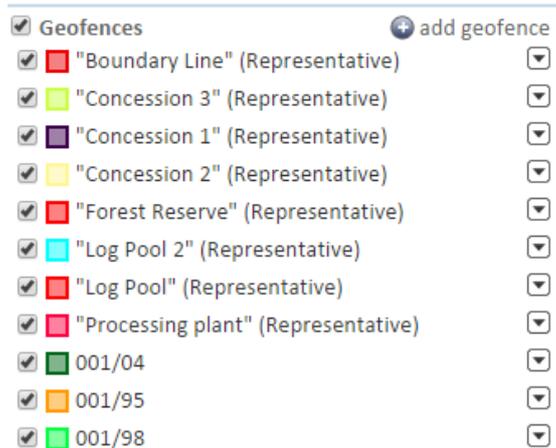
[Asset Details](#)

[Contracted To](#)

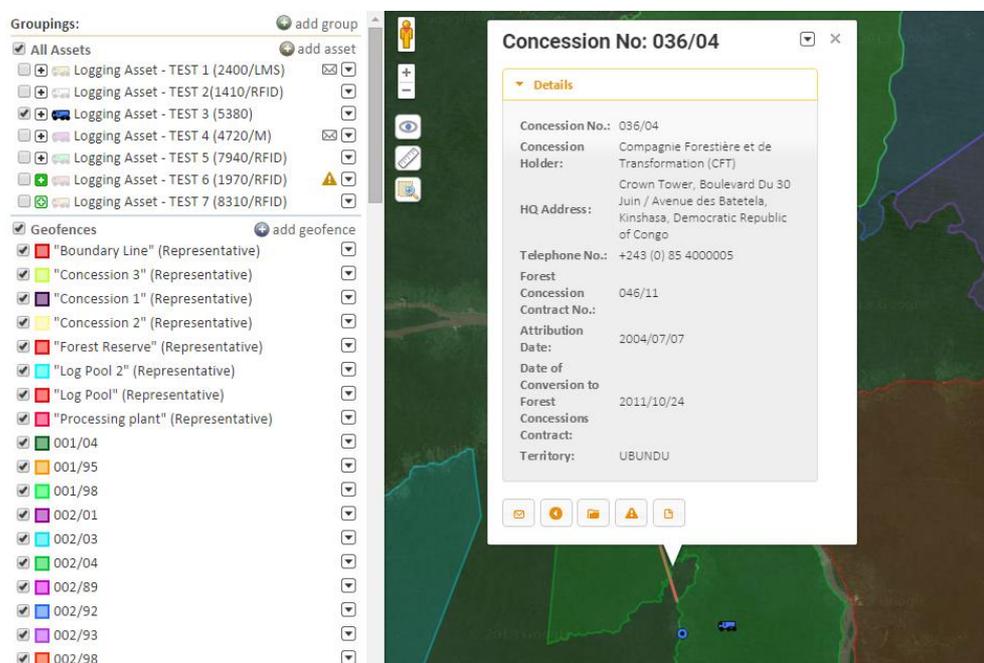
[Asset Owner/Operator](#)

## Geofences

All available geofences are presented in a list as well as on the map, with the user having the ability to display or hide data as they see fit.



As with the assets, clicking on a geofence (concession), shows its location along with additional working data.

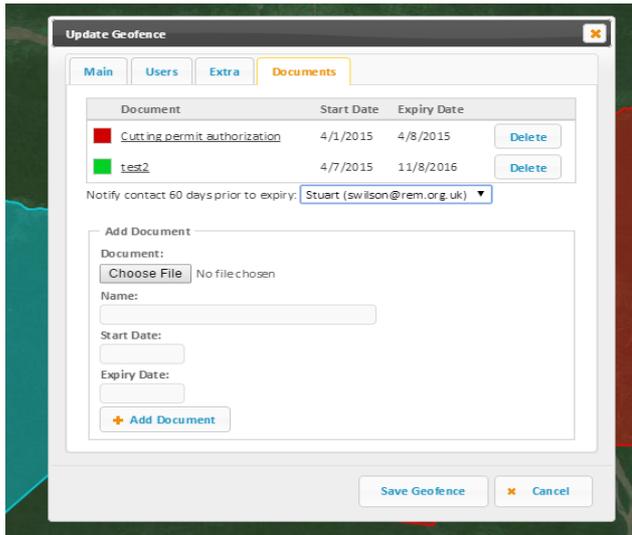


### Concession or cutting permit validity

In order for a geofence or concession/cutting permit not to be placed in an “alarmed” status and allow for the free movement of assets within its boundaries, a concession/cutting permit needs to be valid and have the necessary paperwork recorded on the system.

This feature allows for the close and automated monitoring of the compliance of a concession or cutting permit.

The system also changes the colour of the geofence from green to red as a visual indication of an expired concession/cutting permit, as well as notify a nominated user 60 days prior to expiration.



### Alerts and notifications

Essential to the automated monitoring element of the system, the user is able to define various alert settings to monitor the movements or interactions of an asset in and out of a geofence or concession.

New Alert

Name (optional)

Description (optional)

Resolution Procedure (optional)

Requires acknowledgement  
 Yes  
 No

Apply to group(s)  
 Apply to specific asset(s)

0 items selected	Remove all	Add all
		Logging Asset - TEST 1 (2400/LMS) +
		Logging Asset - TEST 2(1410/RFID) +
		Logging Asset - TEST 3 (5380) +
		Logging Asset - TEST 4 (4720/M) +
		Logging Asset - TEST 5 (7940/RFID) +
		Logging Asset - TEST 6 (1970/RFID) +
		Logging Asset - TEST 7 (8310/RFID) +

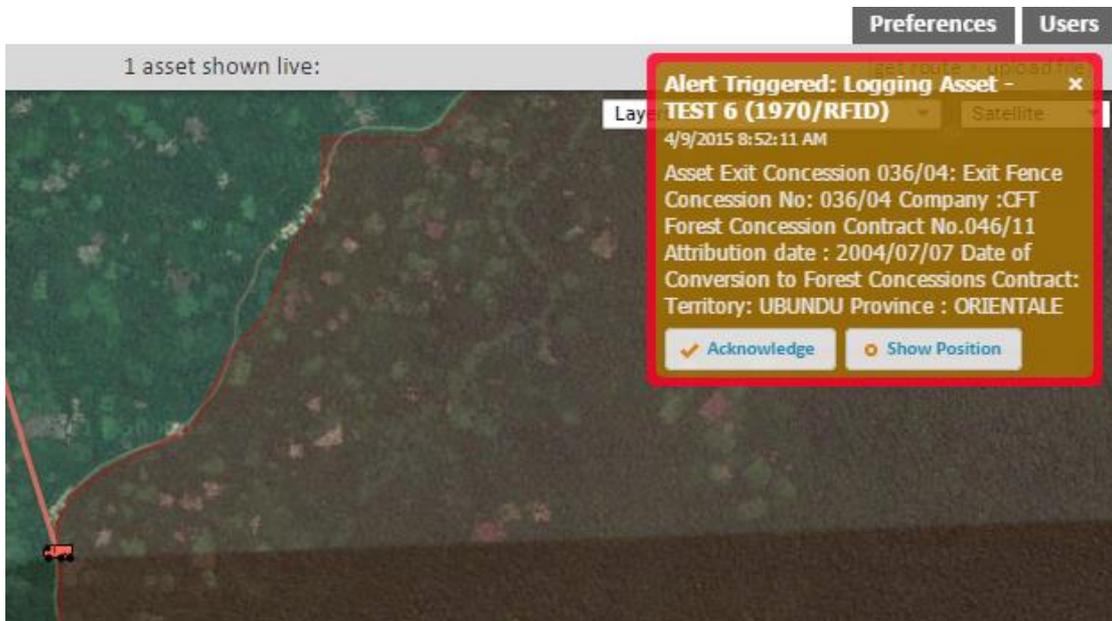
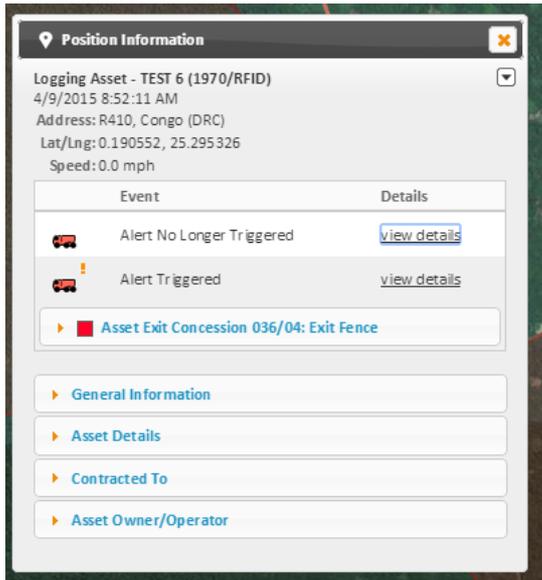
Type

Fences

This alert is triggered when a user-defined geofence is entered. This alert is stateful; There will be separate reports when it is triggered and then no longer triggered.

Alert notifications are presented to the user in several clear and noticeable ways, with some requesting an action to be taken by the user in order to validate. This includes email and SMS notification options.





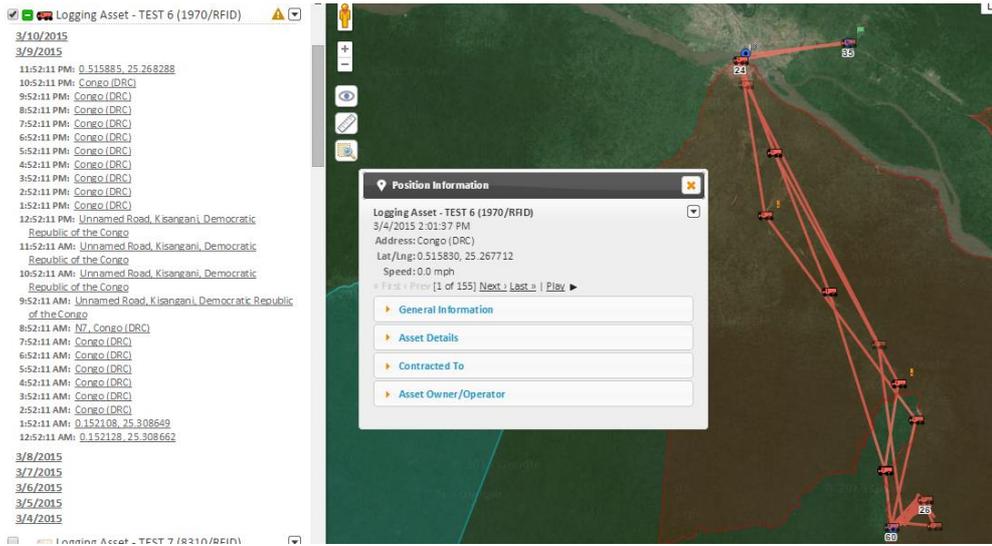
### Places

Like assets and geofences, important/significant places are listed on the system presenting additional working data to the user.



### History mode

History mode allows the user to select a date or date range to view the precise location/s of an asset or group of assets on that day or their movement over the selected period.



## Reporting

By applying various parameters and filters, the user has the ability to build a vast array of custom reports which can then be exported in various formats.

Report on asset(s)

1 items selected	Remove all	Add all
Logging Asset - TEST 7 (8310/RFD) (300234062948310)		Logging Asset - TEST 1 (2400/LMS) + Logging Asset - TEST 2(1410/RFD) + Logging Asset - TEST 3 (5380) + Logging Asset - TEST 4 (4720/M) + Logging Asset - TEST 5 (7940/RFD) + Logging Asset - TEST 6 (1970/RFD) (300234062331970) +

Date Range  
 Between  and

or

### Logging Asset - TEST 7 (8310/RFD)

Date	Address	Lat/Lng	Speed	Heading	Altitude	Near place(s)	Inside geofence(s)	Extra
4/2/2015 12:15:11 AM	Unnamed Road, Democratic Republic of the Congo	<a href="#">0.152468, 25.308823</a>	0.00 mph				Concession No: 036/04	
4/2/2015 1:15:11 AM	Congo (DRC)	<a href="#">0.152482, 25.308855</a>	0.00 mph				Concession No: 036/04	
4/2/2015 2:15:11 AM	Unnamed Road, Democratic Republic of the Congo	<a href="#">0.152480, 25.308788</a>	0.00 mph				Concession No: 036/04	
4/2/2015 3:15:11 AM	Unnamed Road, Democratic Republic of the Congo	<a href="#">0.152517, 25.308826</a>	0.00 mph				Concession No: 036/04	
4/2/2015 4:15:11 AM	Congo (DRC)	<a href="#">0.152597, 25.308489</a>	0.00 mph				Concession No: 036/04	
4/2/2015 5:15:11 AM	Congo (DRC)	<a href="#">0.148940, 25.300062</a>	0.00 mph					
4/2/2015 6:15:11 AM	Congo (DRC)	<a href="#">0.149008, 25.299963</a>	0.00 mph					
4/2/2015 7:15:11 AM	Congo (DRC)	<a href="#">0.149322, 25.300230</a>	0.00 mph					
4/2/2015 8:15:11 AM	Congo (DRC)	<a href="#">0.152398, 25.308805</a>	0.00 mph				Concession No: 036/04	
4/2/2015 9:15:11 AM	Congo (DRC)	<a href="#">0.152407, 25.308815</a>	0.00 mph				Concession No: 036/04	
4/2/2015 10:15:11 AM	Tshopo, Democratic Republic of the Congo	<a href="#">0.148360, 25.306549</a>	0.00 mph				Concession No: 036/04	
4/2/2015 11:15:11 AM	Congo (DRC)	<a href="#">0.149338, 25.300226</a>	0.00 mph					

Filters

Geofence:  
 Inside  Outside

Place:  
 Near  Not Near

Timeframe  
 days  hours  minutes  seconds

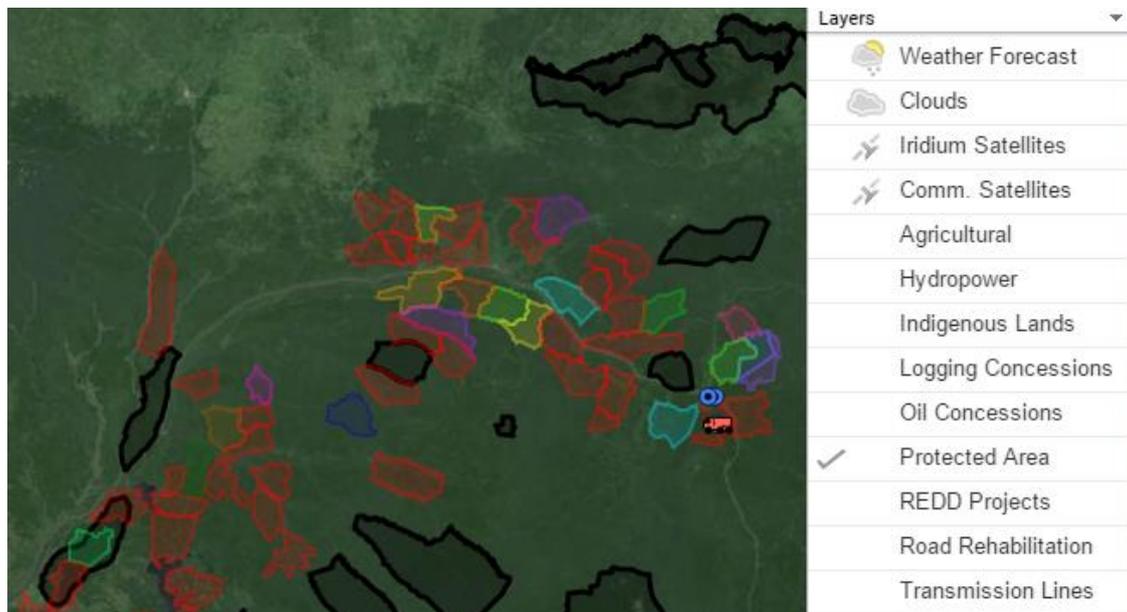
or

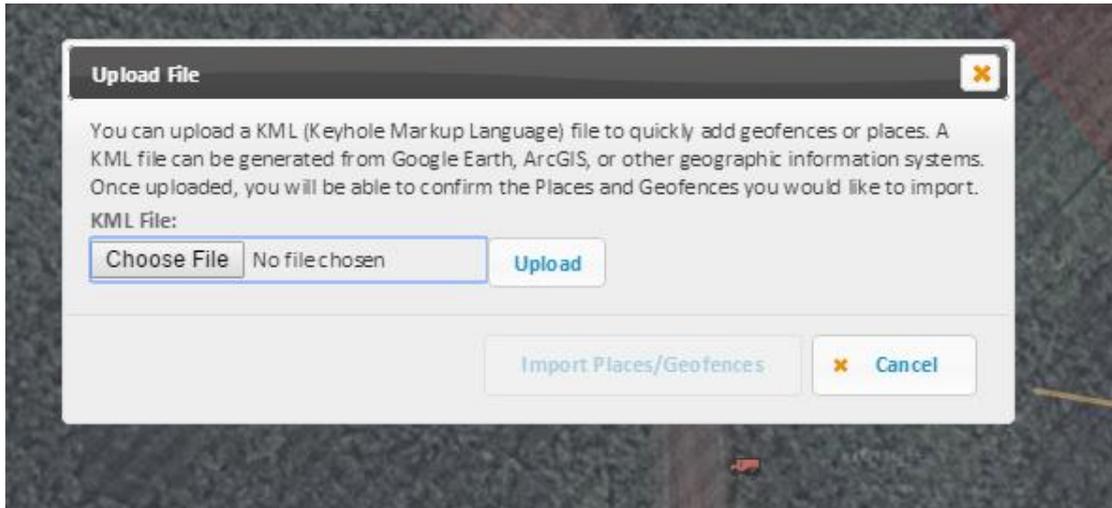
Moved within past 01:00:00
  Not moved within past 01:00:00
  Movement never reported

Asset	Device	Address	Locality	Near place(s)	Inside geofence(s)	Time	Driver	Phone Number	Plate Number
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### Layers and adding 3rd party mapping data integration

Layers offer the user further access to visual data by presenting additional information on the system map.



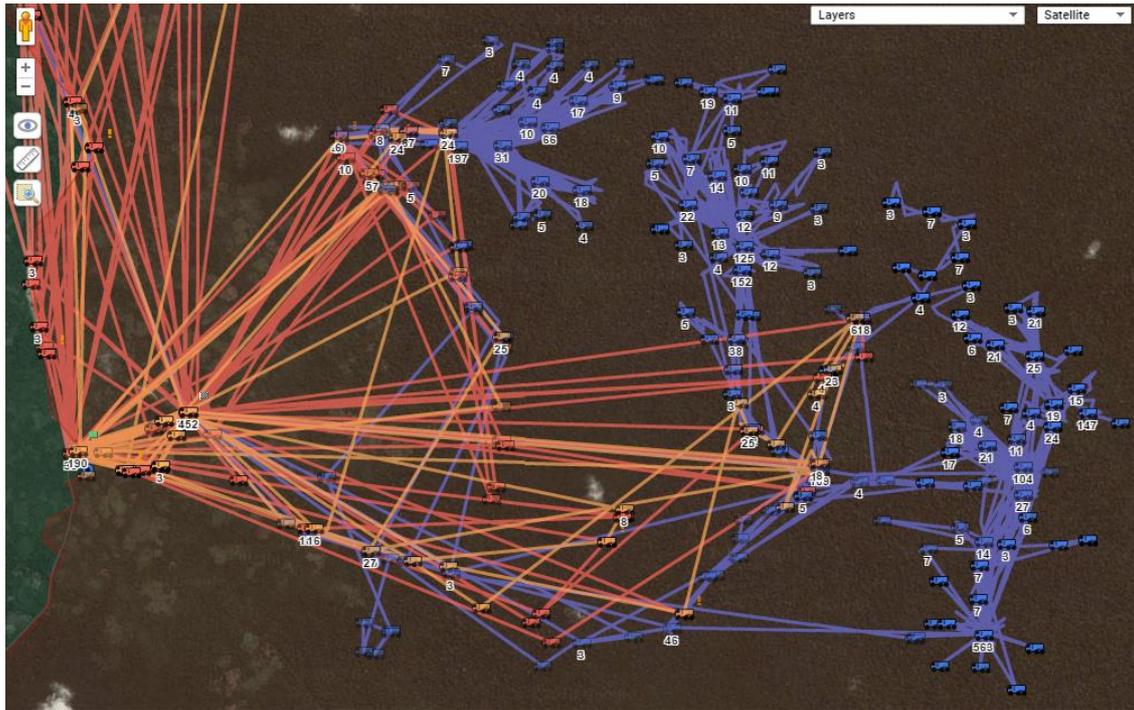


The system has the ability to have third party mapping data added through the built-in upload feature.

**Live test data of real logging activity, conducted as part of system trials**

Demonstrating the benefits and visualisation of the data captured, log extraction and onward transport to sawmill is clearly visible.





## Advantages of the Live Monitoring System

Real time reporting and access to information on the ground is crucial in any monitoring activity. The Live Monitoring System proposes to combine state-of-the-art technology with an intuitive and simple to use platform, delivering extremely powerful data sets and information in an effort to aid law enforcement and other monitoring bodies in their day-to-day activities.

Of significant benefit and one of the primary functions of the system and platform as a whole, is the user's ability to define geofences or boundary lines within operational areas or zones. These geofences or boundaries allow the system to monitor a single or group of assets within its perimeter and then notify the user of any potential violation of this zone. For example, a logging operator will submit an agreed concession management map of the area in which they can operate for a specific period. Once created, the system will monitor this zone and ensure that all assets operating within it respect its sub-boundaries, within the concession itself. Should activities be conducted outside of this area, then the user would be notified and due process follows to verify whether the data reveals an infraction. As this would be reported as trespassing happens, this monitoring aspect of the system would significantly mitigate the occurrences of this type of activity and allow the legality of timber origin to be verified.

In addition, the platform would allow users to access vast amounts of additional data, quickly and easily in a format not previously available, presenting the following advantages:

- Real time visibility of assets and their precise geographical location
- Creation of geofences and other such virtual boundaries
- Automatic monitoring and notification of any asset violating a particular boundary zone
- Group forest blocks identified by operators in their forest management plans
- Access to operator details including concession license and number of active assets
- Rapid location of any asset based on its unique ID
- Automatically generated reports used in investigations of concession boundaries' violation or other such infringements
- Integration of information from additional sources, such as the World Resources Institute
- Rapid access to a wide variety of data, all located under one application
- Generation of significant statistical information quickly and easily
- Audit and track user activity on the platform based on the users unique login ID
- Viewing of historical data in an innovative and intuitive manner
- RFID reader capabilities, allowing for the potential integration of chain of custody systems
- Integration with vehicle management systems

The combined benefits of the Live Monitoring System in conjunction with its ability to effectively monitor assets at source, enables:

- Ensuring the overall legal compliance of logging operations
- Ensuring compliance with sustainable forest management plans
- Mitigating the export of illegal logs by tracking their transport from stump to port
- Monitoring operations well beyond what a company or operator may be showing
- Ensuring that companies stick to their logging rotation sustainable forest management plan
- Allowing organisations to track and monitor their own personal assets, optimising productivity and work flow
- Reducing the need for expensive and time consuming field team monitoring/law enforcement

It is important, however, that the Live Monitoring System is not seen as a tool specifically for one user type. It aims to deliver value and functionality to a wide-range of users and organisations alike. For example:

- Law enforcement and monitoring organisations
- Concession operators
- Government and Governmental departments
- Independent Monitors

## Conclusion

With mismanagement, corruption and over-exploitation high on the agenda for all those who are involved with the delivery of sustainable and legally sourced timber worldwide, the sector is under ever-growing pressure to introduce reforms that seek to ensure that forest resources achieve commercial, conservation and community goals which benefit the country of origin more effectively.

As such, new tools and technologies are needed to deliver and maintain good governance within the forest sector and the countries of origin themselves, delivering greater transparency and accountability.

The Live Monitoring System offers such a solution, providing a powerful and adaptable monitoring platform, equipping law enforcement and independent monitors with essential real time data needed to control and prevent over-exploitation and the illegal logging of timber.

After testing multiple systems, both hardware and software, we were able to deliver a highly effective working prototype of the Live Monitoring System.

The prototype system delivered all of the features and functionally presented in the report above, and has the potential to address many of the core issues facing over-exploitation and illegally logged timber.

The working prototype system clearly demonstrates the benefits and allows for great insight into the mechanism and requirements for full scale rollout. It also allows for

extensive and continued real world testing and feature development, as the project has engaged with key stakeholders.

Building on the progress made in this phase, next steps would involve further deployment of both the hardware and software in conjunction with a pilot test phase, where the system would benefit from further testing in real world conditions, evolving where necessary to deliver a more complete and robust solution.

### Tracking prototypes 2 and 3

