Lead-Acid Battery Reserve Assurance

The scientific, non-invasive and modern way to track battery capacity in storage applications.

BATTERY APP USER GUIDE

WELCOME

This new tool helps organizations easily track battery capacity with the same scientific test method used by large Telcos. Designed per my specification and manufactured in Florida, the offering is built upon a proven, flexible and highly secure GPS-based IoT asset tracking platform.

To learn more about the actual test method (and physics behind it) you can download my Battcon papers from the portal help (?) menu. It explains how the technique is used to:

  1) gauge reserve time; 2) warn of battery end-of-life; and 3) detect premature battery failure!

My mission is to advance this patent-pending digital fuel gauge technology, while helping operators and VARs deploy *sustainable* solutions for workers and stakeholders to assure battery reserve.

David F. Essi III
Founder and Chief Technologist
LABRA Technology, LLC
www.LABRATechnology.com
dave@**LABRATechnology**.com

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SENSOR INSTALLATION

The LABRA Technology IoT Sensor is a specially designed high-precision voltmeter that uses a cellular connection to track voltage in the cloud during a Battery on Discharge (BOD) condition. No Ethernet or IT setup is needed to collect data.

It was designed primarily to monitor a battery bank (multiple strings) as found in 48V DC communications backup systems. However, it can monitor lower voltages (as low as 8V) in 12V solar applications.

IoT Voltmeter / BOD Sensor

Safety
Per UL 60950 ITE (Information Technology Equipment) section 1.2.4.3, the device is a **class III** electrical appliance designed for connection directly to a SELV[1] battery voltage.   Note: The device is protected against reverse polarity and when connected properly will report out upon each successful power-up condition.

Mounting Location
With its redundant GPS technology, the sensor is designed to function in less than ideal environments, however the technology relies on good cellular signal for optimal performance. If possible, position the sensor where it has the least obstructed view to the sky.

If necessary, the sensor can be mounted near any sense point (apart from the battery bank) where the bank voltage can be easily measured, such as a Battery Distribution Fuse Bay (BDFB).   In such a case, if there is an appreciable voltage drop at the chosen sense point, a voltage offset setting can added as part of the sensor setup.   Note the Calibration Offset setting on page 5 located next to the BOD Alarm Threshold setting.

Note: due to the nature of all wireless technology, this device will perform poorly inside a metallic enclosure.

Measuring Bank Voltage
Connect the red and black battery voltage sense leads to the sensor (e.g. using a butt splice).

Red wire: (+) **Positive** Battery

Black wire: (-) **Negative** Battery

Note: in a negative grounded battery (-48V DC), the red wire should be connected to ground.

Auxiliary Voltage Inputs
The Aux inputs are referenced to negative battery and should not exceed 60 VDC. Intended use is to track other voltages within the same string, or the midpoint on parallel strings (e.g. to detect voltage imbalance conditions). Black is common to the brown (Aux1), blue (Aux2) and white (Aux3) wire voltage inputs[2].
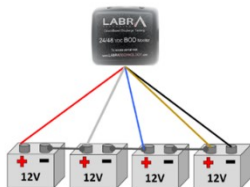
Example wiring diagrams using 3 Auxiliary inputs for tracking block voltages, or mid-string voltages: Aux 1 (Brown), Aux2 (Blue), Aux 3 (White).
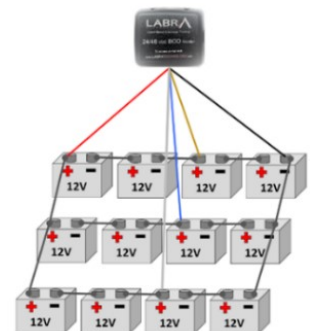
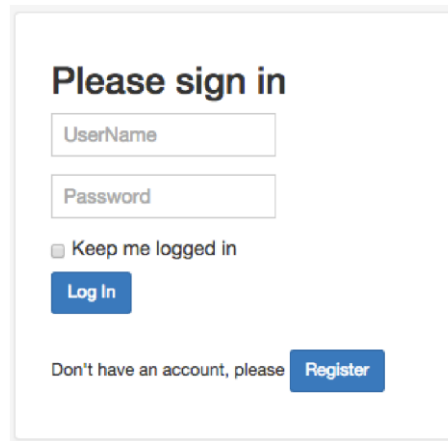[1] Safe Extra Low Voltage (SELV); less than 60V DC and galvanically isolated from AC mains voltage.
[2] For prototype 24/48V BOD units with only 2 Aux inputs, use green (Aux1) and white (Aux2) wires.

QUICK START GUIDE

REGISTRATION & SETUP

Visit: https://labra.inventuretrack.com/ and click on blue Register button to create an account.

This will display the registration page. Then click the blue register button and follow the instructions.
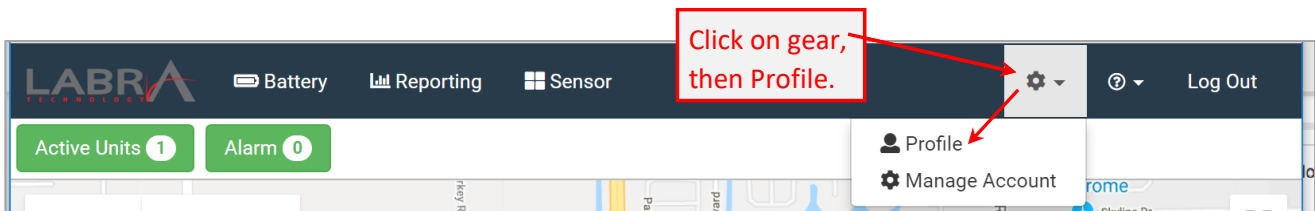
Please sign in
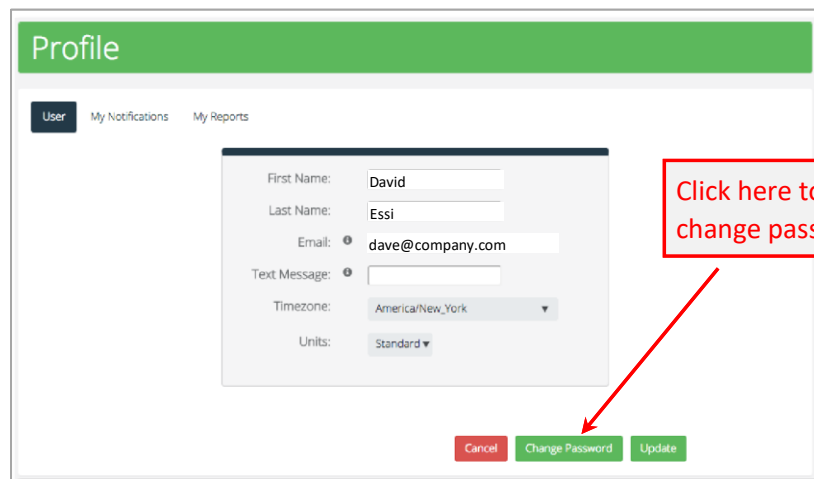
UserName

Password

☐ Keep me logged in

Log In

Don't have an account, please [Register]

Profile Setup

To edit your profile information such as name and email, click the gear at the top right of the portal. In the dropdown, select Profile. The User profile loads where you can edit your name, email, cell phone number, etc.

Click on gear, then Profile.

LABRA TECHNOLOGY | 🔋 Battery | 📊 Reporting | ▦ Sensor | ⚙ ▾ | ❓ ▾ | Log Out

Active Units 1 | Alarm 0

👤 Profile
⚙ Manage Account

If you wish to change your password, click the Change Password button on the bottom right. Another page will load and ask for your current password, and then ask that you input your new password once and again to confirm. Press Update to save the changes.

Profile

User | My Notifications | My Reports

First Name: David
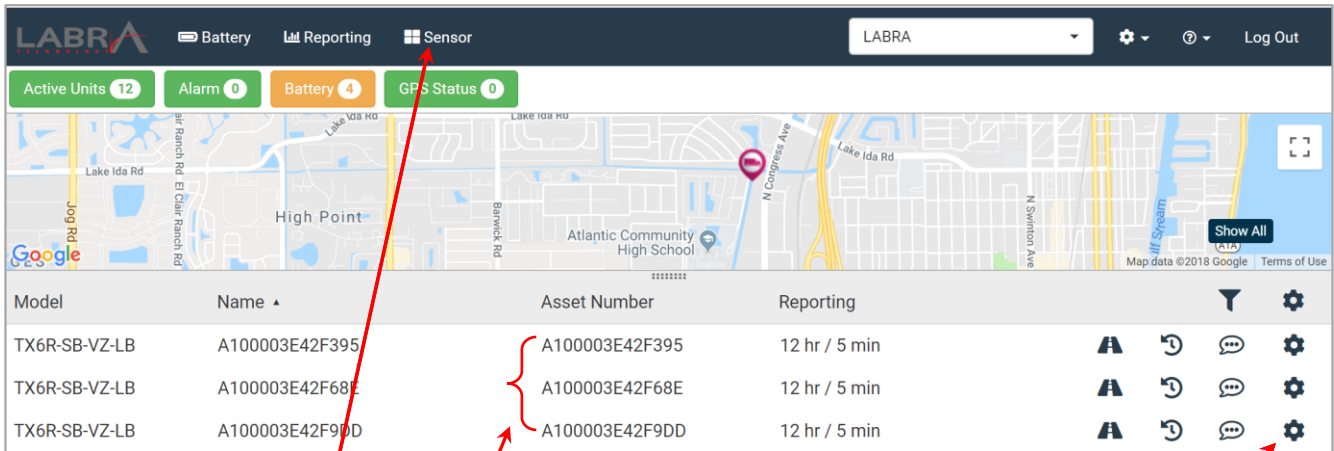Last Name: Essi
Email: ❶ dave@company.com
Text Message: ❶
Timezone: America/New_York ▾
Units: Standard ▾

Click here to change password.

Cancel | Change Password | Update

ACTIVATING THE SENSOR: $1-2-3$

The BOD alarm threshold ships with a setting of 0 volts (= off) and must to be changed to collect discharges. Click on the Sensor menu to display the sensor dashboard and retrieve a list of sensor(s).
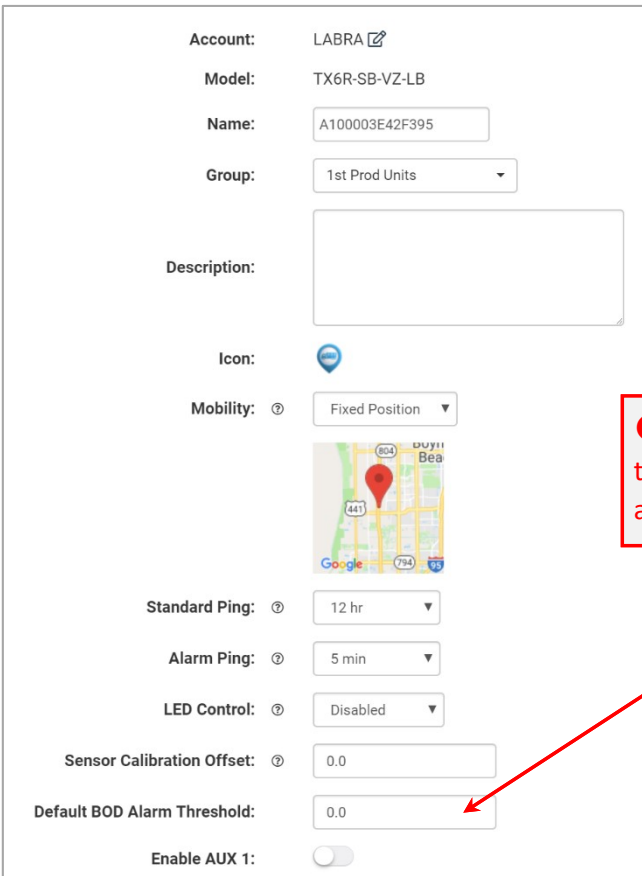
Model	Name ▲	Asset Number	Reporting				
TX6R-SB-VZ-LB	A100003E42F395	A100003E42F395	12 hr / 5 min	A	🕑	💬	⚙
TX6R-SB-VZ-LB	A100003E42F68E	A100003E42F68E	12 hr / 5 min	A	🕑	💬	⚙
TX6R-SB-VZ-LB	A100003E42F9DD	A100003E42F9DD	12 hr / 5 min	A	🕑	💬	⚙

❶ Click Sensor menu for Sensor dashboard & list.

Account:	LABRA 📝
Model:	TX6R-SB-VZ-LB
Name:	A100003E42F395
Group:	1st Prod Units
Description:	
Icon:	📍
Mobility: ⓘ	Fixed Position ▼
Standard Ping: ⓘ	12 hr ▼
Alarm Ping: ⓘ	5 min ▼
LED Control: ⓘ	Disabled ▼
Sensor Calibration Offset: ⓘ	0.0
Default BOD Alarm Threshold:	0.0
Enable AUX 1:	⚪

❷ Click on gear to open settings dialog box below.

❸ Set the BOD alarm threshold to the desired threshold (e.g. 51.25V) and press save.

Note: sensor settings will take effect the next time the sensor is scheduled to report in, which could take 24 hours. The unit also reports in whenever power is removed and re-applied.

GRAPHING A DISCHARGE: $1-2-3$

Once the sensor is updated with a valid BOD alarm threshold, it will record 5m averages during the discharge. The actual report frequency during the discharge depends on the alarm ping rate setting (see page x).

❶ Click Battery for the battery dashboard & list.

❷ Click on graph icon to open the graphing dialog box.

❸ Click the graph checkbox to display the actual discharge.

INTRODUCTION

LABRA Technology is an **App** built on a proven and highly secure IoT computing and hardware platform designed and made in the USA. The solution includes a high-precision voltmeter sensor and special algorithm that enables a revolutionary approach for gauging and tracking reserve time in lead-acid battery storage applications.

The main cloud application by InventureTrack Systems provides powerful reporting and grouping features to foster collaboration among the Operators, OEMs and VARs that install, service and test lead-acid batteries. Geo-map icons indicate status such as battery health, charge status and fuel gauge bars during a discharge.

The centerpiece of the solution is the patented voltage-slope algorithm that calculates reserve time during a discharge. A self-calibrating algorithm, it helps solve two long-standing problems for constant load applications:

> 1) It provides an actual time-to-empty fuel gauge (not %)

> 2) It gauges reserve time early (~25%) into the discharge

The net result is a *universal* reserve-time gauge based on physics that can help flag potential battery reliability and EOL issues when used in conjunction with an alarm threshold (e.g. set at 80% of expected reserve time).

METRICS AND DEFINITIONS

The following battery terms and settings are defined for this application.

| BOD	Battery on Discharge	Voltage alarm condition when a battery is discharging, each Battery asset has a voltage threshold to assert when a BOD condition occurs. Note: each sensor includes a default BOD threshold setting of 0.0 volts.
ERT	Expected Reserve Time	The expected (or engineered) backup time (e.g. 8 hours) to when the preset end-voltage (e.g. 42.0 volts) is actually reached.
TTE	Time-to-Empty	While on discharge, this is the predicted time (in minutes) to the preset end-voltage. During the initial part of the discharge the TTE value is simply a countdown timer preset using the ERT value. Once predictions become valid (roughly 25% into the discharge) the TTE countdown time is updated with the new prediction. Updated predictions are made at every alarm reporting cycle.
CRT	Calculated Reserve Time	This is calculated total backup reserve time, which is the sum of TTE prediction plus time-on-discharge (TOD) when the prediction is made; CRT = TTE + TOD. Essentially this is the demonstrated total backup reserve time and during the course of a discharge for a healthy battery, this figure will remain fairly constant. It is re-evaluated periodically during the discharge according to the alarm report (ping) frequency.
SOC	State-of-Charge	Indicates the battery charge status, and how long it has been at the standard charge (float) voltage. See related SOC icons.
SOH	State-of-Health	Indicates a health concern, such as a mid-string voltage imbalance or unusual voltage slope. See related SOH icons.
EOL	End-of-Life	Alarm condition when the CRT falls below a preset (e.g. 80%) of the *Engineered Reserve Time* setting (e.g. 8 hours).

ASSETS AND DASHBOARDS

The application consists of a geo-map dashboard for two kinds of assets: batteries and IoT (voltmeter) sensors. The dashboards has an upper pane for the Map view and a lower pane for the asset list; panes are separated by a slider-bar to adjust how the screen is shared. Click on the name to switch between dashboards.
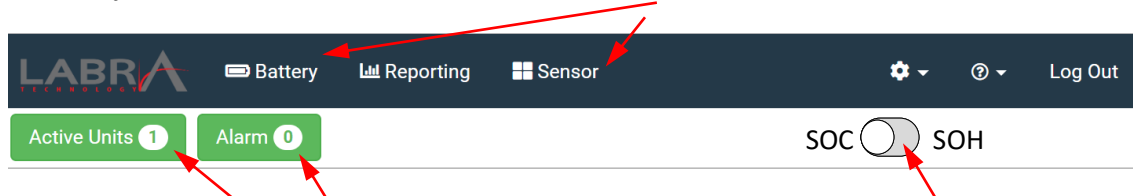
Dashboards have Quick Filter buttons, while the Battery Dashboard employs a slide-switch to select between the battery status icons: State-of-Charge (SOC) or State-of-Health (SOH).

List View Customization

To customize a list view, first open the edit dialog box by clicking on the <u>top</u> gear icon in the header row. Then select items to display with these buttons and then the order they appear.
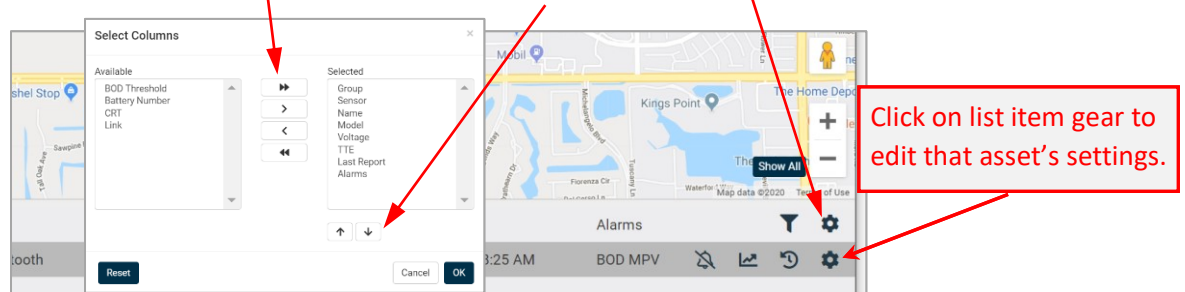
Battery Assets

A battery asset is automatically created in the database when a sensor reports in with a discharge. However, it is also possible to manually create a battery asset, which may useful when the sensor is used as a portable testing device to record a battery rundown test. When a battery is manually created, it must then be assigned to a sensor. See the Battery Setup Menu on page 13.

Help Menu

To download this User Guide and White Papers or submit a Support Request click on the Help menu.
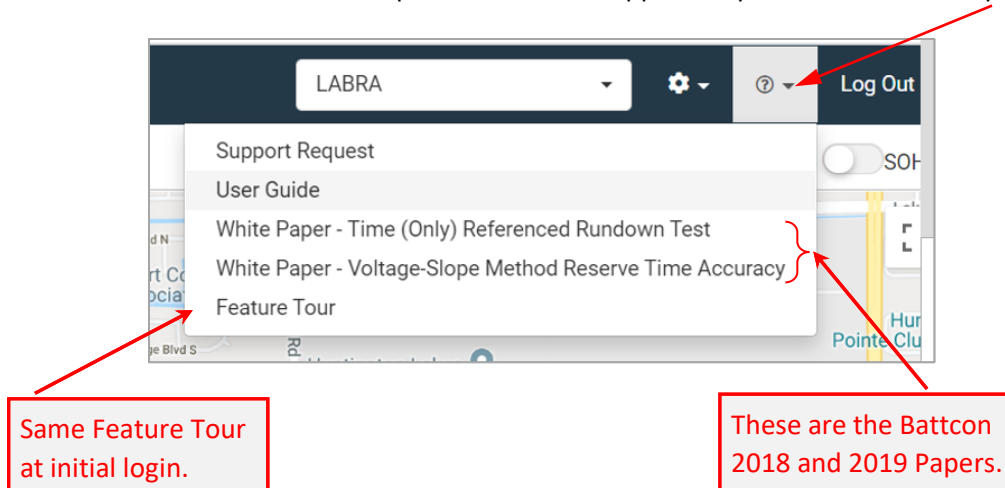
BATTERY STATUS ICONS

State-of-Charge (SOC)

The following icons designate the battery state-of-charge.

	Reserve Gauge	Charging at float voltage > 24 hours (No Alarms)
	Reserve Gauge	Charging at float voltage < 24 hours (No Alarms)
	Reserve Gauge	Charging below float voltage (With Low Voltage or Other Alarm)
	Reserve Gauge	Estimated TTE > 90% of Engineered Reserve Time (ERT)
	Reserve Gauge	Estimated TTE > 80% of ERT
	Reserve Gauge	Estimated TTE > 60% of ERT
	Reserve Gauge	Estimated TTE > 40% of ERT
	Reserve Gauge	Estimated TTE > 20% of ERT
	Reserve Gauge	Estimated TTE < 10% of ERT
	Battery Null State	Undefined or missing (power removed).

State-of-Health (SOH)

The following icons designate the battery state-of-health.

	Battery OK	No alarms are present
	Check Battery	Bad voltage-slope detected (as reported by Lambda Function)
	Battery Imbalance	Midpoint voltage deviation threshold exceeded on AUX inputs
	Check Battery	External Voltage Battery Fail Alarm feature (using AUX inputs; future)
	Battery End-of-Life	CRT Value detected below EOL Threshold (e.g. 80%)
	Battery Null State	Undefined or missing (power removed).

BATTERY SETTINGS

Depending on your account permission, you may access all or some of the settings described below.

SENSOR SETTINGS

Depending on your account permission, you may access all or some of the settings described below.

Note there are two types of ping rates and two types of logging rates. The ping rate controls the frequency of cellular call outs while the logging rate controls the density of the data collection.


Select either Fixed or Mobility.

When Mobility is set to Fixed, click here to manually drop a pin.

This is the default BOD alarm that actives alarm ping and logging rates. The BOD setting in the Battery setup takes precedence.

Logging rates govern the rate of data collection during normal and alarm conditions. Shown here, the normal logging is a one-hour average while alarm logging captures a 5-minute average.

ACCOUNT MANAGEMENT

To manage your account, in the upper right hand of the menu click on gear icon, then select the desired item.
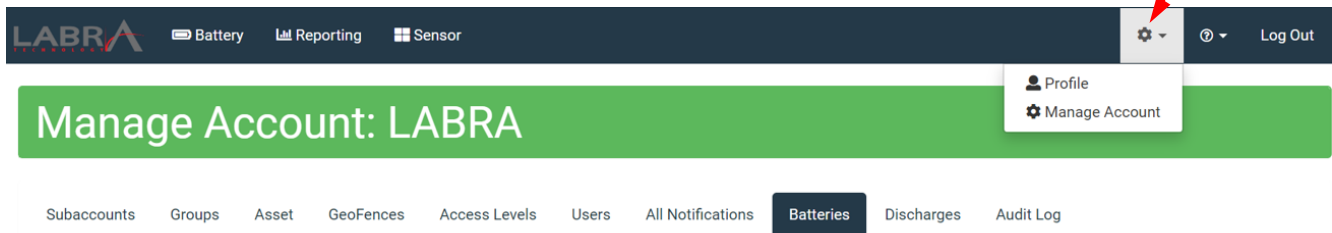
Depending on your account permission, you may access all or some of the tabs that are described below.

SUBACCOUNTS

If you are an Admin, you may find that some of your enterprise clients may need similar portal functionality to what you have. The portal provides the ability to create sub-accounts to fulfill this need. To create an account within your own, a sub-account, click on the Sub-account tab at the top of the Manage Account page. Then click Create New Account. If this feature is not available and you need it, please reach out to your account support representative to enable this feature.

GROUPS

The ability to create Groups is powerful feature that allows multiple items such as users, batteries or sensors to be put into set. Groups are useful for restricting view or access to specific assets by region, as an example.

a)	By default, the root group is called "Company" and any groups created will reside under it.
b)	Assets, Users, and Geofences are assigned to the Company group by default. So, a Geofence assigned to the Company Group would cause said Geofence to be automatically assigned to all of the Assets in the account.
c)	Groups can have Subgroups; this collection of Groups is known as a Group Tree. See the example and explanation on the next page.
d)	An Asset is assigned to Geofences in its Group and all of the Groups above it.
e)	A User can view all of the assets in his or her Group and below.
f)	Users in higher Groups can view assets in lower Groups; by default, Company Group can see all Assets.

Example Group Tree
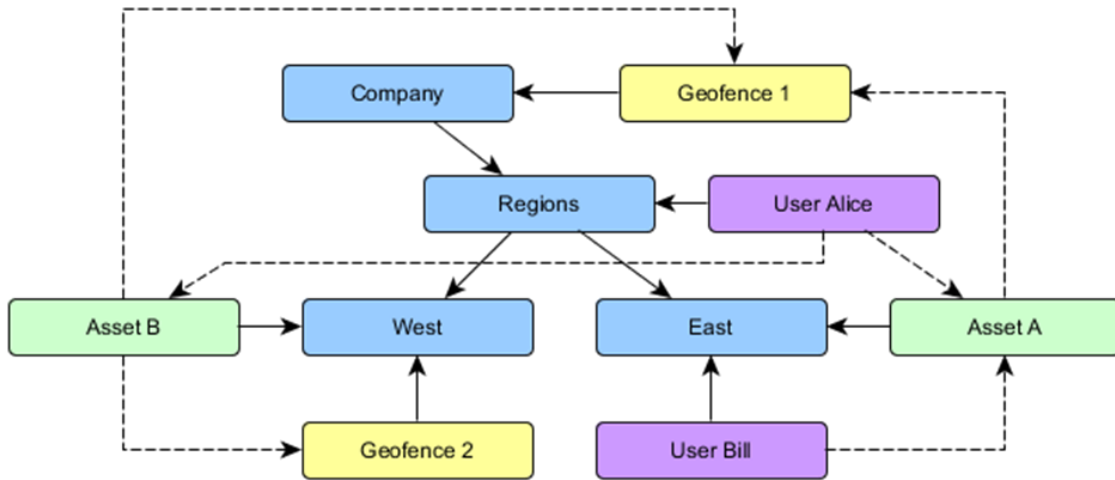
Explanation of Example Group Tree

● Group hierarchy: root is Company, Regions subgroup of Company, East and West subgroups of Regions
● Geofence 1 in Company Group, Geofence 2 in West Group
● Asset A in East Group
    ○ Assigned to Geofence 1 because Geofence 1 in Company and East is a subgroup of Company
● Asset B in West Group
    ○ Assigned to Geofence 1 because Geofence 1 in Company and West is a subgroup of Company
    ○ Assigned to Geofence 2 because Geofence 2 also in West Group
● User Alice in Regions Group
    ○ Can view Asset A and Asset B because both Assets are in subgroups of Regions
● User Bill in East Group
    ○ Can view Asset A because he is also in East Group

ASSET

The Asset tab view lists all the sensors in your account. You can filter by group and model number as well as search for specific assets using the search feature.   Beneath the filters is the filtered list showing the model, name, description, asset MEID/IMEI (mobile equipment ID), current ping schedule, and the last time that asset reported. Click on the View Asset button to see its Geo-location. Click on the gear icon to edit sensor settings.

GEOFENCES

The Geofence feature allows you to create virtual barriers for assets. This tab view lists all the active geofences and allows you to add, edit, and remove them. Click on the gear icon to edit and assign it to a group. Use the Create New Geofence button to draw a custom fence; click on the map where you want the shape to begin. Continue clicking around the map until you have the shape you desire.

Click gear to Edit Geofence and assign to a group.

ACCESS LEVELS

If you are an administrator, it is possible to create access levels for different types of users and give them custom names. Customize what kind of access you want each role to have, whether it's read/write, read-only, and what things can be edited.

USERS

This tab shows all of the users in the account, the group the user is assigned to, the username, name, role, Time Zone, and last login. PLEASE NOTE: It does not list users in any subaccounts.

Clicking on the gear icon will take you to that user's Edit Profile page. If a user needs to reset their password, as an Account Manager you can send that user a password reset by clicking the green Send Welcome Email button next.

NOTFICATIONS

This tab shows all notifications in the account. As an admin you may add, remove, and edit them as needed.

BATTERIES

This tab lists all the batteries in the account. Click the Add button to create a Battery or the gear to edit the Battery settings (see page 10 for details).

DISCHARGES

This view lists all the discharges, and respective Calculated Reserve Time values.

Click to Edit or Delete the Discharge Information.

Update Calculated Reserve Time.

Download **JSON** File Format.

REPORTING DASHBOARD

This dashboard provides 5 default report types: Asset List, Asset Alerts, Asset Reporting History, Asset Sensor Data, Asset Configuration History. You may create a new report, view/edit a saved report, or view/edit a shared report.

● You can give the report a name and if you plan on saving it, you can decide whether this report should be private, accessible only to specific user groups (if user groups are enabled in your account), or public by selecting those options from the Visibility drop down.

● Some reports have filters to help you narrow down results. You can select which columns to view in your report by checking or unchecking labels in that section.

● Select how much data to view on one page by selecting the drop down box Items per page and choose one the following options: 10, 25, 50, 100.

● After naming the report, save it, and it will appear under the Reporting tab under My Reports.

● To update an existing report, simply press the save button, and press save again in the new dialog box.

● The report will be overwritten with the new parameters when you press the save button.

● To delete a report, go to the top right corner of the dashboard and click your name, then select Profile, and click the reports tab. Under the Delete column, check the report you'd like to delete and press update.

● You can export reports by pressing the export button on the top right. This will immediately initiate a download of the report.

ALGORITHM FAQs

What is the Calculated Reserve Time (CRT), and how does it relate to the Battery Calculation Mode?

Calculated Reserve Time is a new battery metric based on the battery reserve algorithm discovered at Bell Labs and later patented by Telcordia Technologies. LABRA Technology has reverse-engineered the voltage-slope technique and encoded refinements into a microservice URL end point.[3]

Similar to a scientific calculator mode (octal, decimal and hexadecimal), the Battery Calculation Mode is a setting that defines the mode[4] performed by the microservice. Mode 1 and 2 correspond to Methods 1 and 2 described in the patent; Method 3 (voltage-based calibration) is not yet implemented. The default is Method 4 uses the refined LABRA gauge.

How does the voltage-slope fuel gauge compare to other gauges that count coulombs (charge)?

A simpler and logical choice for a battery fuel gauge, the voltage-slope technique offers these benefits:

> *"The No Fuss Fuel Gauge"*
>
> **C**redible – Based on Simple Physics; Not a Model; No Cal; No Amps
>
> **A**ccurate – Highly Accurate ($\pm$ 3%) as Early as 20% into Discharge
>
> **R**obust – One Setting; Self-Correcting; Adjusts for Bad Cells
>
> **E**xceptions – Downward Trending CRT Indicates Either:
> 1. Premature Battery Failure
> 2. Battery End-of-Life (e.g. < 80%)
> 3. Change in Load or Strap Connections

In addition, it does not require attention to aging or efficiency factors required for coulomb counters.

Can other algorithm methods be defined? Yes, please setup a meeting with LABRA Technology to discuss.

Does the algorithm reduce the value of or the need to do impedance testing? No. Periodic impedance tests can reveal battery degradation or poor battery strap connections.

Can the algorithm work with NiCd batteries? In theory yes, since NiCd and Lead-Acid have similar energy densities, though it could require a tweak to the algorithm divisors.

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[3] The endpoint uses AWS Lambda server-less technology; hence the use of a Lambda character in the company logo.
[4] The Calculation Mode is similar to a scientific calculator display mode (octal, decimal and hexadecimal).

TIPS

About Pings

The standard ping rate is a scheduled report that will wake up the GPS module regardless of any sensor related rules that have been established by the user; the asset will wake up regardless of whether it is in motion or still and report in.

The alarm ping rate is activated when a user defined alarm event occurs. Once the event takes place, your asset will report immediately and display the alarm event(s) on the web portal, then go to sleep for the duration of the alarm standard ping. If another alarm event occurs after the alarm ping time has passed, the asset will enter into alarm mode again.