CelloTrack Nano
Product Overview

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Intellectual Property

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1 Introduction

The purpose of this document is to provide high-level information required by service providers and enterprises wishing to utilize the CelloTrack Nano 20 as a standalone asset monitoring option, or as part of a wireless sensor network (WSN) solution (the CelloTrack Nano solution). The CelloTrack Nano 20 offers real-time visibility, security and awareness of cargo and asset location, in addition to the condition, problems and delays throughout the supply chain.

1.1 Document Scope

This document describes the high level system features and capabilities of the CelloTrack Nano 20. For further details about MultiSense devices, the other main component of the CelloTrack Nano solution, refer to the *CelloTrack MultiSense Product Overview*.

This document does not deal with the protocols and interfaces between the CelloTrack Nano 20 and the backend, nor with the algorithms and logic engine implemented in order to deliver a complete remote monitoring and tracking system. These protocols, APIs, and algorithms are described in separate documentation, as listed in the following sections.

1.2 Definitions, Acronyms and Abbreviations

Name	Description
WSN	Wireless Sensor Network
CelloTrack Nano 20	Asset & Cargo Management IoT solution using internal sensors and also functioning as a hub for a Wireless Sensor Network (WSN) together with MultiSense devices.
Lone worker	Customer responsibility working under SAR certification
MultiSense	Cellocator's WSN endpoint sensor device
BT	Bluetooth
BLE	Bluetooth Low Energy (BT Smart)
PCB	Printed Circuit Board
OTA	Over The Air
ALS	Ambient Light Sensor
FOTA	Firmware Update Over The Air

Table 1: Definitions, Acronyms and Abbreviations

1.3   References and Bibliography

No.	Document Name
1	CelloTrack Nano 20 – Release Notes
2	CelloTrack Installation Guide
3	CelloTrack Nano Evaluation Suite Manual
4	CelloTrack MultiSense Product Overview
5	Cellocator Cello Programming Manual
6	Programmer Manual
7	Serial communication Protocol
8	Wireless Communication Protocol

Table 2: References and Bibliography

1.4   List of Changes

Version	Change	Remarks	Date Approved
1.0	1st version		July 21, 2016
1.1	New release		December 20, 2016
1.2	Update table 10 – HW components		January 5, 2017
1.3	Add SAR to certifications list		June 22, 2017
1.4	Add warning at Nano Power Harness section		September, 17, 2018

Table 3: List of Changes

2 CelloTrack Nano 20 at a Glance

2.1 General

With the ever increasing growth in global supply chains, maintaining an accurate picture of happening across your business at any given time is practically impossible. The CelloTrack Nano 20, used as a standalone monitoring tool or together with accompanying MultiSense devices, can greatly enhance your supply chain management and costs.

Based on technology incorporating a WSN, CelloTrack Nano 20 is an innovative, smart and compact monitoring system that enables a wide range of businesses in an ever-increasing array of industries to monitor global cargos and assets in real-time.

Using renowned Cellocator firmware and technology, the Nano utilizes additional BLE[1] cutting edge technology and extensive sensing capabilities to provide a solution that not only tracks assets but also monitors the environment and conditions in which the asset is currently located or handled, including temperature, light, humidity and more.

Figure 1: CelloTrack Nano 20 Sensors

CelloTrack Nano 20 enables three important factors in the remote monitoring of global cargo and assets:

- **Real-time Visibility of your Global Assets:** CelloTrack Nano 20 enables real-time awareness of cargo and asset location, as well as its condition and possible problems and delays using its internal sensors, and can function as a portable gateway and

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[1] BT SIG certification is currently in the product evolution process

short range **Wireless Sensor Network (WSN)**. This network is comprised of the CelloTrack Nano 20 hub, which communicates with the back-office application, and up to 16 paired MultiSense devices, which can be located almost anywhere in the cargo bay.

◆ **Ensures Business Efficiency:** CelloTrack Nano 20 ensures continuous recording, event-triggered logic and 'management by exceptions' through a flexible programming of business rules to avoid supply chain mistakes, delays or damages. This, in turn, helps reduce insurance expenses.

◆ **Secures against Tampering and Theft:** CelloTrack Nano 20 prevents losses due to theft, loss and misplacement using proximity, tampering and location sensing throughout the entire transport chain.

2.2   CelloTrack Nano 20 System Communications

The CelloTrack Nano 20 is based on a multi-GNSS (GPS and GLONASS Hybrid positioning) engine for accurate positioning. The Nano can be configured to communicate with a control center backend via Cellocator's enhanced OTA protocol over cellular networks (2G/3G), and can be configured to communicate with up to 16 paired MultiSense devices via Short Range Low Energy Wireless Communication technology.

The CelloTrack Nano 20 also has the capability to communicate with unlimited MultiSenses in Guest mode and Tag mode, which is explained in the *Pairing MultiSense Devices with the Nano 20 Hub* section.

The following diagram illustrates how the CelloTrack Nano 20 works.
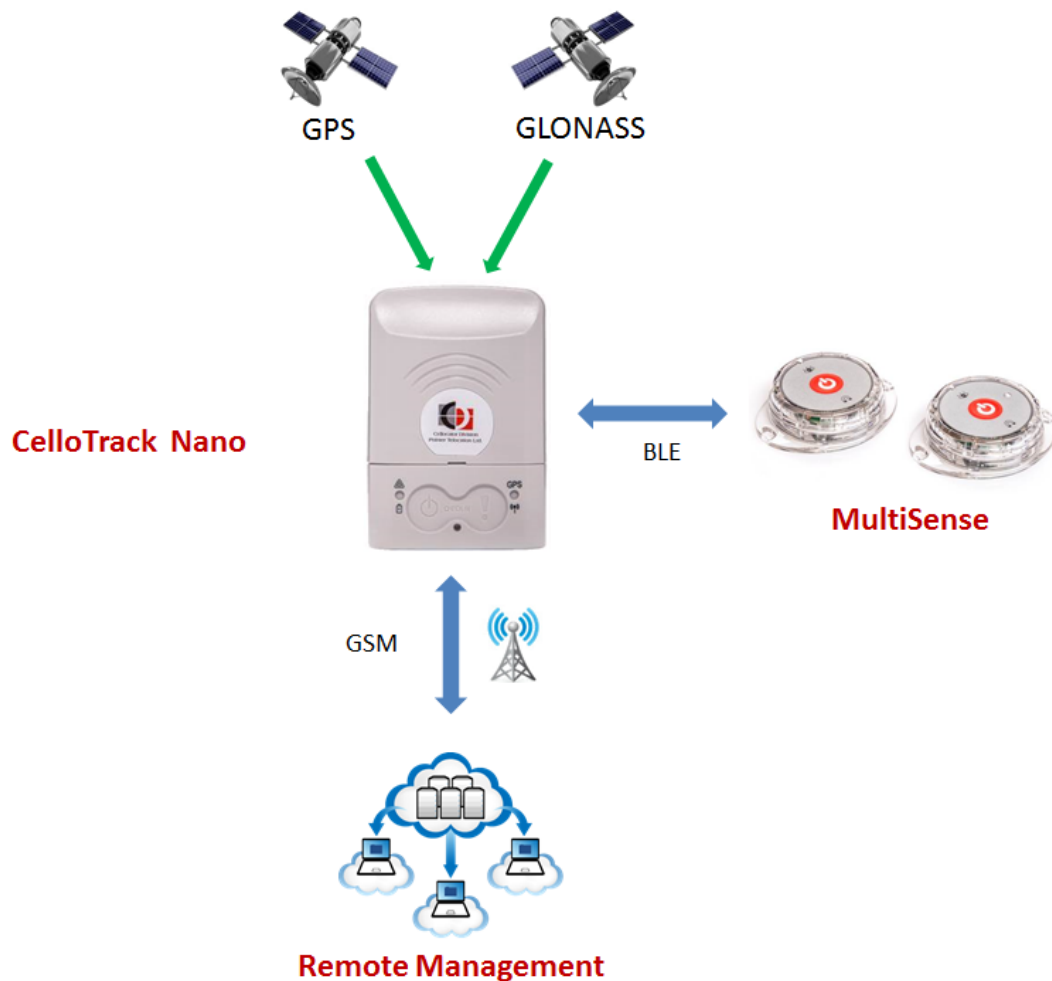
Figure 2: CelloTrack Nano 20 System Communications

2.3 Main Features and Benefits

This section lists the main features of the CelloTrack Nano 20 and the benefits they provide. For a full list of the available features and further explanations on each feature, refer to the *CelloTrack Nano 20 Feature List* section.

- ◆ Built-in **SiRFstarV** best of breed GNSS engine (**Hybrid GPS** and **GLONASS**)

- ◆ A range of **Internal embedded sensors** that can sense temperature, light, freefall, impact, movement, orientation change, air pressure, noise, and more. These sensors play a big role in reducing risk and exposure to losses, in turn bringing peace of mind to customers.

- ◆ Can be used as a **Wireless Sensor Network** via BLE communication (MultiSense devices are easily paired with the Nano hub to form the WSN, see page 38), with **2G/3G** communications with the back-office application. This network is easily *scalable.*

- ◆ Advanced **MMI** that comes with a buzzer, LEDs, and two multi-function buttons.

- ◆ The CelloTrack Nano is a low profile / compact solution and comes in a slick, modern design (~85x60x23mm).

- ◆ **Micro USB connector** for recharging the Nano's battery and configuring via a PC/laptop.

- ◆ The CelloTrack Nano has a **long life rechargeable** Li-ion battery (up to 5 weeks of transport chain usage - @1Tx/Day and 4 Locations/Day (every 6 hours)).

- ◆ Dual **Tampering** detection.

- ◆ **OTA** updates for Firmware updates and configuration.

- ◆ Robust plastic enclosure, protecting against sunlight and chemicals.

- ◆ Various attachment methods.

- ◆ Compliance with **IP 66** (dust and water jets).

- ◆ Designed to meet **EN12830** standards (temperature recorders for the transport, storage and distribution of chilled, frozen, deep-frozen/quick-frozen food and ice cream).

- ◆ Compliance with **GDP – Good Distribution Practice** (Europe, US).

2.4   Intended Markets

The CelloTrack Nano 20 is intended for a wide-range of vertical markets within the MRM industry, many of which can greatly benefit from Cellocator's long-standing expertise in logistics and tracking.

The four example vertical markets in the following sections are just a sample of the capabilities of the CelloTrack Nano 20.

2.4.1   *Cold Chain Compliance*

With CelloTrack Nano 20 (and optionally a number of MultiSense devices) installed inside a temperature controlled container / trailer, or attached to a pallet, box or other type of package loaded with pharmaceutical or perishables, stakeholders in the cold chain process can easily and reliably monitor in real-time the microclimate of the pallet / box, rather than the container environment only.

This helps to ensure adequate shelf-life time, guarantee compliance with shipment regulations, and even enables a real-time response in exceptional cases.

Figure 3: Cold Chain Solution

2.4.2 *Rental Equipment Usage*

Rental companies and service providers specializing in equipment and assets for short term rental (such as storage containers, construction machines, generators, trailers, towed carriages, mobile offices, and chemical toilets), can efficiently monitor a profile of their assets' usage during the rental period, including location, damage, displacement, and other inventory management aspects.

Figure 4: Rental Equipment Solution

2.4.3 *Employee Safety*

Lone or remote workers (such as guards) who require a quick and intuitive way to indicate distress can easily activate a panic button or a 3D accelerometer profile (such as *man down* or *idling*).

CelloTrack Nano 20 also enables the monitoring of workers for their location, health status and general activity (such as check-in, and general movement).

The device is "always connected", enabling backend personnel to closely monitor the worker's location or status at any given moment.

Figure 5: Employee Safety Solution

2.4.3.1 **BLE (CelloTrack Nano) vs. Active/Passive RFID**

The following table presents a matrix of parameters comparing the BLE communication adopted by the CelloTrack Nano 20 and commonly used in IoT devices versus old RFID technology in use in various existing logistic and warehouse solutions.

Feature / Technology	BLE	Passive RFID	Active RFID
Power source	Internal (<15mA)	Energy transferred using RF from reader	Internal to tag
Battery	Yes	No	Yes
Required signal strength to unit	Medium	Very low	Very high
Range	Up to 100m	Up to 3-5 meters	Up to 100m

Feature / Technology	BLE	Passive RFID	Active RFID
Cost	Expensive (~10$)	Cheap (<1$)	Expensive (~10$)
Support internal sensors	Yes	No	Yes
Security	Strong	Weak	Strong
Smartphone/Tablet communications	Yes	No	No
Applications	App, logistic, inventory, asset tracking (WAN)	Inventory, logistic, security (restricted area), user identification, vending machine	Tracking person/asset
Standards	Bluetooth SIG	ETSI, ISO, GS1, IEC, JTC1	
Frequency	2.4G	Various: LF, HF, UHF, SHF	
Bit rate	~200 kbit/s		

Table 4: BLE (CelloTrack Nano) vs. Active/Passive RFID

2.4.3.2 CelloTrack Nano vs. Smartphone app

The following table presents a matrix of parameters related to Lone Worker solutions, comparing the CelloTrack Nano 20 with smartphone apps.

#	Parameter	CelloTrack Nano 20	Smartphone
1.	Worker SOS triggering	Instant and intuitive access to activate panic button, even during distress events.	Need to open an app and press a button, or apply a certain sequence on small and inconvenient buttons to manage a distress event.
2.	Solution resilience and reliability	Administrator controls the CelloTrack Nano Parameters and FW version. A dedicated solution.	Depends on lone worker activity, smartphone settings, CPU load by other applications, battery capacity due to other applications' consumption, etc.
3.	Improved safety and activity monitoring	Built in and integrated HW/FW for activity / inactivity – monitoring passive alert.	Needs to be developed and validated from scratch in the smartphone's application.
4.	Loss / theft indication	Tamper triggering from belt clip cradle.	Not available.
5.	Monitoring capabilities richness	Communicate with external sensors in a wireless sensor network mode (suitable for various scenarios, like	No compliant sensors availability.

#	Parameter	CelloTrack Nano 20	Smartphone
		patrolling).	
6.	Shift start / end indication	Instant access to check-in / check-out button.	Need to open an app and press the relevant button.
7.	Complete visibility and safety	Additional external sensing capabilities (temperature, light, barometric pressure, noise, movement, impact).	Depends on the smartphone HW and applicative features.
8.	Communication security	Proprietary OTA protocol with NOC, increasing security against frauds and/or cyber-attacks.	Depends on the app's capabilities.
9.	Tracking continuity	Up to 10K logged events, in case no communication is available.	Depends on the smartphone type and available internal memory. Other applications might consume all available memory.
10.	Battery operational time	Long battery-operated periods (up to a few weeks for typical lone worker use).	Depends on the smartphone HW type and efficiency of the app. Usually smartphones are also used for other private activities, which reduces power operation to a single day.

Table 5: Lone Worker – CelloTrack Nano vs. Smartphone app

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3   CelloTrack Nano 20 Features and Capabilities

3.1   CelloTrack Nano 20 Feature List

Feature	CelloTrack Nano 20 Hub
Orientation and Absolute Orientation	√ (also as event)
Man Down	√
Movement	√
Impact	√ (or free-fall)
Free-fall	√ (or impact)
Ambient Light Sensor (ALS)	√
Temperature Sensor	√
Listen in (voice)	√
Automatic radio off in Flight Mode	√
Geo Fencing	√
Barometric Pressure Sensor	√
Microphone Sensor	√
Short Range Low Energy Wireless Communication	√
Tampering Detection	√
GNSS Module (SiRFStar V)	√
USB Charging	√
Memory Log	√
System Modes	√
Long life battery	√
SIM card and MIM (SIM on chip)	√
Communication Message Type	√

Feature	CelloTrack Nano 20 Hub
Secured Communication	√
PL Templates (Type 0 /Type 11)	√
Work ID	√
Disable turning off by button	√

Table 6: Applicability Table

3.1.1 *Internal Sensors*

The internal sensors are the main elements of the CelloTrack Nano 20 unit, and provide the monitoring abilities that ensure your assets stay secure. The following sections describe each of the sensors and their capabilities.

3.1.1.1 Accelerometer

The legacy CelloTrack accelerometer is used to detect movement, vibrations or impact of assets and enables different transmission rates for a moving asset and a standing asset. It is based on the interrupt mechanism (of the accelerometer chip) for acceleration incidents that pass a certain (configurable) threshold. When the acceleration reading crosses the configured threshold for longer than the configured time, an Impact event is generated.

Orientation change and Absolute Orientation

When the Earth-gravity vector of the Nano changes more than the configured threshold (degrees measured), an Orientation event can also be generated and logged. This feature can be used to detect rollover situations, where the tracked asset is rolled on one of its sides or is placed upside down. The Absolute Orientation (x,y,z vectors) is reported via all transmissions of data regarding the asset(s) orientation.

Freefall/Impact

The legacy accelerometer is also able to distinguish between impact, freefall and ordinary movement events. Impact events detect harsh and dangerous incidents such as a crash, and are easily distinguished from freefall, load/unloading movements and breaching attempts.

Man Down

Suitable for lone workers (after they have "checked in" with the Nano unit), the unit will recognize a change in the orientation of the unit that breaches a defined angle threshold as a possible "man down" event.

Movement

When movement amplitude crosses the hardcoded accelerations threshold, the device is considered as being in motion. After a period of time without any significant movement sensed, the device moves to a "Stationary" state.

Impact and Free-fall

Used in order to detect harsh and dangerous incidents such as a crash, careless loading/unloading, or breaching attempts.

3.1.1.2 Ambient Light Sensor (ALS)

If enabled, the ALS can trigger events that indicate a significant change in the amount of light to which the Nano is exposed, such as when a package is opened or closed. For example, after a specified amount of time in low-light (below the configured threshold), the unit triggers a Package Closed event. In this state, a sudden increase of light level longer than the configured time and intensity thresholds triggers a Package Opened event.

The ALS has a range up to 1024 lux in the CelloTrack Nano, the equivalent of daylight, which indicates in what conditions the package is held.

The typical threshold parameter in order to identify an opened cargo box could be around 20 lux.

3.1.1.3 Temperature Sensor

Getting real time temperature measurements dramatically improves the control of the shipment and gives the ability to react accordingly. The readings collected by the sensor ensure *data logging capabilities* that are smart and adaptive in that they help reserve battery life and save energy.

In order to be compatible with GDP (Good Distribution Practice), the internal temperature sensor guarantees an accuracy of ±1°C and a minimum resolution of 0.1°C.

3.1.1.4 Barometric Pressure Sensor

In cases where the height location of package inside truck/container/logistic center is important, the barometric pressure sensor can identify height changes of ≥1m and above.

Since the barometric pressure is sampled every 1 minute, if the absolute difference value between the slow filter value and the very-slow filter is above the threshold, an event is created.

Note: The pressure measurement is relative (can be between different CelloTrack Nano units).

3.1.1.5 Microphone Sensor

The microphone sensor provides the ability to listen-in to noises around the device. Via a voice dial-in, and after typing the appropriate password or according to a dialer white-list of numbers, the unit opens the microphone to listen-in.

3.1.1.6 Voice Listen-in (Eavesdropping)

In order to prevent an unauthorized number calling the Nano, a whitelist is added to the PL and only calls from the listed numbers are allowed to create a voice call. Up to 10 numbers can be defined in the whitelist.

3.1.1.7 Tampering Detection

There are two ways in which the CelloTrack Nano can detect tampering:

◆ When attempts are made to remove the Nano hub from its cradle that comes with the unit.

◆ When the unit and the cradle stay attached but are removed from the mounting surface. This is implemented by algorithms which analyze the accelerometer readings, and determine if they breach the predefined tilt / rotation threshold.

3.1.2 Prevent the Switching Off of Nano Units

In order to prevent the accidental/targeted switching off of Nano units, there is an option to prevent them being switched off via the power button.

3.1.3 Flight Mode

An automatic radio OFF mode is mandatory when on-board aircraft; this is relevant for shipment supply chains with a transportation leg that is a flight (domestic or international). This flight mode complies with FAA regulation instructions (14 CFR 91.21, and 121.306).

3.1.4 Geo Fencing

The Geo Fencing feature provides another level to your asset management control. By defining areas such as ports, airports, logistics centers, distributing centers, etc., the shipper can follow the cargo and check if it is still shipping according to the planned schedule.

Furthermore, lack of goods in a certain place (defined as a geo fence area) at a specific time can indicate asset loss or theft.

The Geo Fencing feature supports up to 100 square geo fence zones.

3.1.5 BLE Wireless Communication

The method of communication between the CelloTrack Nano 20 and MultiSense devices is *BLE*[2] (Bluetooth Low Energy) *2.4 GHz short range low energy wireless communication*. This method of communication is intended to provide considerably reduced power consumption, footprint and cost, with these three parameters the most important values within the IoT world.

Using *BLE*, the Nano 20 can communicate with up to 16 MultiSense devices in a *Master* and *Slave* type setup. However, in order to function correctly as a WSN, the Nano unit and MultiSense devices must be paired, as described on page 38.

Using Nano 20 and paired MultiSense devices as a local WSN enables you to leverage an environment, within which you can sense where different measurements are expected such as inside cooled cargo boxes, or in a long trailer where the environmental conditions inside the trailer may be different from those closer to the door.

Another form of communication between the CelloTrack Nano 20 hub and MultiSense devices is via *transparent* (guest) mode. In this mode, no pairing process is required and thus the CelloTrack Nano 20 does not manage or save MultiSense device data or thresholds. As a result, in transparent mode the CelloTrack Nano 20 can be used as a gateway to unlimited MultiSense devices.

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[2] BT SIG certification is currently in the product evolution process

In situations where only MultiSense MAC addresses are required, Tag mode (similar to iBeacon mode) can be activated.

3.1.6 GNSS Module (SiRFStar V)

The GNSS module is based on the SE868 (Hybrid GPS+GLONASS) Telit GNSS module.

This module improves the availability and accuracy of position solutions in urban environments with low power operation modes to improved unit battery life in a variety of use cases. SiRFStar V brings higher sensitivity and margins for acquisition and tracking.

For metal noisy environments, such as sea ports where containers are stacked, the use of SiRFStar V can help improve the Noise to Signal ratio.

3.1.7 RTC (Real Time Clock) Acquisition and Accuracy

When the GSM signal strength is low and no fix is valid (typically indoors), upon power up process (BIST), and after modem registration to the network, the unit acquires the RTC provided by the cellular operator (UTC).

In any case, if the RTC was not acquired from anywhere (GPS, Cellular network), the modem continues querying for the RTC after each registration. If RTC was acquired, the unit stops querying the modem for the RTC.

3.1.8 USB Charging

The Micro USB slot on the CelloTrack Nano 20 ensures that charging is quick and easy, with charging also possible via a USB/laptop connection.

The *adaptability* of the USB charging feature ensures that the CelloTrack Nano 20 can adjust the charge current according to the power source it is connected to. For example, if it is connected to a wall socket, a faster current can be used; if connected to a laptop or car adapter the Nano units adjusts accordingly.

The typical charging time while connected to a wall mounted charger is 2-3 hours. This may increase to 4-6 hours if the unit is charged via low current sources, such as a laptop.

The unit cannot work directly from an external power source; power consumption is always taken from the internal battery.

3.1.9 Battery Management

It is possible to control the battery recharging mode (keep charging / stop charging) according to the dry contact digital input.

When an external larger battery (power bank) is implemented, the digital input can be used to signal to the Nano on connection of the power adapter, thus ensuring optimal battery life and design.

3.1.10 Memory Log

The memory log maintains a buffer of up to 10,000 Type 0 messages in the event there is no OTA cellular communication with the server.

Type-11 messages are with varying length and thus cannot be defined with the actual capacity for logged messages. These messages should use the entire log memory size actually allocated.

The entire buffer is cyclic and provides several days of normal operation without being connected to a cellular network.

3.1.11 *Operational States*

The CelloTrack Nano operational states inherits its behavior from CelloTrack Legacy (refer to the *CelloTrack T Family Overview* document). In addition, the CelloTrack Nano has the following two improvements: an *improved tracking mode*, and *management by exception*.

Improved Tracking Mode

In this mode, the unit uses an improved glancing mechanism. It takes extra GNSS location stamps between any two full cellular glancing periods (with times that are configurable) and logs them internally, as shown in the figure below.
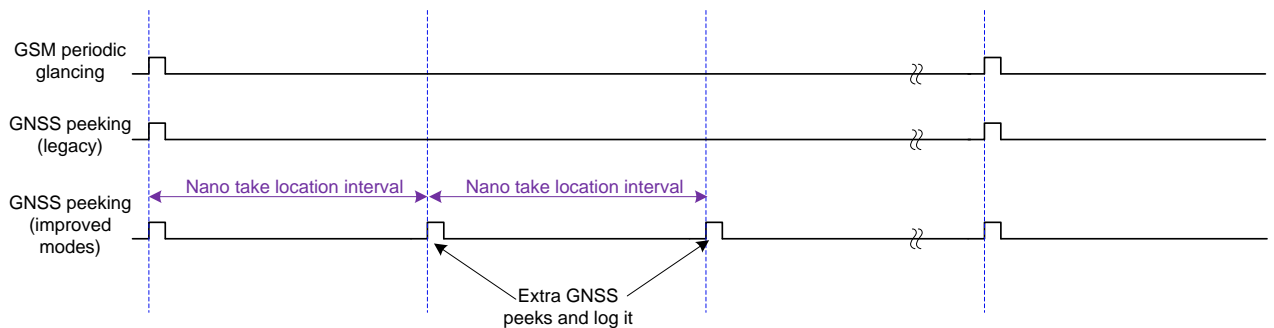
Figure 6: Improved Mode Waveform

Management by Exception

For each type of sensor, whether for the CelloTrack Nano or MultiSense, the user can determine the following:

◆ The applicative sampling/logging rate (if applicable)

◆ Monitoring rules (what triggers an event, such as threshold values)

◆ Feedback rules (buzzer and LEDs activation patterns)

◆ Data upload rules

MultiSense provisioning (such as: low battery, lost communication)

3.1.12 *Long Life Battery[3]*

The long life rechargeable Li-ion battery ensures a minimum life of 5 weeks when transmitting once a day, and taking GNSS location readings four times a day.

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[3] All operation times stated in this section refer to operation at room temperature with an optimal cellular network and GNSS coverage and Max Tx power of the MultiSense device (+8dBm).

Online Tracking

- The location and MS status are transmitted every 1/5/10 minutes (three scenarios).
- Shuts down any unnecessary modules between transmissions in order to save energy.

Tx Policy	Days
Location is transmitted every 1 minute	0.5
Location is transmitted every 5 minutes	2
Location is transmitted every 10 minutes	4

Table 7: Power Consumption – Online Tracking

Offline Tracking

- The modem is off during the whole trip and only the GPS is switched on every 1/5/10 minutes (three scenarios) to acquire and log the location and other status elements.
- All information is uploaded at the end of the trip or according to memory and time parameters.
- Assumption: daily operation time is assumed to be 33% (8 hours per day).

Tx Policy	Days
Location is logged every 1 minute	1.3
Location is logged every 5 minutes	5.5
Location is logged every 10 minutes	10

Table 8: Power Consumption – Offline Tracking

3.1.12.1   Use Case Templates

The following table shows a matrix of various battery performances for both the CelloTrack Nano and MultiSense.

Template number:	#1	#2	#3	#4	#5	#6	#7
Template name:	**Long shipment with MS** almost live-tracking	**Long shipment without MS** almost live-tracking	**Typical CelloTrack-T users** improved tracking	**Long shipment with MS**, offline tracking (15-25 C)	**High value goods** (3rd party shipper)	**Land shipment - cold chain 2-8C** (food, Pharmaceutical, flowers, antiques)	**Employee safety** (lone worker)
Scenario:	**Nano**: Tx every 15 min, **MS**: Sample every 1 min	**Nano**: Tx every 15 min	**Nano**: Tx every 24 hours, **MS**: Sample every 1 min	**Nano**: Live tracking 8h per day, logging location every 5 min **MS**: Tx every 5 min	**Nano**: Tx every 15 min	**Nano**: Tx every 15 min, **MS**: Tx every 5 min	**Nano**: Tx every 6 hours
	6 days	6 days	34 days	5 days	6 days	5 days	35 days (optimal condition) 12 days (harsh conditions)
	16 months	NA	16 months	22 months	NA	12 months	NA

Table 9: Power Consumption – Use Case Templates

Notes:

◆ Where temperature is not mentioned, the battery performance is valid for +20°C.

◆ The templates above are based on the CelloTrack Nano PL templates Excel file that describes the templates in detail.

◆ Templates #2, #5, and #7 are also suitable for CelloTrack Nano 10.

◆ Template #6 is for lower operation temperatures over the lifetime of the MultiSense battery.

3.1.13 *SIM card and MIM (SIM on chip)*

The CelloTrack Nano 20 unit has a full size SIM holder that is easily accessible. Note that regular SIM cards have a limited operating temperature range and cannot be used in many applications. As an option for extreme environmental conditions, we recommend using a SIM card with a temperature resistance range of -35°C to +85°C.

The Nano unit also supports the SIM-on-chip option. Please contact your account manager for more information about this option.

3.1.14 *Communication Message Types*

The CelloTrack Nano 20 uses Type-0 legacy events and/or commands or the advanced Type-11 messages, all according to the configuration bits per feature.

The "General Event Message" is a Type-11 message designed to reflect system events and notifications towards the server. The message is built as follows:

Type 11 Header	Fw Hw ID Module 8	GPS Stamp Module 6	Time Stamp Module 7	nano inherent sensors Module 42	General Event Module 28

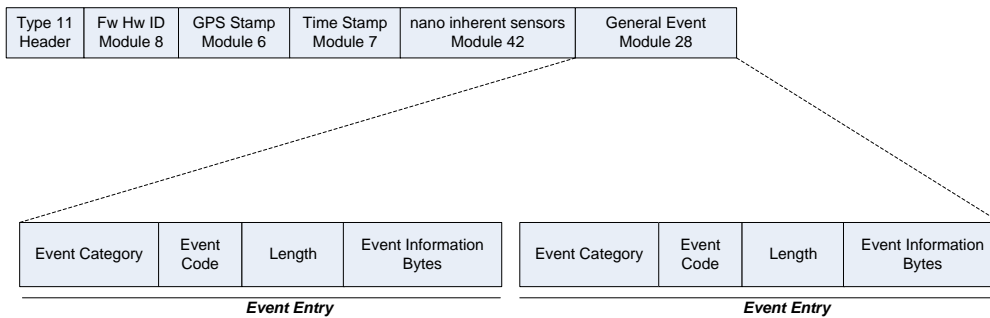| Event Category	Event Code	Length	Event Information Bytes	Event Category	Event Code	Length	Event Information Bytes
		Event Entry				*Event Entry*	

Figure 7: Type-11 Message

Modules 8, 6, 7 and 42 are mandatory fields, and come first in this exact order; everything else (Module 28 is shown as an example) follows these fields.

3.1.15 *Secured Communication*

Communications via a short range network between the CelloTrack Nano 20 and MultiSense devices, is secured through a basic proprietary encryption method of the data transmitted (such as temperature and humidity readings) and received. This encryption ensures that MultiSense devices and and/or the Nano are not being manipulated by 3rd party devices and applications using the same communication technology.

3.1.16 *PL Templates*

The CelloTrack Nano 20 unit comes with a range of PL templates suitable for a number of operational scenarios for different industry segments / vertical markets. These templates provide an easy starting point for your device's configuration, but can be modified as required.

The template categories are:

- Land shipment - cargo tracking (trailer, short and long term)
- Land shipment - cold chain (food, pharmaceutical, flowers, antiques)
- Maritime cold chain shipment (long offline cold chain tracking)
- Equipment/machinery tracking (mainly fixed equipment)
- High value goods (3rd party shipper)
- Employee safety (lone worker)
- Parameters lay on type 0 only
- Flight mode templates added (with or without BLE shutdown)
- Low/High duty cycle BLE scanning

For more information about the attributes of each PL template and operating parameters configuration options, please refer to the *Cellocator Nano Programming Manual*.

3.1.17 *Work ID*

The Work ID indicates the current task / mission / route number to which the Cellocator Nano is assigned. CelloTrack Nano 20 advances this Work ID by counting each power ON event. The Work ID method is aligned with the backend need to track and report locations, events, exceptions and other supply chain attributes, separately for each shipment task.

3.2 External Interface

3.2.1 *CelloTrack Nano 20 Hub*

The CelloTrack Nano 20 unit is the hub of the WSN. The Nano can be paired with (up to 16) MultiSense devices in a wide range of possible scenarios and applications, as described in the *Intended Markets* section.

For a detailed description of the buzzer, LEDs and button functionality of the Cello Track Nano 20, refer to the *MMI: Buzzer, LEDs and Button Functionality* section.

Figure 8: CelloTrack Nano 20 Hub

3.2.1.1 CelloTrack Nano 20 Cradle

As shown in the image above, the CelloTrack Nano 20 hub comes with its own cradle. The cradle enables the CelloTrack Nano 20 to be easily secured in the relevant location using either three screws or the two built-in magnets.

For ease of use, the CelloTrack Nano 20 cradle can also be attached to the target location with double-sided adhesive tape, two nylon ties (which can be inserted into the relevant holes in the cradle), and a special clip add-on for belts (especially for lone worker scenarios).

3.2.1.2 Nano Power Harness

The CelloTrack Nano Power Harness is intended for use as a robust connectivity to a power source for the CelloTrack Nano hub, while also providing one dry contact outlet.

The Power Harness is an add-on to the CelloTrack Nano family, ensuring its compatibility with existing models and part numbers belonging to the CelloTrack Nano family.

Warning:

Connecting CelloTrack Nano to the vehicle power should be done ONLY by using Cellocator approved accessories (such as the Nano Power harness). Using any other connectivity may harm the unit and invalidate the Cellocator warranty.

For more information, please refer to the *Nano Power Harness Overview* document.

3.2.1.3 Micro USB Slot

The Micro USB slot on the CelloTrack Nano 20 hub is used to perform the following:

- ◆ Recharge the battery using the wall adapter.
- ◆ Recharge the internal battery from a PC USB 2.0 port.
- ◆ Interface via a PC USB 2.0 port for log retrieval/browsing (using existing legacy "harvesting" tools).
- ◆ Interface via a PC USB 2.0 port for configuration and firmware updating.

3.2.2 *MultiSense Devices*

The MultiSense devices are the monitoring sensors which can be used to form the slave part of the WSN system. For a detailed description of the MultiSense device, refer to the *CelloTrack MultiSense Product Overview*.

Figure 9: CelloTrack MultiSense device

3.3 CelloTrack Nano 20 Hardware Components

The CelloTrack Nano 20 hardware components are listed in the table below:

Name/Part Number	Description	Picture
CelloTrack Nano 20 Hub **PN:** GC9770001-000	The CelloTrack Nano 20 is used as a hub in a WSN.	
CelloTrack Nano Charger EU **PN**: 711-20083	White charger with micro USB connector for European market.	
CelloTrack Nano Charger US **PN**: 711-20082	White charger with micro USB connector for US market.	
CelloTrack Nano USB data cable **PN**: 711-00326	USB Data Cable	

Name/Part Number	Description	Picture
CelloTrack Nano Cradle Kit **PN:** 805-60903	Includes cradle, one sticker, three screws.	
CelloTrack Nano Magnetic Cradle kit **PN:** 815-60903	Includes cradle, two coin magnets, two screws, two screw nuts.	
CelloTrack Nano Belt Clip **PN:** 705-60904	Belt clip for Nano cradle.	
CelloTrack Nano Accessories **PN:** 712-00007	Includes two Nano stickers, three screws.	
CelloTrack Nano rechargeable battery **PN:** 711-20081	1000 mAh, 3.7 volt.	
CelloTrack Nano 20 Evaluation Kit **PN:** K091-001 (EU) K091-002 (US)	Includes the CelloTrack Nano 20, Cradle kit, Magnetic kit, accessories, belt clip, modem recorder cable, recording adaptor, USB charger (EU or US), and MultiSense-TH.	

Name/Part Number	Description	Picture
CelloTrack Nano Power Harness **PN:** 715-50400		

Table 10: HW Components

4 The CelloTrack Nano 20 Hub

This section describes the CelloTrack Nano 20 external and Man-Machine interface, including the functionality of the buzzer, LEDs and buttons.

4.1 MMI: Buzzer, LEDs and Button Functionality
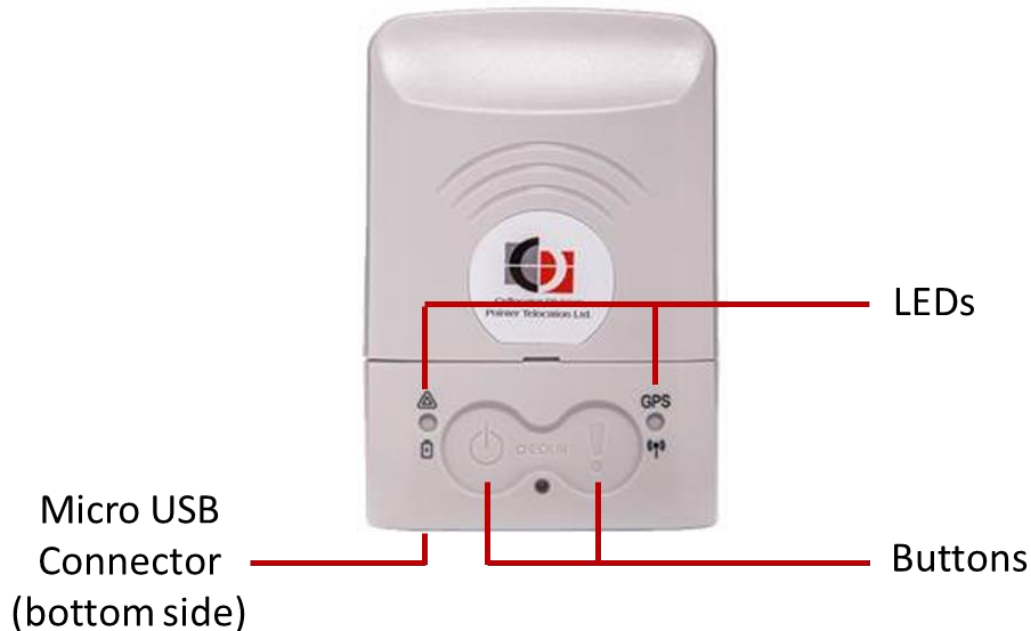
Figure 10: CelloTrack Nano 20 MMI

4.1.1 The CelloTrack Nano 20 Buzzer

The buzzer provides audio feedback of certain events and actions via a range of beep sequences.

For example, when the unit is switched on there is a short beep of 200mS. Similarly, when a distress event has been activated (in the scenario of a lone worker) a short beep is sounded, and when that distress event has been received and acknowledged by the server, a longer two second beep is sounded.

The full list of buzzer audio feedback is as follows:

Event	Description	Buzzer sequence
Power up	Upon power-up (turning ON)	Short beep of 200mS
Reset	System reset (for any reason)	Short beep of 200mS

Event	Description	Buzzer sequence
POST	After a successful POST (Power On Self-Test) process	Dual short beeps of 200mS ON, 200mS OFF, 200mS ON
Button pressed	Every valid press on the buttons	Beep of 20mS
Panic/Check-in activation	After Panic/Check-in event activation	Short beep of 200mS
Panic ack.	After Panic (special distress) event is acknowledged by the server	Long beep of two seconds
Voice call	After the modem receives a ring(s) for a voice call	Ring beeps of ten cycles of 200mS ON, 200mS OFF for a total of four seconds
Sensors	After any active sensors go out of defined limits	Short beep of 200mS
MultiSense power up	After any power-up packet is received from a preregistered MultiSense device	Short beep of 200mS
Pairing with MultiSense device	During the pairing process	Beep every elapsed second in the first four seconds and then dual short beeps after the fifth second (0.5 seconds each) to indicate the pairing "window" is open. Once the Nano pairs with each MultiSense device, a long beep of two seconds is heard.

Table 11: Buzzer Audio Feedback

4.1.2 *CelloTrack Nano 20 LEDs*

4.1.2.1 Left LED: Battery and Deviations

Event	Left LED sequence
Unit is turned ON	Short blinks of 100mS every X seconds show the battery status according to the following legend: Battery is 50-100% - Green Battery is 20-49% - Orange Battery is 0-19% - Red
Out of range indications	When any sensor creates an out-of-range (alert) event, and if enabled by a parameter in the PL, the left LED will signal a three second long continuous (once) or non-continuous pulse according to the following color scheme: Light sensor out of range: Accelerometer out of range: Temperature out of range: Geo-fence violation:
Charging indications	When a micro-USB connector is plugged-in and charging is in progress, whether from charger (AC wall adaptor) or PC, the left LED will act as described below: These indications have the highest priority and they override all other indications on this LED.

For the charging indications:

Unit mode:	OFF (inactive)	ON (active)
During actual charging	Constantly orange	Constantly orange
After charge completion — Inside the "Indications time window"	Constantly green	Regular LEDs indications
After charge completion — After (outside) the "Indications time window"	Constantly green	Constantly green
Battery Fault	Constantly red	Constantly red

Table 12: Battery Indications

4.1.2.2 Right LED: Cellular/GPS Status

Event	Left LED sequence
Two time slots of five seconds long each. The first one is for indications from a cellular modem in green and the second one is for GNSS module indications in orange. Each pulse is 500mS ON and 500mS OFF.	
Cellular Status	HSDPA/HSUPA (3G) communication: GPRS/EDGE communication: Registered (GSM-2G): Not registered (no activated network found):
GNSS module	GNSS module indications: Tracking good (Fix "Tight"): Tracking poor (Fix "Plain"): Acquisition (from power-up to "Plain" or "Tight") : No satellites at all ("no fix" after fix), only at the first operation and cannot be reached if using A-GPS:
Indications after power up (Built-In Self-Test)	The indications look like the examples below for the first 5-10 seconds only: Turning ON press feedback from the buzzer: If all tested components are OK: If all OK, the indication on the buzzer will be: GNSS module failure (Basic communication): Cellular modem failure (Basic communication + SIM card valid): Battery failure: ←--------------------first 5÷10 Sec after turn ON--------------------→

Event	Left LED sequence
Indications for shutdown sequence	When the user shuts down the unit by pressing the power button, and one of the configuration bits of "Transmission before shutdown" is enabled, the unit will push to the log the event message of Transmission-reason = 102 ("Activation mode change") with STR= 0 ("About to move to Inactive mode").
	If any form of immediate transmission method is selected by the user ("Active log event" and/or "Distress"), the unit also initiates communication with the server and also transmits its entire log. During this process it will blink the right LED (which has a higher priority than all other indications) green at 200mS ON and 200mS OFF until completion and full shutdown.
	The buzzer will beep in 200mS ON and 800mS OFF during the transmission.
	In any case (even when not transmitting), "Dual short beeps" are heard before actually moving to inactive mode.

Table 13: Cellular / GPS Indications

4.1.3   *CelloTrack Nano 20 Buttons*

The two capacitive sensing buttons on the Nano 20 interface are used for a number of operations.

For example, the POWER button (the button on the left) is pressed for three seconds to switch ON the unit (and five seconds to switch it off). The SOS button (the button on the right) can be pressed for two seconds to activate a distress mode.

An option to prevent the power off button from being switched off exists in the Cellocator Programmer (using the CelloTrack Nano Editor).

When pressing the buttons simultaneously for one second (and less than five seconds), the user can also "check-in" to a location. The system is then aware of that user's location and a baseline for the accelerometer position is set (in case of a possible *man down* incident).

The two buttons are also used for pairing the MultiSense devices with the CelloTrack Nano 20, as described on page 38.

Pressing Duration	Left button	Right button	Both simultaneously
T < 200mS	Ignored		

Pressing Duration	Left button	Right button	Both simultaneously
T > 200mS	Very short feedback from buzzer Opens the indications time window		
2 Sec > T > 200mS	-	-	Check-in event
5 Sec > T > 2 Sec		Panic event	Check-in event
T > 5 Sec	Power OFF unit	Panic event	MultiSense pairing window open

Table 14: CelloTrack Nano 20 Buttons

4.2 Pairing MultiSense Devices with the Nano 20 Hub

In order to create a WSN, the CelloTrack Nano 20 should be "paired" with MultiSense devices.

The Nano 20 can pair with up to 16 devices, though it is also possible to report on "Guest" or "Tag " MultiSense devices, which are not actually paired with the Nano 20 hub (but part of a VLR (Visitor Location Register) database, meaning the Nano 20 can transparently transfer the MultiSense device data to the backend but the Nano 20 does not manage MultiSense devices, i.e. logs/thresholds).

The Nano 20 can work in parallel with paired MultiSense devices and "Guest" or "Tag" MultiSense devices. "Guest" or "Tag" MultiSense devices could be especially useful for a scenario in which many mobile cargo loads / assets need to be monitored.

The difference between "Guest" and "Tag" modes is that the CelloTrack Nano only reports on the existence (advertisements) of unpaired MultiSense units in Tag mode, while in Guest mode the sensors data is sent to the backend.

Pairing is performed in the field; pressing simultaneously on both the Nano 20 buttons for five seconds opens a Pairing Window for a configurable period of, for example, ten seconds. Only one MultiSense device can be paired simultaneously during this time window by inserting the battery to the MultiSense or turning the MultiSense on, but the timer is reset automatically after each pairing, enabling the user to process up to 16 devices one after the other. For further information please refer to the CelloTrack Nano Installation Guide.

4.3 Mechanical Interfaces and Attributes

The CelloTrack Nano 20 hub includes the following interface and hardware attributes:

- Convenient but protected access to the SIM and battery.
- Micro USB connector, via which the unit can perform programming / configuration / charging / log download operations.
- GNSS module with an 18x18mm antenna.
- Reliable battery status report (%).
- IP66.

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5 Technical Specifications

2G Variant Cellular Communication	
GSM Modes	Quad band GSM (2G - worldwide): GSM/GPRS: 42.8[UL]/85.6[DL] Kbps, 850/900/1800/1900MHz
Power Output	Up to 2W for 850/900 bands, and up to 1W for 1800/1900 bands
SIM	Internal, full size, replaceable, remote PIN code management, option for M2M type SIM chip
Antenna	Internal, On board (PCB) Penta band GSM antenna
Packet Data	TCP/IP, UDP/IP
SMS	PDU mode
3G Variant Cellular Communication	
GSM Modes	Five bands UMTS (WCDMA/FDD): 800, 850, 900, 1900 and 2100 MHz HSDPA data rates: 7.2[DL] / 5.76[UL] Mbps Quad-band GSM: 850, 900, 1800 and 1900 MHz EDGE data rates: 237[DL] / 237[UL] Kbps EDGE data rates: 237[DL] / 237[UL] Kbps GPRS data rates: 85.6[DL] / 85.6 [UL] Kbps
Power Output	Up to 2.7W for 800/850/900 bands, and up to 1.9W for 1800/1900/2100 bands
SIM	Internal, full size, replaceable, remote PIN code management, option for M2M type SIM chip
Antenna	Internal, On board (PCB) Penta band GSM antenna
Packet Data	TCP/IP, UDP/IP
SMS	PDU mode
GPS	
Technology	CSR SiRFstarV™ engine supporting Hybrid GNSS
Sensitivity (tracking)	-165dBm
Acquisition (normal)	Cold <35Sec, Hot<1Sec, Warm <9 Sec

Internal Antenna	Internal, on board patch antenna
Wireless Sensor Network	
BT 4.1 (BLE)[4]	2.4GHz wireless communication
Interfaces	
Voice Interface	Noise suppression Eavesdropping listening option
COM port	Via USB 2.0 interface over standard micro-USB connector
Connectors	Micro-USB connector
Nano Power Harness	Supports: one Dry Contact digital input. Power: Input: 7.5-32V, Output: 5V • Harness length: 120 cm
Power	
Input Voltage	5VDC ±5%
Average Current Consumption	Normal: 30mA Economy: <12mA Hibernation: <1mA Shipment (Off): <50uA
Internal Battery[5]	Li-Ion Polymer, 3.7V, 1000mAh, rechargeable Embedded NTC for temperature controlled charging Operating Temperature: -20 (65% charge) to 60°C Protections: Temperature, over current, overcharge and over discharge
Sensors	
Temperature[6]	Typical accuracy: 0°C to 85°C : ±0.5°C -25°C to 0°C: ±1.0°C -30°C to -25°C : ±2.0°C Resolution: 0.1°C
Light	Effective range 1÷1023 lux

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[4] BT SIG certification is currently in the product evolution process. BLE functional only for CelloTrack Nano 20.

[5] CAUTION: Risk of explosion if batteries are replaced by an incorrect type. Dispose of used batteries according to instructions.

[6] If the Nano is charging, the temperature sensor value is irrelevant.

Accelerometer	3D, ±8g range, 12 Bit representation, 4mg resolution, I2C interface
Impact/Free Fall	Impact/Free fall with threshold up to 8g
Movement	Detection of stationary or movement state by accelerometer
Tampering	Duel tampering detection: from cradle and from mounting surface
Barometric Pressure	Air pressure translated to "Meters above sea level" Effective range -400m÷6153m, Resolution 0.1m
Listen-in	Built-in microphone with a whitelist of authorized phone numbers
Environment	
Temp, operation	-20°C to +60°C full performance (Discharging) Charging: 0°C ÷ 45°C
Temp, storage	-40°C to +85°C
Humidity	95% non-condensing
Ingress Protection	IP66
Vibration, Impact	According to standards EN 12830
Mounting without cradle	Double-sided adhesive
Mounting with cradle	Three screws or two nylon tie-wraps and/or double-sided adhesive Optional strong magnetic cradle Optional belt clip adapter
Certifications	
FCC[7]	Part 15 Subpart B, part 22/24 compliant
CE	CE EMC & R&TTE according to 89/336/EEC or 1999/5/EC CE Safety EN60950-1:2001+A11:2004
IC	Industrial Canada
PTCRB	TRP, TIS, Spurious and harmonics emission
UL	Unit passes all relevant UL regulation tests
IEC 60529 – IP66	Unit passes all relevant IEC 60529 – IP66 regulation tests

[7] FCC Compliance Statement – see Appendix A

AT&T	Unit passes all relevant AT&T tests
EN12830:1999	Temperature recorders for the transport, storage and distribution of chilled, frozen, deep-frozen/quick-frozen food and ice cream. Tests performance and suitability.
GDP	Good Distribution Practice (Europe, US)
FAA	Comply with regulation instructions (14 CFR 91,21 and 121.306)
SAR	According to IEC 62209-2, 2.5 cm from the body
Dimensions and Weight	
Dimensions	86.2x59.1x22.7 mm
Weight	94 gr

Table 15: CelloTrack Nano 20 Specifications

6 CelloTrack Nano 20 Release Package

The release package of the CelloTrack Nano 20 includes, in addition to the components mentioned in the *CelloTrack Nano 20 Hardware Components* section, a number of software tools and documents, as described in the following sections.

6.1 Evaluation Suite

The Evaluation Suite is the application which contains all the software components necessary for the evaluation of any Cellocator unit. The software components required for evaluating the CelloTrack Nano 20 are described below.

6.1.1 *Communication Center*

The Communication Center also supports the KML generator. The **Keyhole Markup Language (KML)** is an XML notation for expressing geographic annotations and visualizations within Internet-based, two-dimensional maps and three-dimensional Earth browsers, such as **Google Earth, Google Maps**, and **Google Maps for Mobile**.

For more details about the new Communication Center capabilities and usage during the integration process, please refer to the *Cellocator Evaluation Suite Manual*.

6.1.2 *Cellocator Programmer*

The concept of operation and parameters flow between the four entities of HW, Programmer screen, storage and Nano Editor is shown below:
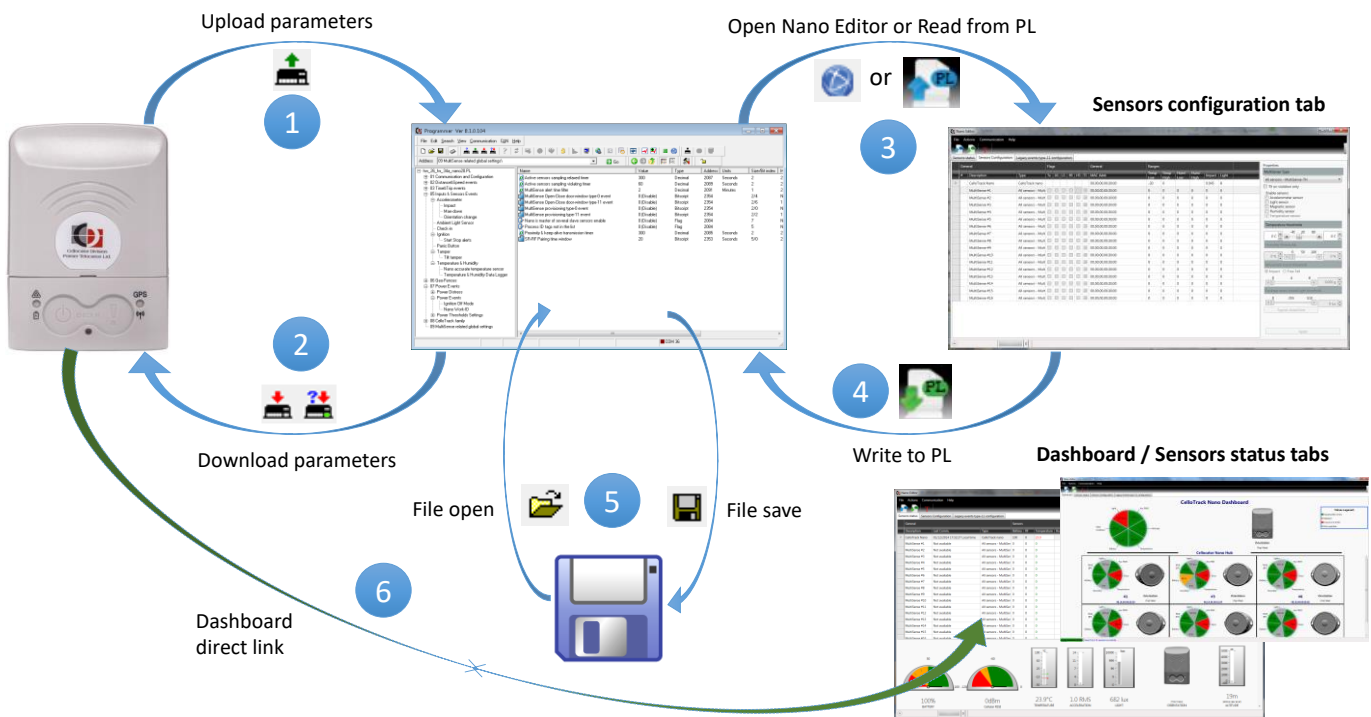

Figure 11: Operation Flow

The Cellocator Programmer supports the CelloTrack Nano 20 Editor which can read, edit and write PL parameters for CelloTrack Nano 20 and MultiSense devices.

The CelloTrack Nano 20 Editor has four main tabs:

◆ **Dashboard:** This tab provides you with a real-time overview of the entire system when the Nano is connected to the Cellocator Programmer.

◆ **Sensors Status:** This tab is a dashboard where all relevant CelloTrack Nano 20 and Multisense data is presented. When selecting one of the listed devices, its data is shown graphically in the lower part of the window, providing a visual overview of the selected device.

◆ **Sensors Configuration:** This tab provides the ability to activate sensors (i.e. accelerometer, light, magnetic, humidity, temperature, proximity) and sensor thresholds per device (Nano, MultiSense) which can be downloaded as a PL afterwards via the standard PL OTA/Serial procedure.

◆ **Legacy events type-11 configuration:** This tab contains all type-0 fields related to the CelloTrack Nano 20 that can be transmitted over Type 11 protocol. The user can set each one of the fields, which can be sent as a PL afterwards via the standard PL OTA/Serial procedure.

6.2 Integration Package (Cellocator GW)

The Cellocator Gateway is a set of software components offered to Cellocator customers wishing to integrate the Cellocator OTA protocol into their production environment.

Customers using the Cellocator Gateway benefit from a quicker and easier integration process, and are also entitled to software upgrades, technical support and more.

Cellocator Gateway is built utilizing the latest MS-based technologies, and provides high availability and load balancing options, as well as enabling clients the opportunity to integrate and start working with Cellocator units without investing a large amount of time and resources.

The new version of Cellocator GW includes all new fields related to the CelloTrack Nano 20 solution.

6.3 CelloTrack Nano 20 Hardware Installation Guide

This document provides all the necessary information for a technician involved in the installation of a CelloTrack Nano 20 system. It describes how to install and verify the proper functioning of the installation kit elements.

6.4 Cellocator Wireless Communication Protocol

This document explains the unit's wireless communication structure. It describes every byte of the incoming/outgoing packets, which can be sent or received by the unit over-the-air.

6.5 Cellocator Serial Communication Protocol

This document explains the unit's serial communication structure. It describes every byte of the incoming /outgoing packets, which can be sent or received by the unit via the serial interface.

6.6   Cellocator Integration Package

This document provides a complete product description of the Integration Package solution and other integration related information, for the purposes of integrating the Cellocator OTA protocol within a new client's production environment.

6.7   Evaluation Suite Manual

The Cellocator Evaluation Suite Manual is a comprehensive guide that provides information required to run an initial appraisal and testing process of Cellocator units.

The Cellocator Evaluation Suite contains a complete set of components that simplify bench testing of the system and serve as a demonstration platform for people wishing to understand the operational aspects of the system. The Suite is also intended to facilitate the development of interfaces to the Cellocator system by integrators or service providers.

6.8   Cellocator Programmer Manual

This document describes the features supported by the Cellocator unit and provides details about the configuration parameters.

6.9   Integration Manual

This document provides the software integrator with information and hints on how to integrate an application with the CelloTrack Nano 20.

6.10   Training Presentation

This documentation provides preliminary Integration Manual information through the beta phase.

Appendix A: FCC Compliance Statement

This device has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in residential installations. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio and television reception.

However, there is no guarantee that interference will not occur in a particular installation. If this device does cause such interference, which can be verified by turning the device off and on, the user is encouraged to eliminate the interference by one or more of the following measures:

◆ Re-orient or re-locate the receiving antenna.

◆ Increase the distance between the device and the receiver.

◆ Connect the device to an outlet on a circuit different from the one that supplies power to the receiver.

◆ Consult the dealer or an experienced radio/TV technician.

WARNING: Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

NOTE: This device complies with FCC Rules Part 15 and with Industry Canada licence-exempt RSS standard(s). Operation is subject to two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference that may be received or that may cause undesired operation.

Le present appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisee aux deux conditions suivantes :(1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioelectrique subi, meme si le brouillage est susceptible d'en compromettre le fonctionnement.