(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
14 June 2018 (14.06.2018)

WIPO | PCT

(10) International Publication Number
WO 2018/104584 A1

(51) International Patent Classification:
G08B 21/10 (2006.01) *F42B 4/28* (2006.01)
B64D 25/20 (2006.01) *B63C 9/00* (2006.01)
G01C 21/12 (2006.01) *B64D 45/00* (2006.01)
G01S 19/01 (2010.01)

(21) International Application Number:
PCT/FI2017/050864

(22) International Filing Date:
05 December 2017 (05.12.2017)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
20165930 07 December 2016 (07.12.2016) FI

(71) Applicant: **PEHUTEC OY** [FI/FI]; Elektroniikkatie 10, 90590 Oulu (FI).

(72) Inventor: **ROUSU, Seppo**; c/o PehuTec Oy, Elektroniikkatie 10, 90590 Oulu (FI).

(74) Agent: **BERGGREN OY**; Isokatu 32, 90100 Oulu (FI).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,

(54) Title: APPARATUS, METHOD AND COMPUTER PROGRAM IMPROVING EMERGENCY COMMUNICATION

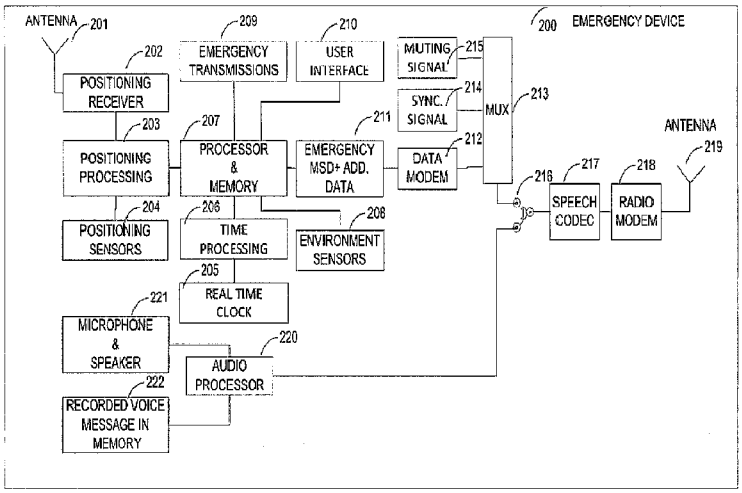


FIG. 2

(57) Abstract: The present invention discloses an apparatus for use in an emergency device (200), where the apparatus comprises a modem (121), a real time clock (131, 205), a positioning functionality, the power enabled emergency device (200) moving further away after an incident or accident without a position FIX and/or real time information. Furthermore, the present invention is characterized by that the apparatus is further configured to reach for a communication counterpart and/or a satellite positioning FIX, track and store for the elapsed time based on the information of the real time clock (131, 205), track and store a movement based on the positioning functionality, and finally, send transmissions.

WO 2018/104584 A1

[Continued on next page]

TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *of inventorship (Rule 4.17(iv))*

Published:

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

Apparatus, method and computer program improving emergency communication

Technical field

The present invention relates to devices (apparatuses), methods and computer program products in relation to an emergency case communication. In particular, it relates to those devices, methods and computer program products utilizing emergency information sending after an incident by dormant awaken emergency devices.

Background of the invention

Emergency eCall (European Emergency Voice Call) communication capability will be a mandatory European requirement for vehicles and emergency agencies. In the event of a vehicle collision, manual operation or eCall sensors and/or airbag/s initiate an emergency call. The eCall provides reliable full-duplex accident related data communications between IVS (In Vehicle System) and PSAP (Public Safety Answering Point) in addition to emergency voice call. The eCall modem allows to transfer a data message and voice from the IVS over the cellular network to the PSAP, which is denoted as eCall MSD (Minimum Set of Data). The MSD data can include, e.g. vehicle location information, time stamp, number of passengers, Vehicle Identification Number (VIN) and other relevant accident/incident information. It is expected that the eCall MSD information will be sent either immediately following the establishment of the voice call or at any point later during the voice call. The integrity of the eCall data sent from the vehicle to the PSAP is ensured by the specified modem.

Regulations require each vessel/boat to have a red parachute rocket and it has to be updated every 6th year. To address the problems associated with the rescue operation, the typical emergency rocket with a flare, the red flare signal is visible around 40-60 seconds and rescue operation is based on an opportunity of a detected flare and it is favorable to have at least two detection signals from different angles. Accident place must be estimated due to wind shift of parachute/flare. Location estimation is challenging especially in extreme weather conditions without reference points visible and poor visibility range in blind spot areas. Especially, the red parachute flare does not provide any information about accident or generally any reason why the emergency rocket has been launched.

Generally, emergency products are used in outdoor and marine incidents/accidents. Emergency rocket with a flare is typically mandatory as a piece of safety equipment in vehicles/boats and some outback trips. Furthermore, a distressed person may activate a personal locator beacon which transmits an emergency message containing a unique identifier number via the geostationary satellite system for further accident/incident position calculation processes and data ending (such as EPIRB (Emergency Position-Indicating Radio Beacon) and PLB (Personal Location Beacon)) e.g. to a rescue coordination center. In using the search and rescue radar Transponder, such as SART (Search and Rescue Transponder) system, a small transponder can receive navigation radar signals and it can reflect those signals in a way which is specific for an emergency situation.

In a prior art patent application EP 1980814, there is discovered an emergency system having a radio frequency transmitter, a code generator, ID, emergency data and a parachute/balloon as an emergency device. In prior art patent publication FR 2843848 (US 2004/0196367), there is discovered a system for observation of a zone in the ground, which has a projector to launch a projectile fitted with a camera, a parachute, a battery, a camera and a transceiver for sending data.

Furthermore, improvement for the prior art concepts is needed in order to enhance information accuracy and emergency message delivery speed in rescue operations saving search time, cost, resources, vehicles, insurance cost savings and environment, and obtaining especially faster and accurately defined rescue force support for the victims of an accident case. SMS (Short Message Service), pocket data or GPRS (General Packet Radio Service) are not suitable for emergency case communication due to delay, unavailability and lower prioritization as compared to a voice call priority.

Summary

The present invention introduces an apparatus for use in an emergency device, where the apparatus comprises a modem, a real time clock, a positioning functionality, where the power enabled emergency device is moving further away after an incident or accident without a position FIX and/or real time information. The invention is characterized in that it is further configured to reach for a communication counterpart and/or a satellite positioning FIX, track and store an elapsed time based on the information of the real time clock, track and store a movement based on the positioning functionality, and send transmissions.

The inventive idea of the present invention also comprises a corresponding method for use in an emergency device.

Furthermore, the inventive idea of the present invention also comprises a corresponding computer program, which executes and controls the steps of the defined method, when the computer program is executed in a processor.

The above computer program product or products may be embodied as a computer-readable storage medium.

Various further aspects of at least some exemplary embodiments of the aspects of the invention are set out in respective dependent claims.

Some aspects of the invention provide the advantage that a present hardware implementation of the emergency device can be widely maintained so that additional cost for the higher performance implementation solution can be avoided. Advantageously, embodiments may be implemented by software adaptation at the modem side of the emergency device. Moreover, emergency module integration can be used as such by adding product required parts.

Although embodiments of the invention will be explained in the following examples with reference to moving emergency device-mounting, the invention is not restricted to moving device-mounting but it may also be applied to other communication devices as it will become apparent from the description of the embodiments.

Further features and advantages of the invention will become apparent from the following detailed description of the embodiments, given by way of examples only, which are made with reference to the accompanying drawings.

Brief description of the drawings

Figure 1 schematically depicts a block diagram of an emergency device according to an embodiment of the invention,

Figure 2 schematically depicts a block diagram of an emergency device for information processing and communication according to an embodiment of the invention,

Figure 3 schematically depicts a flow chart of a process for operation of an emergency device according to an embodiment of the invention,

Figure 4 schematically depicts a block diagram of a simplified cellular system including the PSAP and an emergency device,

Figure 5 shows a dormant awaken emergency device moving further away from an accident position without position information and real time information, and

Figure 6 schematically depicts a diagram of a process for an estimated accident moment and an estimated accident position.

Detailed description of the embodiments

Without limiting the scope of the invention to the embodiments, embodiments of the invention are illustrated in more detail by the following description referring to the accompanying drawings. Indeed, references to certain standards, media and/or resources in this description are supposed to be exemplary for the purpose of illustration of the invention in order to improve the case of understanding of the invention. They are not to be understood as limiting the inventive concept. Likewise, the language as well as terms used herein such as e.g. signal names, device names and the like, are to demonstrate the embodiments only. Use of such language or terms apart from their understanding according to this disclosure shall not be applied to the invention for purpose of limiting its scope.

Generally, emergency devices may be user safety equipment and it can be a mandatory or voluntary user safety equipment. An emergency device may also be a module which can be connected to or inserted in a user safety equipment. The term “emergency device” can also encompass objects which are mobile, such as flying or wearable objects.

Although wireless communication is usually established via radio as a transmission resource, it may also be applied to ultrasonic, infrared light, visible light or some other appropriate transmission resource.

Herein below, however, exemplary aspects of the invention will be described with reference to radio communication as wireless communication medium. Furthermore, exemplary aspects of the invention will be described with reference to the European “eCall” emergency service and examples can be applied for the Russian ERA/GLONASS (Russian Emergency Voice Call) emergency service and the New Generation 911 emergency service in the United States.

One application domain in particular, namely a dormant awaken emergency device, does not have any real time or time zone information and it remains thus without positioning FIX while moving further away from an accident position. Delay in having a positioning estimation FIX degrades the accuracy of the accident position and the accident moment estimations. The constraints of other environments may also present challenges, such as those of hills or mountains, altitude, wind direction, sea current vector, swell of the sea, temperature or the like.

In relation to a device such as a flying emergency device, such as an emergency rocket, an emergency balloon, or an emergency drone, it is typically a desired place for eCall modem integration, since this integration may provide a line of sight visibility communication to cellular network base stations and positioning satellites from various heights. Height of the flight path of the balloon may be controlled by height information, and with processor generated controls to adjust the amount of gas in the balloon. The line of sight visibility as such improves the received communication quality and positioning signal strength due to less attenuation in the radio path and signal quality due to less reflections and thus, less multipath propagations in the radio path, such as in the proximity of the surface of the earth, or in relation to hills and forest across the canopy. To address the issues associated with the proximity of the earth, the path loss behavior is linear and the path loss behavior shift is logarithmic when the distance to the earth increases. The advantage is that a logarithmic path loss enables a longer base station reach than the linear path loss. Generally, in higher altitudes, the bigger probability for an increased number of visible positioning satellites enables a faster FIX and more accurate positioning estimation. In weak signal areas, even a minor hill, a valley or an island may block the modem access to the cellular network. From higher altitudes, even without any line of sight visibility between the device antenna and the base station antenna, the cellular network coverage will be increased remarkably in the point of view of the emergency eCall message delivery. Generally, a low band 2G (Second generation cellular system) cellular reach is up to 30 km in an earth surface position depending on the radio path conditions, but in higher altitudes above the same earth surface position, the line of sight radio path enables a connection length of even more than 70 km to a base station. The cellular network reach also enables requesting an assisted GNSS ("Global Navigation Satellite System") positioning data from the network, which enable quite instant positioning after the assisted GNSS positioning data are received. In another embodiment, an advanced GNSS receiver may be used for having a technology to receive and use ionospheric delay corrections for received positioning

signals and/or multi-frequency receivers, such as L1 and L2 frequencies (frequencies for positioning signals) or the like. Such corrections may be delivered via a cellular network, via a local network or via a satellite, which enables improved positioning estimate accuracy.

However, this positioning delay brings with it an undesired impact on the position accuracy of an accident place due to the emergency device movement between the launch and the satellite position estimation FIX. The drift is impacted by the delay, the direction of the wind vector, and the strength of the wind vector. As an example, in a strong wind of 32 m/s and with a 30-second delay to the first FIX, the device will move further away approximately 1000 meters. By extracting the drift from the satellite position, it will improve the accuracy which further will speed up the rescue operation. Therefore, technology related to improving the position drift estimation is needed and it is highly reasonable for implementation as well.

To address the issues associated with the rescue operation, the environmental information of the accident place may be delivered to the emergency center in the eCall message. Environmental information may be computed from sensor generated information, such as heading information, speed information, height information, position information, pressure, direction of the wind vector, strength of the wind vector, altitude, sea current vector, swell of the sea, temperature of air, or temperature of water, as various examples. Generally, sensors may comprise a positioning receiver, a gyroscope, an accelerometer, a temperature sensor, a pressure sensor etc. Furthermore, detailed information about the accident and its severity may be comprised in the emergency eCall message by user voice recording and storing to the device memory until the eCall connection to the emergency center is established. In an embodiment, a camera can be integrated in the device for sharing accident condition picture(s) and/or a video clip to the PSAP and for the rescue operation as a live signal or as a time-shifted picture(s) or video.

Figure 1 depicts emergency device integration with some peripherals for functionalities of a device 100. Generally, electronics need to fulfil various requirements for the eCall functionality, such as global cellular coverage, explosive environment, ingress protection, long storage time, transmission pulse burst discharge current, RoHS (“Restriction of the use of certain Hazardous Substances”), battery retention after long storage time, battery capacity, light weight, hermetically sealed, a wide operational temperature range, vibration, shock, spinning, and a low unit cost, just to mention a few of the requirements. The device 100 is powered by a battery 114,

which favorably is continuously unpowered during the storage time to avoid the battery 114 capacity reduction. The battery 114 technology may be lithium metal oxide cell/s, as an example. The device's 100 off-powering state may be done by an electrical isolation strip 117 between the contacts of a power on/off switch 115 and the device's 100 activation to power-on state by removing the isolation strip 117. The implementation for the isolation strip 117 removal may be a user-initiated action, a cotter pin removal initiated action, a seal cap removal initiated action, a trigger launch initiated action, a device body versus electronic integration relative movement initiated action, or some other functionality, which performs the wanted power-on activation operation. In a supply voltage conversion, such as up- and/or down-conversion, device 116 input supply voltage from the battery 114 is converted to operational power supply 118 for powering modules 101, 110. The module 110 integration may contain functionalities, such as a positioning receiver 128, sensors 127, a CPU (Central Processing Unit) 129, interfaces 111, a memory, and transceiver(s) 130. Positioning signals 119, such as satellite positioning signals, are captured by antenna 113 and attenuation for out-of-band interference sources is provided by RF filter 112. Positioning estimation is supported by positioning receiver 128, accelerometer and gyroscope sensors (the positioning sensors 127) fusion with computational algorithms in CPU 129. In safety device positioning, the receiver is favorably of a GNSS type and a multi-receiver capable device enables to search multiple satellite signals, such as GPS (Global Positioning System, the US), GLONASS (Russian satellite positioning system), Galileo (European satellite positioning system) etc. simultaneously, which increases the probability for the required number of satellites and signals visible to estimate the position. Interfaces 111 enable data communication and also a reference clock between modules 101, 110. Cellular modem circuitry integration, such as module 101, SoC (System on Chip), typically comprises modem/s 121, a CPU 122, a memory 123, power management 125, interfaces 111, transceivers 126, a temperature measurement sensor (as part of internal sensors 124), a battery capacity tester, a real time clock 131, etc., and integration functionalities vary between products. The cellular modem 121 must have in-band modem capability, such as the IVS system used in vehicles, in order to support eCall voice and message transfer using same radio resources according to the eCall standardized documentation 3GPP 26.267. Radio resource used for the emergency communication may be for example 2G, 3G (Third generation cellular system), HSPA (High Speed Packet Access), VoLTE (Voice over LTE feature), LTE (Long Term Evolution), LTE-A (Long Term Evolution Advanced), 5G (Fifth generation cellular system), ProSe (Proximity Services), IoT network (Internet of Things), a narrow band communication resource, a wide band communication resource, FDD

(Frequency Domain Division), TDD (Time Domain Division), or the like. Microcontroller/s, such as a CPU 122, 129, may be used for software task execution according to a predefined algorithm. Subscriber identification module 106, such as SIM (Subscriber Identification Module) card or MIM (Machine Identification Module), is not essentially needed for making an emergency call and implementation but it may be needed in GNSS assisted data request, product validation phase or in some other applications than the eCall product applications. The device without SIM/MIM 106 has a regulatory requirement for the emergency call capability. Typically hosting the device with a mandatory non-stop activated SIM/MIM generates maintenance costs, at least a prepaid subscription cost. The modem 121 of module 101 transmits and receives communication signals 120 with a communication counterpart via antenna 102. Microphone 108 and loudspeaker 109 may be used for voice communication with the communication counterpart, to repeat stored voice or instruction from memory 123 or to store voice to memory 123. The device 100 may comprise various interfaces 104, 105, 107 such as an analog interface, a digital interface, a test interface, a status interface, a user interface, a USB interface, a charging interface, a switch for emergency message record, an interface to detect the end of life time of the emergency device, or the like. A user interface 104, 105, such as a LED and/or a high power LED, may indicate current status with various transmissions such as GNSS positioning status, cellular network status, eCall progress status, visible light communication, transmissions indicating an emergency case such as high intensity pulsed red S.O.S. (Save Our Souls) signal, or the like. Environmental sensor/s 103 may be used to observe environmental information such as air pressure, air temperature, humidity, or the like. All relevant parts for the device functionality are not shown for clarity, such as controls, clocking, grounding, shielding, powering, etc. Generally, various additional embodiments can be created from the above description and/or by removing some functionalities from the above description and/or as a combination of the presented features with other available technologies.

An emergency device system may be an integrated one, such as a system on chip, as an example. The system may comprise various functionalities according to the design. In an embodiment, an integrated system chip may comprise one or more modems, a transceiver, a real time clock, power management, internal sensors, a memory, a CPU, interfaces, an antenna, a user interface, a microphone, a loudspeaker, a positioning receiver, positioning sensors, a SIM/MIM, or in-band modem functionality, as examples. An alternative embodiment may be implemented with a combination of two or more chips comprising various functionalities. In the following,

there is explained an embodiment with two system chips. In an embodiment, the system may comprise a positioning receiver and/or positioning sensors.

Figure 2 depicts an embodiment of a modem principle architecture in an emergency device 200 for information processing and communication. An antenna 201 captures satellite positioning signals to a positioning receiver 202. A positioning processor 203 takes care of positioning estimation processing based on information from the positioning receiver 202 and positioning sensors 204. A processor 207, such as a CPU, takes care of information processing, device controlling, and device timing according to the programmed tasks. The processor code may be stored in a memory 207 and loaded into the memory of operation during the initialization, as an example. The memory 207 may be used for storing data and information, such as default values, measured values, calculated values, received information, results, environmental sensor information 208, start values, time processing information 206, position processing information 203, or the like. Time information may be extracted or calculated from a real time clock 205, time processing 206, positioning processing 203 or from the cellular communication. The processor may control a user interface 210 for status communications and for emergency transmissions 209, such as pulsed or continuous visible light. The processor 207 may take care of the data communication using data modem 212, such as emergency data 211. The emergency data buffer or source may contain specified MSD ("Minimum Set of Data") data information and potentially useful additional data.

A data transceiver comprises a multiplexer 213, a muting signal generator 215, a synchronization signal generator 214 and a data modem 212. After an emergency voice call has been (automatically or manually) established, the data modem receiver constantly monitors the incoming signal from the speech decoder output. When prompted by a request from the PSAP operator for the MSD emergency data, the data modem 212 connects a switch 216 from the data modem transmitter to the input of a speech codec 217 and mutes any speech from the user for the duration of the MSD emergency data transmission to prevent it from interfering with the eCall data transmission. The emergency information input to the data modem 212 transmitter is first appended with CRC (Cyclic Redundancy Check) information. These bits are then encoded in a hybrid ARQ encoder using FEC (Forward Error Correction) coding to reduce susceptibility to transmission errors. The HARQ (Hybrid Automatic Repeat-reQuest) encoder employs a powerful state-of-the-art turbo encoding scheme with incremental redundancy added for each retransmission. The data modem 212 receiver continues to monitor the feedback messages from the PSAP

data modem. As long as the received feedback messages are NACK (Not Acknowledged) messages, retransmissions of the emergency data with incremental redundancy are automatically continued until an ACK (Acknowledged) message is received by the data modem 212, or operation is terminated by the PSAP. After the transmission of the emergency information is completed, the emergency modem transmitters in both the emergency device and PSAP return to an idle state and the signal paths from the transmitters are switched off to avoid interference with the normal voice call. The received and transmitted signals pass through an antenna 219 and a radio modem 218. The speech codec 217 interface switch 216 is connected to the multiplexer 213 when the PSAP communication is emergency data and the interface switch 216 is connected to an audio processor 220 when the PSAP communication is emergency voice communication. The audio processor 220 has a microphone and a speaker 221 for voice communication with the PSAP. In an embodiment, the audio processor 220 may communicate a recorded voice message, such as an emergency voice message, from the memory 222 to the PSAP. In a use case, the audio processor may communicate a recorded voice message 222 from the memory, such as guidance or instructions, via a microphone and speaker 221.

Figure 3 illustrates a flow chart of a process for operation of the emergency device. According to an exemplary aspect and referring to Figure 3, the operation can be as follows:

At step 310, a user follows an emergency device operation instruction to launch the emergency device.

At phase 320, on the launch process, the emergency device gets activated from power-off state to power-on state 321. In the power-on state the microcontroller is powered and initialized 322 with a predefined software code. A real time clock 323 of the device is enabled, a start time value of the real time clock is stored 325 and time elapse tracking is started 324 from a predefined time moment. Because the device has been dormant, the enabled time stamp of the real time clock is not necessarily correct and it needs to be corrected later for an emergency message transfer to estimate the moment of the accident. In predefined software execution steps, the microcontroller enables cellular modem 326, satellite positioning search 327, the user interface, environmental sensors 328, and positioning sensors 328 which have computational capability to estimate the relative movement of the device. Some sensors 328 may need a calibration process prior to the proper operation. For later position estimations, start position values of the sensors 328, such as default values,

are stored. Potentially user interface(s) 329 may be enabled for status communications.

At phase 330, the typical cellular modem in activation starts to search for access to the cellular network or to a communication counterpart. The cellular network(s) availability may be blocked due to an attenuated base station signal level, resulting from e.g. distance, mountains, canyon, valley, weather and/or foliage, and from the successful emergency information transfer point of view, the advantage is to reach a better radio link regarding its quality. In offshore and other remotely happening accidents without any instant network coverage available, there is an opportunistic probability to reach the cellular network or discover a ProSe UE (User equipment) for the emergency message transmission, when the device moves further away from the accident position. In successful access to the cellular network and handshaking process 332, from a communication counterpart found 331, the modem receives cellular network time 333. For later accident time estimations, received network time 334 and tracked elapsed time 335 are stored. The launch information, both prior to the launch and after the launch from the air, can be indicated for the user as status information of a cellular or a positioning communication link through the user interface (e.g. through a blinking LED or other visual indication), such as showing a slow blink when searching a network, a fast blink when a network connection is established, and showing a continuous light when a successful emergency message has been delivered.

At phase 340 and more specifically in step 341, in the cellular network connection, the modem may send a request for assisted satellite positioning data. When the assisted satellite positioning data is available, then positioning the receiver time to a first FIX can be reduced to ~2 seconds from around 30 seconds without the assisted data. The fast position FIX 342 enables a quick transfer from the environmental sensor positioning, such as untethered dead reckoning or the like, to satellite positioning, meaning that the sensor based positioning time and thus, the error of the flight path of the device, remain as low as possible. For later position estimations, position 343 values may be stored at the FIX moment, or estimated positions of sensors 344 may be stored at the FIX moment, or the GNSS satellite time 345 may be stored, or the tracked elapsed time 346 may be stored, for instance.

At phase 350, an estimate 351 for the possible accident or incident moment is valuable information for the rescue operation planning and as an MSD information field requirement. The estimated incident (accident or emergency) time stamp 354 can be calculated by using the received cellular network time 333 extracted when a

tracked and stored elapsed time 335 has passed since the power of the device has been turned on 321. When the power has been turned on 321, the real time clock is enabled 323, and the start time of the real time clock is obtained from the cellular network and then stored 325. The elapsed time tracking starts 324 then. When the stored elapsed time 335 is subtracted 352 from the received and stored cellular network time 334, the start time is obtained which is the same as the estimated incident time stamp 354.

Alternatively, the estimated incident (accident or emergency) time stamp 354 can be calculated by using the received and stored GNSS satellite time 345 extracted when a tracked and stored elapsed time 346 has passed since the power of the device has been turned on 321. When the power has been turned on 321, the real time clock is enabled 323, and the start time of the real time clock is obtained from the cellular network and then stored 325. The elapsed time tracking starts 324 then. When the stored elapsed time 346 is subtracted 353 from the received and stored GNSS satellite time 345, the start time is obtained which is the same as the estimated incident time stamp 354.

In some embodiments of the invention, the received GNSS satellite time 345 or the received cellular network time 333 may be used as the incident moment as a part of the emergency message.

Furthermore, at phase 360, an estimate 361 for a possible accident or incident or emergency position is an important MSD information field requirement. The estimated incident (such as accident) position 363 can be calculated starting from the GNSS position 343 at a FIX moment, from where an estimated movement since the power of the device has been turned on is extracted 362. The estimated movement can be calculated from the estimated position of sensors 344 at the FIX moment, extracted by the default position values 328, when the sensors were enabled. In an embodiment, a computed GNSS position 343 at the FIX moment may be used as the incident position as a part of the emergency message.

In an embodiment of the invention, an estimated accident or incident position may be defined based on device movement information, such as height information, heading information and/or velocity information, while these can be extracted from a positioning receiver or obtained as sensor information. Generally, this positioning receiver movement information is available after the position FIX is achieved and average movement information computation can be done according to predefined time periods or when needed. The positioning receiver movement information

and/or an average movement information after FIX with a tracked elapsed time at position FIX moment may be used to estimate movement prior the position FIX is achieved. The movement calculation may utilize predefined values, such as constants, and multipliers as examples to remove potential error sources in the position estimation after the device activation as an example of a user operational time needed to launch the device. The estimated accident position can be calculated by the GNSS position 343 at FIX moment, extracted by the estimated movement prior to the FIX since the device has been powered on. The emergency message may include an accuracy estimation field, such as an index or a range, for the estimated accident place.

At phase 370 and more precisely in step 371, to address the issue associated with a dormant awakened emergency device, it does not have any information about the emergency call number of the current geographical area location 372. The right call number of the emergency center for the emergency call initiation 373 and the right emergency service, such as “eCall”, “ERA”/”GLONASS”, “NG911” (New generation Emergency Voice Call in US) or the like, can be defined 371 from cellular network communication parameters, from a look-up table of the device memory based on the geographical location, SIM/MIM, or in some other appropriate manner.

At phase 380, the emergency transmission 381 is performed, and a visible eCall feature operation requires both data and voice for using the same physical voice channel. As a requirement, an eCall capable modem transceiver has an implementation as an “in-band modem” which allows data transmission 382 over the voice channel. In case of an accident, the PSAP receives a standardized minimum set of the data MSD, such as a device ID (Identification Number), an owner ID registered at purchase (device misuse solving), and optional additional data. To address the issues associated with the rescue operation, like marine and outdoor environments, further additional information of the accident type and environmental conditions may be included into the transmission communication to the PSAP. The additional information may be an emergency message which originates from an emergency device moving further away (such as a rocket, or a balloon), estimated accuracy or an index of position information due to environmental conditions, a recorded voice message, air pressure, estimated remaining operational life time based on the battery voltage and estimated operations, direction of the wind vector in different heights, strength of the wind vector in different heights, an estimated altitude of the accident place (valuable in outback mountains), sea current vector, swell of the sea index or height, temperature of air, temperature of water, or the emergency device landing position

as a group of examples. Detection of landing and transmission of the landing position enables picking up the device later, for e.g. picking up fingerprints, keeping nature reserves clear, or in military cases which are also possible. Instructions for recording an emergency message, including e.g. the ID of a person, the number of people involved, or the type of accident etc., may be played from the device memory. As an advantage of using the additional information, rescue operation may gain information about estimated vehicle drift in current and wind, an estimated travel time, or needed equipment and preparation for rescue challenges, such as in deep diving.

Finally, the emergency transmission is terminated 383, and in phase 390 and more precisely in step 391, the user interface status communications are continued.

Fig. 4 depicts a block diagram of a simplified cellular system diagram comprising the PSAP 400 and an emergency device 411. An emergency device 411 has a communication link 414 via the emergency device antenna 413 to an antenna 410 of a base station in a PLMN 406 ("Public Land Mobile Network"). The other antenna of the emergency device 411 is a satellite positioning antenna 412. The PLMN 406 comprises a radio modem 409, a speech transcoder 408 and a mobile switching center 407. The PLMN has a communication link via PSTN ("Public Switched Telephone Network")/GSTN 405 ("General Switched Telephone Network") to the PSAP 400. The PSAP has specified functionalities for the emergency data and emergency voice communication, such as data or voice path selection switch 404, PSAP data modem 402, data display 401, and microphone or speaker 403.

Figure 5 shows a dormant awaken emergency device moving further away from an accident position 500 without any accident position information, positioning FIX or real time information in activation. The emergency device 501 may move further away due to an external force to the emergency device, a human force to the emergency device, a natural force to the emergency device, such as wind 518 or the like. The emergency device 501 is lifted and carried in the air by a balloon 502. The vertical 508 and/or horizontal 507 movement degrades the accuracy of the required accident position and accident time in the emergency MSD message. A network communication to the base station 513 and its antenna 517 may be blocked due to a radio shadow at the cellular antenna 503, such as a valley, a canyon, a mountain, a canopy, an island, or otherwise by a weak signal strength or the like, and it may prevent the emergency call communication to the PSAP 516 and the reception of the local network time. The radio shadow may prevent also reception of the required amount of satellite positioning signals with a satellite positioning antenna 504 from

the GNSS satellites 509, 510, 511, 512 and thus, it prevents the positioning estimation. The emergency device 501 may transmit an emergency transmission 506, such as pulsed or continuously visible light communication, by using a transmitter 505, such as LED or LEDs. The emergency transmission 506 may be detected by a person and/or an UE 514 near the flight path area of the device. The person may detect the emergency transmission, such as an S.O.S. signaling. The UE 514 may detect visible light communication data or ProSe communication advertisement for creating a ProSe communication link. The ProSe communication link may enable communication between the UE 514 (person) and a UE 515 at the accident position 500. When the emergency device reaches at least four GNSS satellites and FIX, the position estimate is not necessarily the accident place position and according to present circumstances, the position accuracy may be very poor for rescue force use. An estimated accident position can be calculated with tracking the movement after initialization of the device with positioning sensors and/or with a positioning receiver. When the emergency device reaches a cellular network or a communication counterpart, the device receives the network time as a communication parameter. An estimated accident time can be calculated by tracking the elapsed time after the initialization of the device with a real time clock. The emergency device may create the emergency call to the PSAP 516 via the base station 513 and communicate the estimated accident position and the estimated accident time and other accident related information.

In a use case scenario, the ProSe communication capable emergency modem may operate as a link between the ProSe communication capable UE or vehicle 515 at the accident location and also between the ProSe communication link UEs 514 and the base station 513 to the PSAP 516. The accident vehicle 515 may locate in a radio shadow and the network is not available in all road sections. Information transmission from the UE 515 of the accident location to the PSAP 516 may be voice and/or video, and the UE 515 may receive an acknowledgement of a successful eCall message delivery, instructions, or a status of rescue operation, etc.

In an embodiment, an emergency device having an IoT network connection, such as LoRa communication or Sigfox communication as examples, may deliver accident related information via an IoT base station to PSAP. In an alternative embodiment, the IoT base station may deliver the received emergency message to the PSAP in the eCall message format, such as in MSD data.

Figure 6 schematically depicts a diagram of a process for an estimated accident moment and an estimated accident position since an emergency device is enabled

in the above embodiments. According to signal strengths, the amount of signals and quality of signals, either a cellular or a satellite communication link may be enabled first. In some circumstances, cellular network connection is achieved prior to the satellite FIX and the device processing needs to take this into account, e.g. if the computer program results in an endless loop for some reason. In challenging radio path conditions, it is very typical that the communication link may disconnect or there is a need to reinitiate or to find a new FIX.

The apparatus may comprise a dormant after sales part or module which is located in a vehicle. The after sales part does not need to be connected to the electrical system of the vehicle or to the sensors (or airbag) placed within the vehicle. Such an after sales part or module can be activated after the incident or accident separately by the human user. The benefit of such an after sales part is that it is cheaper to manufacture, and thus, its price is cheaper than the main product disclosed above.

Generally discussing the alternative options according to the embodiments of the apparatus, these optional features are summarized next.

In an embodiment of the invention, the positioning functionality comprises a sensor positioning unit and/or a satellite positioning unit.

In an embodiment of the invention, an emergency transmission is using the modem as an in-band type modem for data and/or voice communication.

In an embodiment of the invention, a communication transmission is an estimated accident or incident time based on a tracked elapsed time since the emergency device is enabled and which tracked elapsed time is based on a received network time or a received satellite time.

In an embodiment of the invention, a communication transmission is an estimated accident or incident position and/or height based on a tracked movement since the emergency device has been enabled and a positioning FIX has been reached.

In an embodiment of the invention, a communication transmission comprises an estimated accident or incident position based on a position FIX and an estimated movement prior to the position FIX with a tracked elapsed time since the emergency device is enabled to the position FIX, and positioning receiver movement related information after the FIX.

In an embodiment of the invention, a communication transmission is a visible light communication transmission.

In an embodiment of the invention, a communication transmission is a Proximity Services (ProSe) communication transmission.

In an embodiment of the invention, a communication transmission comprises environmental data in proximity of an accident position based on the sensor positioning and/or the satellite positioning information.

In an embodiment of the invention, one of voice inputs of a speech codec in the in-band modem is a memory of an incident related recorded voice message.

In an embodiment of the invention, data sources of a data modem in the in-band modem comprise estimated position data of an accident or an incident, estimated height position data of the accident or incident, landing position data, estimated accident or incident moment data and observed environmental data.

In an embodiment of the invention, the emergency device is an emergency drone, an emergency balloon, an emergency rocket, a handheld emergency equipment or an outdoor emergency equipment.

In one embodiment, the apparatus comprises an after sales part which is a dormant module in a vehicle, and the after sales part can be activated after the incident or accident.

The respective method comprises the same optional features as presented in the above.

Other systems can also benefit from the principles presented herein as long as they have identical or similar properties such as the emergency device, the user device, or the public safety device in the message transmission.

Embodiments of the present invention may be implemented as a rocket without a flare, a rocket with a flare, a balloon, as wearable products, or accessory equipment, just to present some examples. Use case conditions cover solutions in various emergency cases, and solutions considering the public safety, solutions in sports, solutions in general human safety, and solutions in animal safety, to illustrate some possible examples.

Embodiments of the present invention may be implemented in software, hardware, application logic or as a combination of software, hardware and application logic. The software, application logic and/or hardware generally reside in control modules of terminal devices or network devices.

In an embodiment, the application logic, software or an instruction set is maintained on any one of various conventional computer media. In the context of this description, a "computer-readable medium" may be any media or means that can comprise, store, communicate, propagate or transport the instructions for use by or in connection with instruction execution system, apparatus, or device, such as a computer or internet of things (IoT) device or user equipment or wearable.

The present invention can advantageously be implemented in a user equipment or an internet of things device or wearables or computers connectable in such networks. That is, it can be implemented in a form of chipsets to connected devices, and/or modems thereof.

The present invention is not restricted to the embodiments presented above but it may vary within the scope presented in the claims.

Claims

1. An apparatus for use in an emergency device (200), the apparatus comprising:

a modem (121);

a real time clock (131, 205);

a positioning functionality;

the power enabled emergency device (200) moving further away after an incident or accident without a position FIX and/or real time information;

characterized in that the apparatus is configured to:

reach for a communication counterpart and/or a satellite positioning FIX;

track and store an elapsed time based on the information of the real time clock (131, 205);

track and store a movement based on the positioning functionality; and

send transmissions.

2. An apparatus according to claim 1, **characterized** in that the positioning functionality comprises a sensor positioning unit (127) and/or a satellite positioning unit (128).

3. An apparatus according to claim 1 or 2, **characterized** in that an emergency transmission is using the modem (121) as an in-band type modem for data and/or voice communication.

4. An apparatus according to any of claims 1-3, **characterized** in that a communication transmission comprises an estimated accident or incident time based on the tracked elapsed time since the emergency device (200) has been enabled and which tracked elapsed time is based on a received network time or a received satellite time.

5. An apparatus according to any of claims 1-4, **characterized** in that a communication transmission comprises an estimated accident or incident position and/or

height based on a tracked movement since the emergency device (200) has been enabled and a positioning FIX has been reached.

6. An apparatus according to any of claims 1-5, **characterized** in that a communication transmission comprises an estimated accident or incident position based on a position FIX and an estimated movement prior to the position FIX with a tracked elapsed time since the emergency device (200) has been enabled to the position FIX, and positioning receiver (202) movement related information after the FIX.

7. An apparatus according to any of claims 1-6, **characterized** in that a communication transmission is a visible light communication transmission.

8. An apparatus according to any of claims 1-7, **characterized** in that a communication transmission is a Proximity Services (ProSe) communication transmission.

9. An apparatus according to claim 2, **characterized** in that a communication transmission comprises environmental data in proximity of an accident position based on the sensor positioning (127, 204) and/or the satellite positioning (128, 202) information.

10. An apparatus according to claim 3, **characterized** in that one of the voice inputs of a speech codec (217) in the in-band modem is a memory of an incident related recorded voice message (222).

11. An apparatus according to claim 3, **characterized** in that data sources of a data modem (212) in the in-band modem comprise estimated position data of an accident or an incident, estimated height position data of the accident or incident, landing position data, estimated accident or incident moment data (205, 206), and observed environmental data (208).

12. An apparatus according to any of claims 1-11, **characterized** in that the emergency device (200) is an emergency drone, an emergency balloon, an emergency rocket, a handheld emergency equipment or an outdoor emergency equipment.

13. An apparatus according to any of claims 1-12, **characterized** in that the apparatus comprises an after sales part which is a dormant module in a vehicle, and the after sales part can be activated after the incident or accident.

14. A method for use in an emergency device (200), wherein

– a modem (121) is used for data transfer;

– the power enabled emergency device (200) is moving further away after an incident or accident without a position FIX and/or real time information;

characterized in that the method comprises the steps of:

– reaching for a communication counterpart and/or a satellite positioning FIX;
– tracking and storing an elapsed time based on the information of a real time clock (131, 205);
– tracking and storing a movement based on a positioning functionality; and
– sending transmissions.

15. A method according to claim 14, **characterized** in that the method further comprises the step of:

– the positioning functionality positioning the emergency device (200) through a sensor positioning unit (127) and/or through a satellite positioning unit (128).

16. A method according to claim 14 or 15, **characterized** in that the method further comprises the step of:

– using the modem (121) as an in-band type modem for data and/or voice communication in an emergency transmission.

17. A method according to any of claims 14-16, **characterized** in that the method further comprises the step of:

– transmitting a communication which comprises an estimated accident or incident time based on the tracked elapsed time since the emergency device (200) has been enabled and which tracked elapsed time is based on a received network time or a received satellite time.

18. A method according to any of claims 14-17, **characterized** in that in the method,

transmitting a communication which comprises an estimated accident or incident position and/or height based on a tracked movement since the emergency device (200) has been enabled and a positioning FIX has been reached.

19. A method according to any of claims 14-18, **characterized** in that in the method,

transmitting a communication which comprises an estimated accident or incident position based on a position FIX and an estimated movement prior to the position FIX with a tracked elapsed time since the emergency device (200) has been enabled to the position FIX, and positioning receiver (202) movement related information after the FIX.

20. A method according to any of claims 14-19, **characterized** in that in the method,

a communication transmission is a visible light communication transmission.

21. A method according to any of claims 14-20, **characterized** in that in the method,

a communication transmission is a Proximity Services (ProSe) communication transmission.

22. A method according to claim 15, **characterized** in that in the method,

a communication transmission comprises environmental data in proximity of an accident position based on the sensor positioning (127, 204) and/or the satellite positioning (128, 202) information.

23. A method according to claim 16, **characterized** in that in the method,

one of the voice inputs of a speech codec (217) in the in-band modem is a memory of an incident related recorded voice message (222).

24. A method according to claim 16, **characterized** in that in the method,

data sources of a data modem (212) in the in-band modem comprise estimated position data of an accident or an incident, estimated height position data of the accident or incident, landing position data, estimated accident or incident moment data (205, 206), and observed environmental data (208).

25. A method according to any of claims 14-24, **characterized** in that in the method,

the emergency device (200) is an emergency drone, an emergency balloon, an emergency rocket, a handheld emergency equipment or an outdoor emergency equipment.

26. A method according to any of claims 14-25, **characterized** in that in the method, applying an after sales part in a vehicle which after sales part is a dormant module, and the after sales part can be activated after the incident or accident.

27. A computer program for use in an emergency device (200), wherein

– a modem (121) is used for data transfer;
– the power enabled emergency device (200) is moving further away after an incident or accident without a position FIX and/or real time information;

characterized in that the computer program executes the following steps when it is run in a processor:

– reaching for a communication counterpart and/or a satellite positioning FIX;
– tracking and storing an elapsed time based on the information of a real time clock (131, 205);
– tracking and storing a movement based on a positioning functionality; and
– sending transmissions.

28. A computer program according to claim 27, **characterized** in that the computer program is embodied in a computer-readable medium.

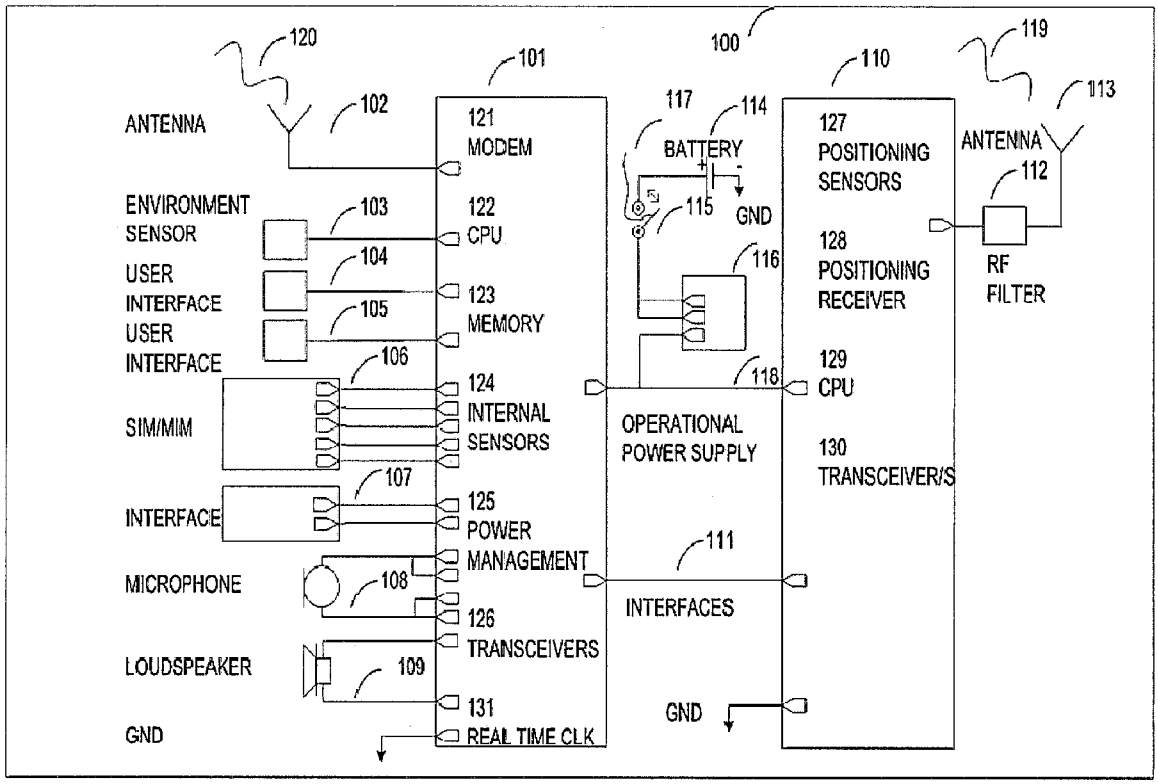

100
101
110
119
120
ANTENNA
102
121
MODEM
117
114
BATTERY
127
POSITIONING
SENSORS
ANTENNA
113
112
ENVIRONMENT
SENSOR
103
122
CPU
115
GND
128
POSITIONING
RECEIVER
RF
FILTER
USER
INTERFACE
104
123
MEMORY
116
USER
INTERFACE
105
106
124
INTERNAL
SENSORS
118
129
CPU
SIM/MIM
OPERATIONAL
POWER SUPPLY
130
TRANSCEIVER/S
107
INTERFACE
125
POWER
MANAGEMENT
111
MICROPHONE
108
INTERFACES
126
TRANSCEIVERS
LOUDSPEAKER
109
131
REAL TIME CLK
GND
GND

FIG. 1

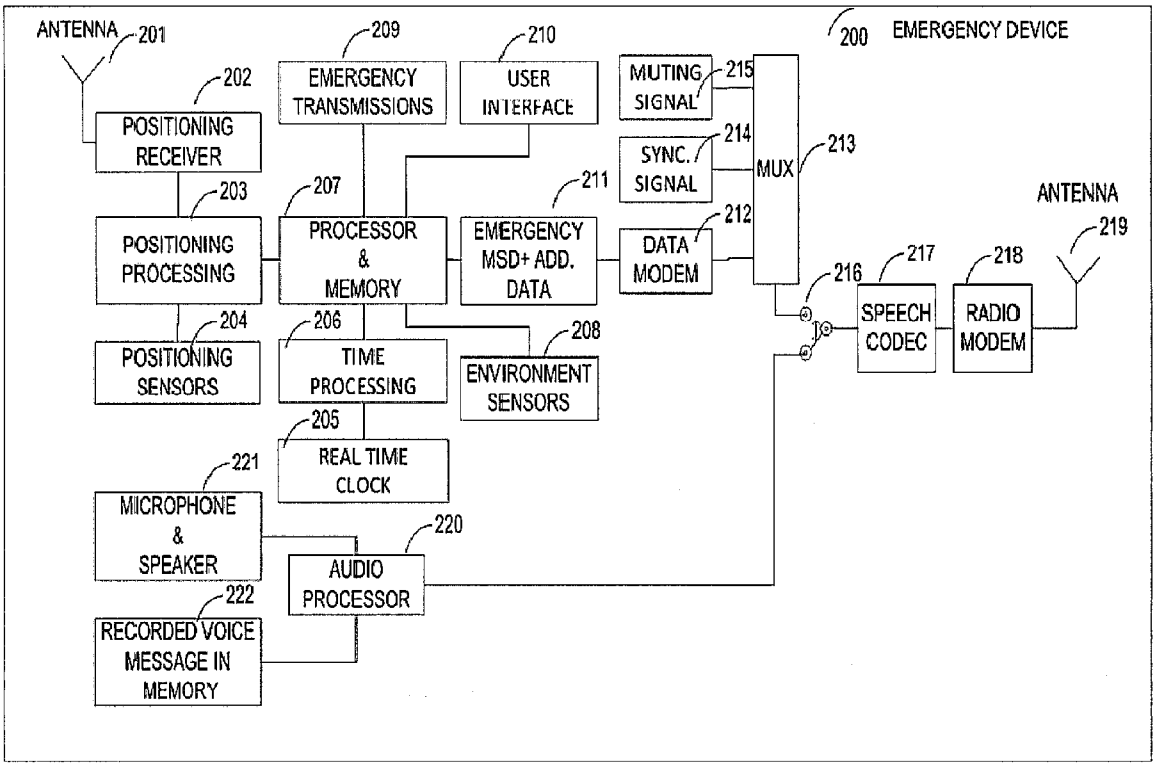

ANTENNA
201
209
210
200
EMERGENCY DEVICE
202
EMERGENCY TRANSMISSIONS
USER INTERFACE
MUTING SIGNAL
215
POSITIONING RECEIVER
214
SYNC. SIGNAL
MUX
213
203
207
211
ANTENNA
219
POSITIONING PROCESSING
PROCESSOR & MEMORY
EMERGENCY MSD+ ADD. DATA
212
DATA MODEM
216
217
218
204
206
208
SPEECH CODEC
RADIO MODEM
POSITIONING SENSORS
TIME PROCESSING
ENVIRONMENT SENSORS
205
REAL TIME CLOCK
221
MICROPHONE & SPEAKER
220
AUDIO PROCESSOR
222
RECORDED VOICE MESSAGE IN MEMORY

FIG. 2

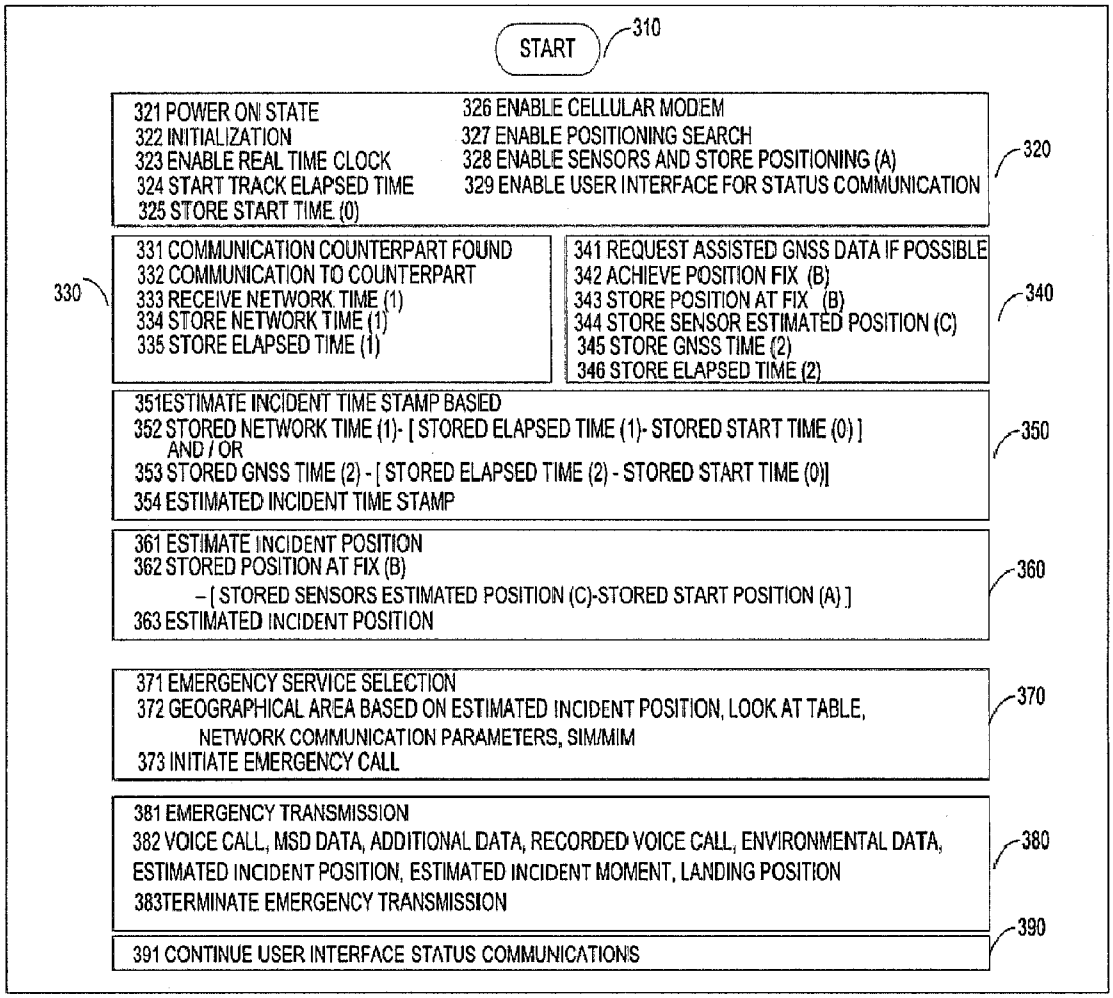

START
310
321 POWER ON STATE
322 INITIALIZATION
323 ENABLE REAL TIME CLOCK
324 START TRACK ELAPSED TIME
325 STORE START TIME (0)
326 ENABLE CELLULAR MODEM
327 ENABLE POSITIONING SEARCH
328 ENABLE SENSORS AND STORE POSITIONING (A)
329 ENABLE USER INTERFACE FOR STATUS COMMUNICATION
320
330
331 COMMUNICATION COUNTERPART FOUND
332 COMMUNICATION TO COUNTERPART
333 RECEIVE NETWORK TIME (1)
334 STORE NETWORK TIME (1)
335 STORE ELAPSED TIME (1)
341 REQUEST ASSISTED GNSS DATA IF POSSIBLE
342 ACHIEVE POSITION FIX (B)
343 STORE POSITION AT FIX (B)
344 STORE SENSOR ESTIMATED POSITION (C)
345 STORE GNSS TIME (2)
346 STORE ELAPSED TIME (2)
340
351ESTIMATE INCIDENT TIME STAMP BASED
352 STORED NETWORK TIME (1)- [STORED ELAPSED TIME (1)- STORED START TIME (0)]
AND / OR
353 STORED GNSS TIME (2) - [STORED ELAPSED TIME (2) - STORED START TIME (0)]
354 ESTIMATED INCIDENT TIME STAMP
350
361 ESTIMATE INCIDENT POSITION
362 STORED POSITION AT FIX (B)
– [STORED SENSORS ESTIMATED POSITION (C)-STORED START POSITION (A)]
363 ESTIMATED INCIDENT POSITION
360
371 EMERGENCY SERVICE SELECTION
372 GEOGRAPHICAL AREA BASED ON ESTIMATED INCIDENT POSITION, LOOK AT TABLE,
NETWORK COMMUNICATION PARAMETERS, SIM/MIM
373 INITIATE EMERGENCY CALL
370
381 EMERGENCY TRANSMISSION
382 VOICE CALL, MSD DATA, ADDITIONAL DATA, RECORDED VOICE CALL, ENVIRONMENTAL DATA,
ESTIMATED INCIDENT POSITION, ESTIMATED INCIDENT MOMENT, LANDING POSITION
383TERMINATE EMERGENCY TRANSMISSION
380
391 CONTINUE USER INTERFACE STATUS COMMUNICATIONS
390

FIG. 3

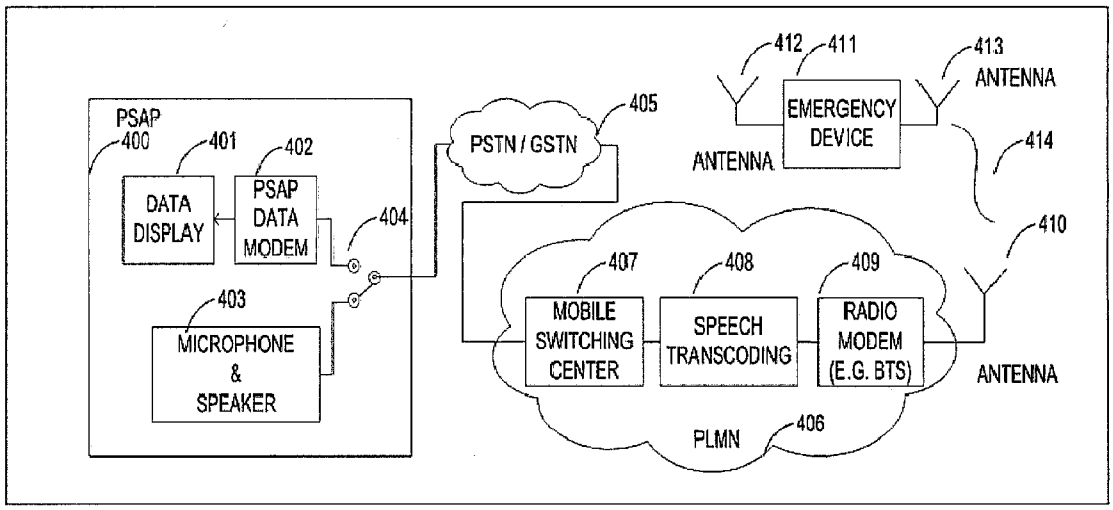

PSAP
400
401
DATA DISPLAY
402
PSAP DATA MODEM
404
403
MICROPHONE & SPEAKER
PSTN / GSTN
405
412
411
413
ANTENNA
EMERGENCY DEVICE
ANTENNA
414
410
407
408
409
MOBILE SWITCHING CENTER
SPEECH TRANSCODING
RADIO MODEM (E.G. BTS)
ANTENNA
PLMN
406

FIG. 4

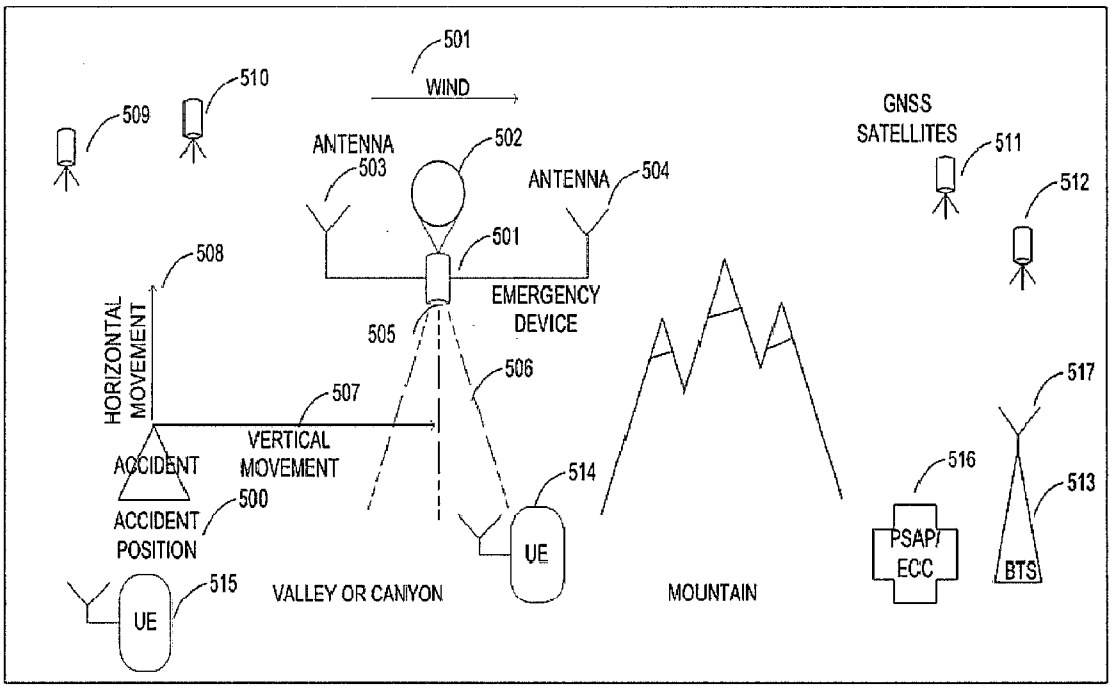

501
WIND
510
509
ANTENNA
503
502
ANTENNA
504
GNSS
SATELLITES
511
512
501
508
EMERGENCY
DEVICE
505
HORIZONTAL
MOVEMENT
506
507
517
VERTICAL
MOVEMENT
516
514
ACCIDENT
513
ACCIDENT
POSITION
500
PSAP/
ECC
BTS
UE
515
VALLEY OR CANYON
UE
MOUNTAIN

FIG. 5

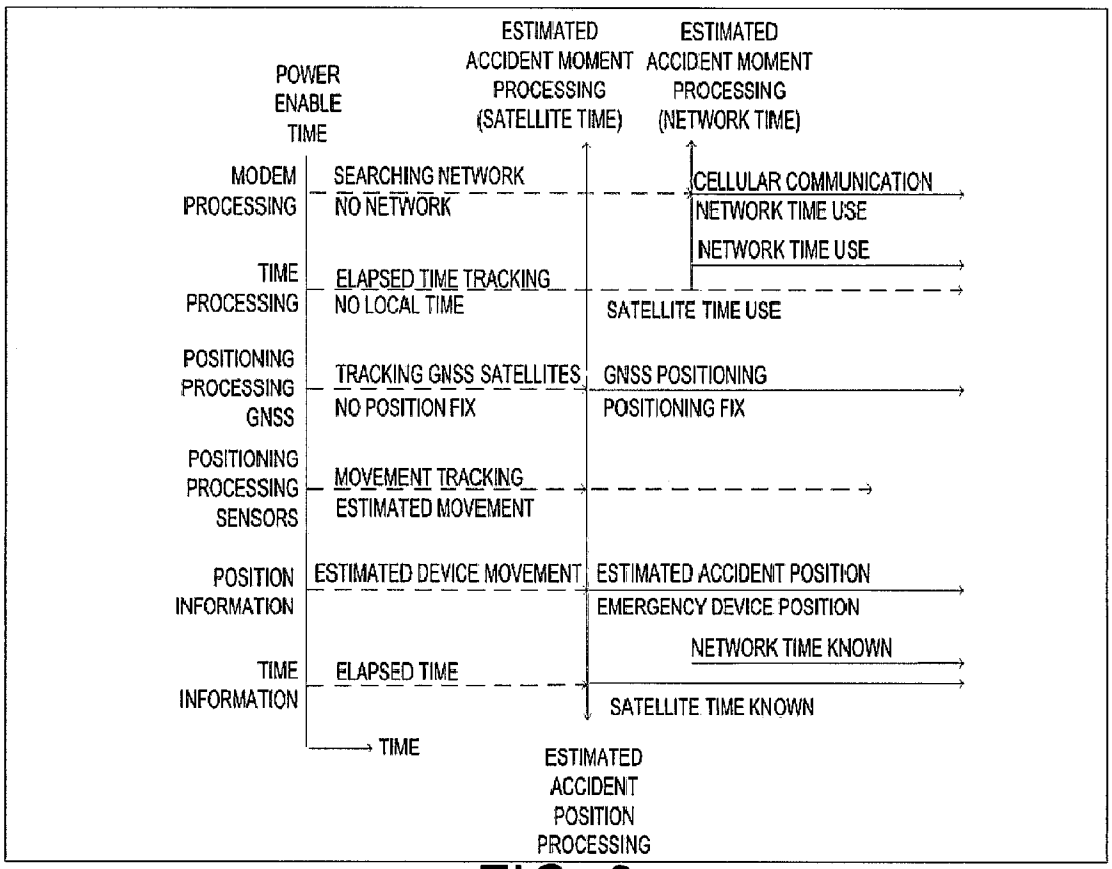

POWER ENABLE TIME
ESTIMATED ACCIDENT MOMENT PROCESSING (SATELLITE TIME)
ESTIMATED ACCIDENT MOMENT PROCESSING (NETWORK TIME)
MODEM PROCESSING
SEARCHING NETWORK
NO NETWORK
CELLULAR COMMUNICATION
NETWORK TIME USE
NETWORK TIME USE
TIME PROCESSING
ELAPSED TIME TRACKING
NO LOCAL TIME
SATELLITE TIME USE
POSITIONING PROCESSING GNSS
TRACKING GNSS SATELLITES
NO POSITION FIX
GNSS POSITIONING
POSITIONING FIX
POSITIONING PROCESSING SENSORS
MOVEMENT TRACKING
ESTIMATED MOVEMENT
POSITION INFORMATION
ESTIMATED DEVICE MOVEMENT
ESTIMATED ACCIDENT POSITION
EMERGENCY DEVICE POSITION
NETWORK TIME KNOWN
TIME INFORMATION
ELAPSED TIME
SATELLITE TIME KNOWN
TIME
ESTIMATED ACCIDENT POSITION PROCESSING

FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI2017/050864

A. **CLASSIFICATION OF SUBJECT MATTER**

See extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: B63C, B64D, F42B, G01C, G01S, G08B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

FI, SE, NO, DK

Electronic data base consulted during the international search (name of data base, and, where practicable, search terms used)

EPODOC, EPO-Internal full-text databases, Full-text translation databases from Asian languages, WPIAP, PRH-Internal, XP3GPP, XPAIP, XPESP, XPETSI, XPI3E, XPIEE, XPIETF, XPIOP, XPIPCOM, XPJPEG, XPMISC, XPOAC, XPRD, XPTK, COMPDX, INSPEC, TDB, NPL

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 2360490 A2 (HEWLETT PACKARD DEVELOPMENT CO [US]) 24 August 2011 (24.08.2011)	1-3, 5, 14-16, 18, 27-28
Y	abstract; par. [0009], [0045], [0053], [0056]-[0058], [0062]-[0064]; Fig. 7	1-28
Y	US 2012232746 A1 (WIEDERWOHL KURT O [AT]) 13 September 2012 (13.09.2012) abstract; par. [0014], [0017]-[0018]	1-28
Y	H. Yoon, et al., "Forward-backward approach for 3D event localization using commodity smartphones for ubiquitous context-aware applications in civil and infrastructure engineering", Computer-Aided Civil and Infrastructure Engineering, Vol. 31, No. 4, April 2016, pp. 245–260. abstract; section 2	1-28
Y	EP 1203966 A2 (NOKIA CORP [FI]) 08 May 2002 (08.05.2002) abstract	1-28

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 April 2018 (13.04.2018)	16 April 2018 (16.04.2018)

Name and mailing address of the ISA/FI
Finnish Patent and Registration Office
FI-00091 PRH, FINLAND
Facsimile No. +358 29 509 5328

Authorized officer
Patrik Pousi
Telephone No. +358 29 509 5000

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI2017/050864

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	RU 2303292 C1 (G OBRAZOVATEL NOE UCHREZHDENIE [RU]) 20 July 2007 (20.07.2007) & abstract [online] EPOQUENET EPODOC & WPI & English machine translation by EPO [online] [retrieved 13.4.2018]; par. [0014]	
A	EP 1243939 A1 (MATSUSHITA ELECTRIC IND CO LTD [JP]) 25 September 2002 (25.09.2002) abstract; par. [0002], [0024], [0056]-[0057]	

INTERNATIONAL SEARCH REPORT
Information on Patent Family Members

International application No.
PCT/FI2017/050864

Patent document cited in search report	Publication date	Patent family members(s)	Publication date
EP 2360490 A2	24/08/2011	US 2011184646 A1	28/07/2011
		US 8396661 B2	12/03/2013
US 2012232746 A1	13/09/2012	EP 2507769 A1	10/10/2012
		WO 2011067334 A1	09/06/2011
EP 1203966 A2	08/05/2002	None	
RU 2303292 C1	20/07/2007	None	
EP 1243939 A1	25/09/2002	EP 1243939 B1	03/03/2010
		DE 60141450 D1	15/04/2010
		EP 2003464 A2	17/12/2008

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI2017/050864

CLASSIFICATION OF SUBJECT MATTER

IPC
G08B 21/10 (2006.01)
B64D 25/20 (2006.01)
G01C 21/12 (2006.01)
G01S 19/01 (2010.01)
F42B 4/28 (2006.01)
B63C 9/00 (2006.01)
B64D 45/00 (2006.01)