Cellocator
Cell ID Based Location
Application Notes

Cellocator Division
Pointer Telocation Ltd.

Proprietary and Confidential

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POINTER

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Table of Contents

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1 Introduction

This document describes the configuration, logic & state machine, usage, benefits and possible server side implementation based on the Cell ID feature introduced in CelloTrack v28 and Cello-F/R products.

The document discusses gathering information of the GSM Cells locations as well as the possible implementation of location finding algorithms on the server side.

The document does not go into details of triangulation algorithms, but provides relevant links and references.

1.1 Revision History

Version	Date	Description
1.0	19/10/10	Original version.
1.1	25/10/10	After review, added simple triangulation calculation example.
1.2	25/1/11	Tech Writer edited and formatted.

1.2 References

No.	Document Name	Version	Date	Remark
1	Cellocator Wireless Communication Protocol	v30a (rev2)	19/09/10	Or newer
2	Programming Manual Cello	30c4	5/10/10	Or newer

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2 General

The Cell ID triangulation is an alternative location method. In cases where the GPS is not available, information regarding in-range cellular towers (Cells) with known locations, along with signal power or SNR (Signal to Noise Ratio) indications, might be used for location approximation of the transmitting device.

2.1 Mobile Network Basics

A GSM-GPRS modem of the unit is a radio device, which when turned on, is in contact with a "cell". A cell is the smallest geographic area covered by a base station in the mobile network. The size of a cell can be from 100 meters in urban areas up to a few kilometers in rural areas. Each cell is identified by a number, the "cellid". Cells are grouped into areas and areas are operated by a Mobile Operator. Together with the area ID and the network code, the Cell ID forms a 3 part key and can uniquely identify the cell, and, if once logged by one of the resources listed below, its location.

2.2 Cell ID Location Resources

In order to perform Cell-ID based triangulation, the geographic (X-Y) location of each of the reported cells should be known.

There are several open source resources with cell ID location data available. Some of these are: CellSpotting; OpenCellID, 8Motions; ZoneTag Cell Location API, Yahoo.

Some services, like Google, provide a commercial service for automatic conversion of the Cell ID information into a geographical position.

Sometimes, it is also possible to obtain network cell location lists from network operators directly.

2.3 Cell ID-based Location Accuracy

Technically the accuracy depends on a few parameters:

- The density of the cells in the area; as mentioned above, the density might differ dramatically between urban areas and rural areas, from 100 meters up to a few kilometers.
- The accuracy of the database of cells location. If open source resources are used it relies on how accurately users fill in the information about cells, areas and operators.
- The number of in-range cells and their geographical spread. For example, the location estimation of a device received by only 2 cells which creates a sharp angle between them will usually be less accurate than a location estimation based on 3 cells or more, spread geographically around the transmitting device.

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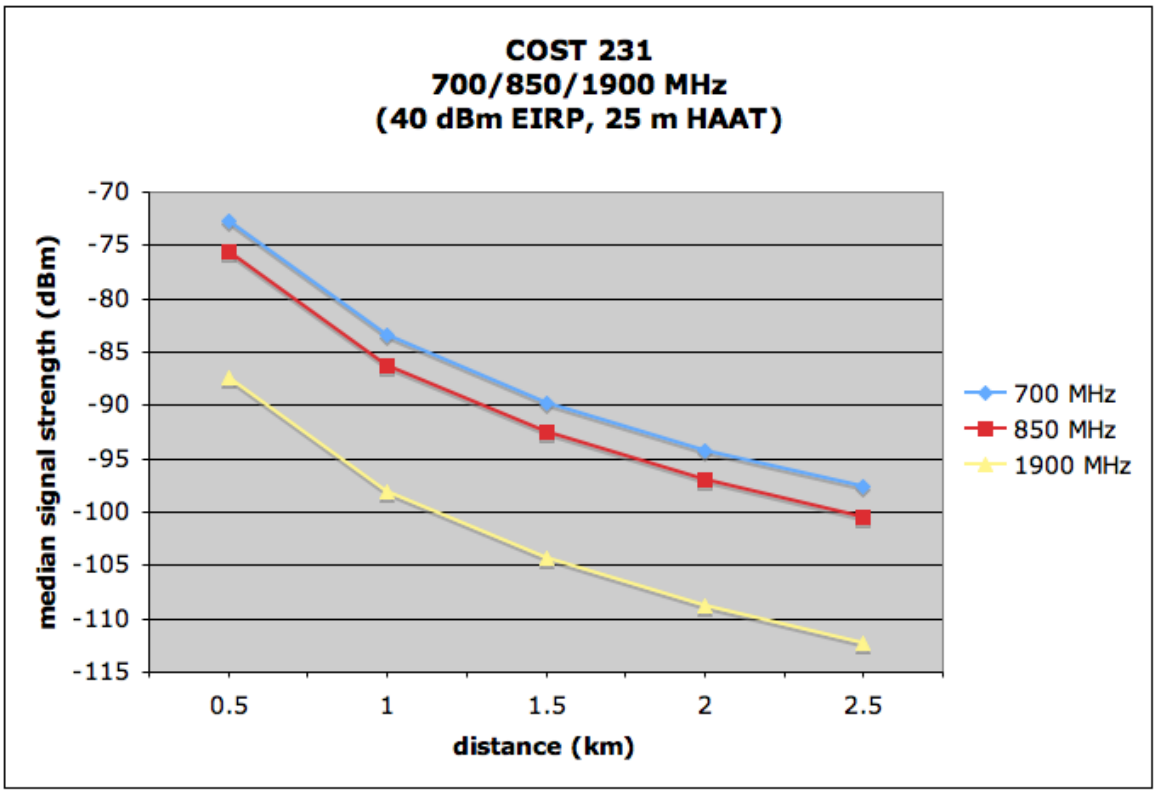

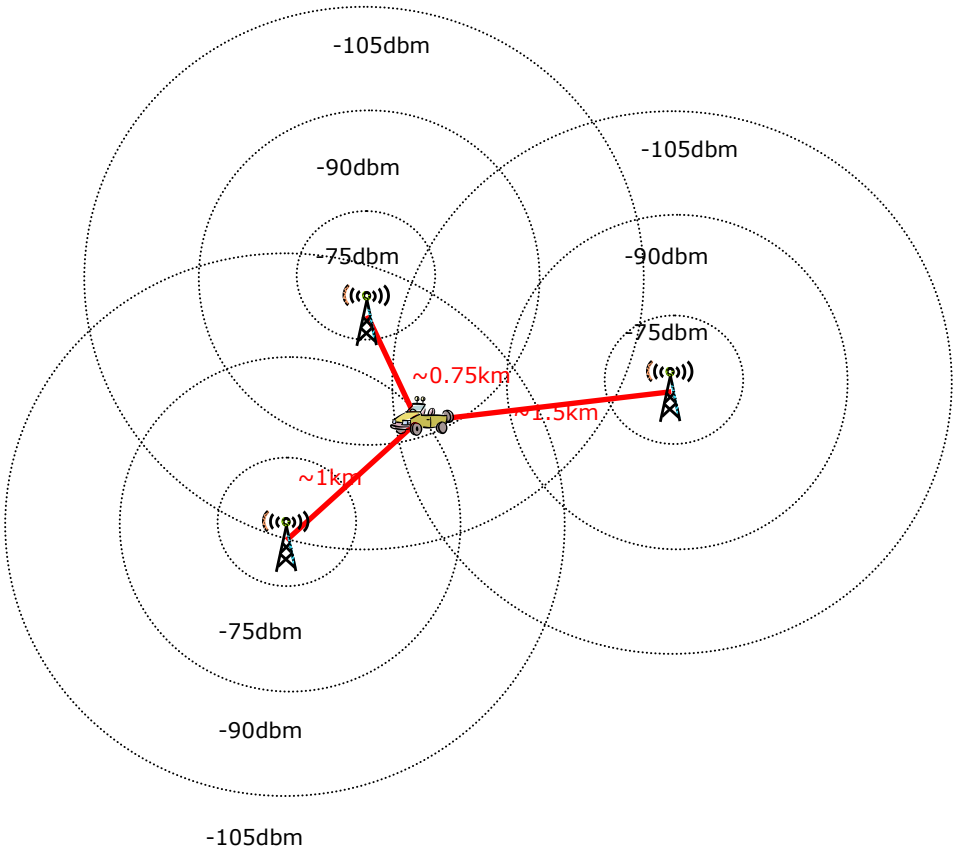

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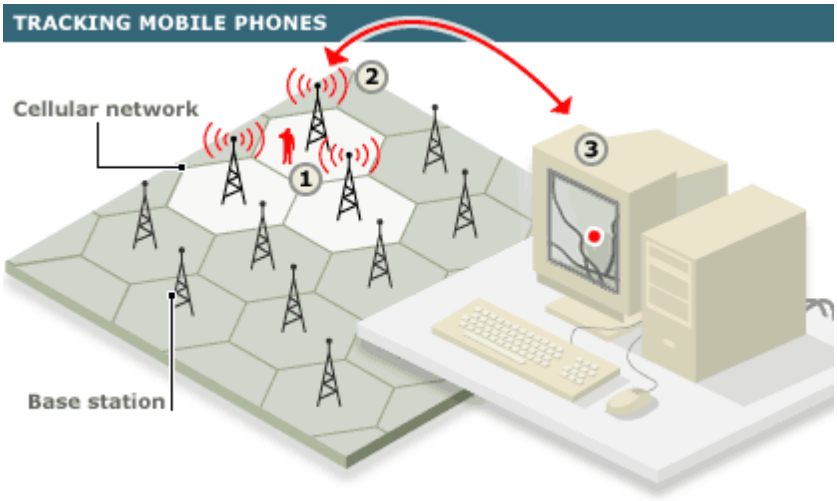
- The location of the transmitting vehicle in respect to the "in-range" cells and the RF signal propagation attributes which can be significantly affected by reflectors, black spots, interference, etc, may all influence the relative "reliability" of the SNR indication as an estimator for the distance of the vehicle from the receiving cell.

2.4 How does it work with the Cellocator unit?

When the unit loses a GPS signal for longer than 2 minutes, it will poll the modem for Cell ID information. The modem will update with the following parameters of up to 7 cells (the serving cells and up to 6 neighboring cells):

- Base station identification code
- Cell ID
- Location Area Code
- Received signal strength in dBm

The message, containing this information and the Cell ID retrieval timestamp, will accompany any log or distress message (as per configuration) generated by the Cellocator unit during GPS coverage loss.



Positioning software performs a triangulation calculation on the information and the data is converted into a geographical location: the strongest reception signal theoretically defines the closest cells.

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3 Detailed Description

3.1 Conditions to consider for GPS coverage loss and restore

The GPS coverage loss is considered when:

- The GPS is communicating (connected).
- The location appears as invalid for longer than 2 minutes in Standby mode or timeout, as programmed in the "GPS Max On time" parameter in hibernation mode.

The GPS coverage restore in Standby mode is considered when the GPS location is considered as valid continually for longer than 1 minute in Standby mode or 10 seconds in hibernation.

3.2 Behaviour during No GPS Mode

Once the "NO GPS" mode is started, the unit polls Cell ID neighborhood information from the modem periodically, every 1 minute.

The data session (to the operational server only) is suspended during polling, and the connection does not drop. Messages generated during Cell ID polling are delivered after data mode is restored.

The Cell ID neighborhood data is stored in a unit and delivered as an additional message to a central control after any event or distress message. The additional message contains the next sequential message numerator for easy correlation.

3.3 Configuration

Flag, enabling generation Cell ID packet (logged) with any event while there is no valid GPS (separately for Home and Roam network)

If this flag is enabled, the unit will generate logged message type 9, (sub data type 9) following any logged message type 0 while the GPS location is considered as invalid.

The logged messages type 9/9 will be stored in the same buffer as corresponding messages type 0 and use the same sequence of numerator for easy correlation.

The message type 9.9 will not be generated if the unit is not logged into GSM.

Flag, enabling generation of Cell ID packet (RT) with any event while there is no valid GPS (separately for Home and Roam network)

If this flag is enabled, the unit will generate real time message type 9, (sub data type 9) following any distress message type 0 while the GPS reading is considered as invalid.

The real time messages type 9/9 will be delivered using the same rules as the corresponding distress messages type 0 and use the same sequence of numerator for easy correlation.

Flag, disabling Cell ID packets on Glancing of CelloTrack

If this bit is enabled, the unit will NOT generate a Cell ID message during glancing (normal and ST), even if enabled in configuration and there is no valid GPS reading upon glancing event/distress generation.

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3.4 Communication

The Cell ID neighborhood information can be polled by OTA command.

NOTE: The table below defines only the format of the sub-data, for full structure of message type 9 refer to *Wireless Protocol*.

The information will only be updated (once in a minute) if GPS location is unavailable (refer to 3.1).

Field	Description
Sub data type	9 - Neighbor list of the serving GSM cell
Sub data length	1
Spare	0

The unit responds with a neighbor list of the serving GSM cell (Sub-Data Type 9). The unit will not query the modem for Cell neighborhood data upon reception of this command, but will use historical **CellID** data with the retrieval timestamp.

3.4.1 *Neighbor list of the serving GSM cell (Msg Type 9, Sub-Data Type 9)*

NOTE: The table below defines only the format of the sub-data, for full structure of message type 9 refer to *Wireless Protocol*.

This packet will be sent:

- Passively, as a response to a Neighbour list of the serving GSM cell request. In this case the packet will be sent using the same communication transport as the request (SMS or GPRS).
- Actively, if enabled in unit's configuration, separately for home and roam GSM networks, on address dec 202 and 204 respectively, bits 6 and 7.

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Description		Value	
Sub-data type		0x09	
Sub-data length		0x35	
Spare		0x00	
Timestamp - UTC time	seconds	0-59	The UTC time is logged upon Cell ID (AT+MONI) query (not the transmission time)
	minutes	0-59	
	hours	0-23	
	day	1-31	
	month	1-12	
	year	Actual year minus 2000 – 1 byte (e.g. value of 7 = year 2007)	
Serving Cell	BSIC	Base station identification code	
	LAC (LSB)	Localization area code	
	LAC (MSB)		
	CellID (LSB)	Cell Id	
	CellID (MSB)		
	Power	Received signal strength in dBm (hex); the sign is not saved, this value is always representing a negative number	
Neighbor cell 1	bsic	Base station identification code	
	LAC (LSB)	Localization area code	
	LAC (MSB)		
	CellID (LSB)	Cell Id	
	CellID (MSB)		
	Power	Received signal strength in dBm (hex)	
Neighbor cell 2	bsic	Base station identification code	
	LAC (LSB)	Localization area code	
	LAC (MSB)		
	CellID (LSB)	Cell Id	
	CellID (MSB)		
	Power	Received signal strength in dBm (hex)	

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Neighbor cell 6	bsic	Base station identification code
	LAC (LSB)	Localization area code
	LAC (MSB)	
	CellID (LSB)	Cell Id
	CellID (MSB)	
	Power	Received signal strength in dBm (hex)
Zero Padding	00	Zero Padding to fulfill the 56 bytes assigned for single event
	00	
	00	
	00	

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