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EMERGENCY CALLING FOR LOW COMPUTING POWER WEARABLE DEVICE

Silva Sung

Nina Chueh

Andy Li

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ABSTRACT

A wearable computing device (e.g., a smart watch, smart glasses, smart bracelet, etc.), referred herein as a "wearable device" or "device," is described that uses a timer that allows for sufficient time to make an emergency call. The time expectations of an emergency system may be such that low computing power wearable devices have difficulty making an emergency services connection in an expected time period which may result in multiple failed connection attempts. The timer may ensure that the low computing power wearable device has enough time after leaving airplane mode to power up and find a suitable emergency services connection.

DESCRIPTION

A wearable computing device, as shown in the example of Figure 1 below, may include devices such as a smart watch, smart glasses, smart bracelet, etc. Due to the wearable devices' size restrictions, these devices often have processors, memories, and batteries with reduced capabilities compared to other, physically larger mobile devices (e.g., smartphones, laptops).

Figure 1 is a block diagram illustrating an example wearable computing device 110 that may be configured with a timer that allows a low computing power wearable device enough time to make an emergency call. Wearable computing device 110 includes components including processors 112, input devices 114, user interface (UI) device 116, communication units 118, output devices 120, motion sensors 122, and storage devices 126. The components of wearable computing device 110 are interconnected and may communicate with each other through communication channels 124.

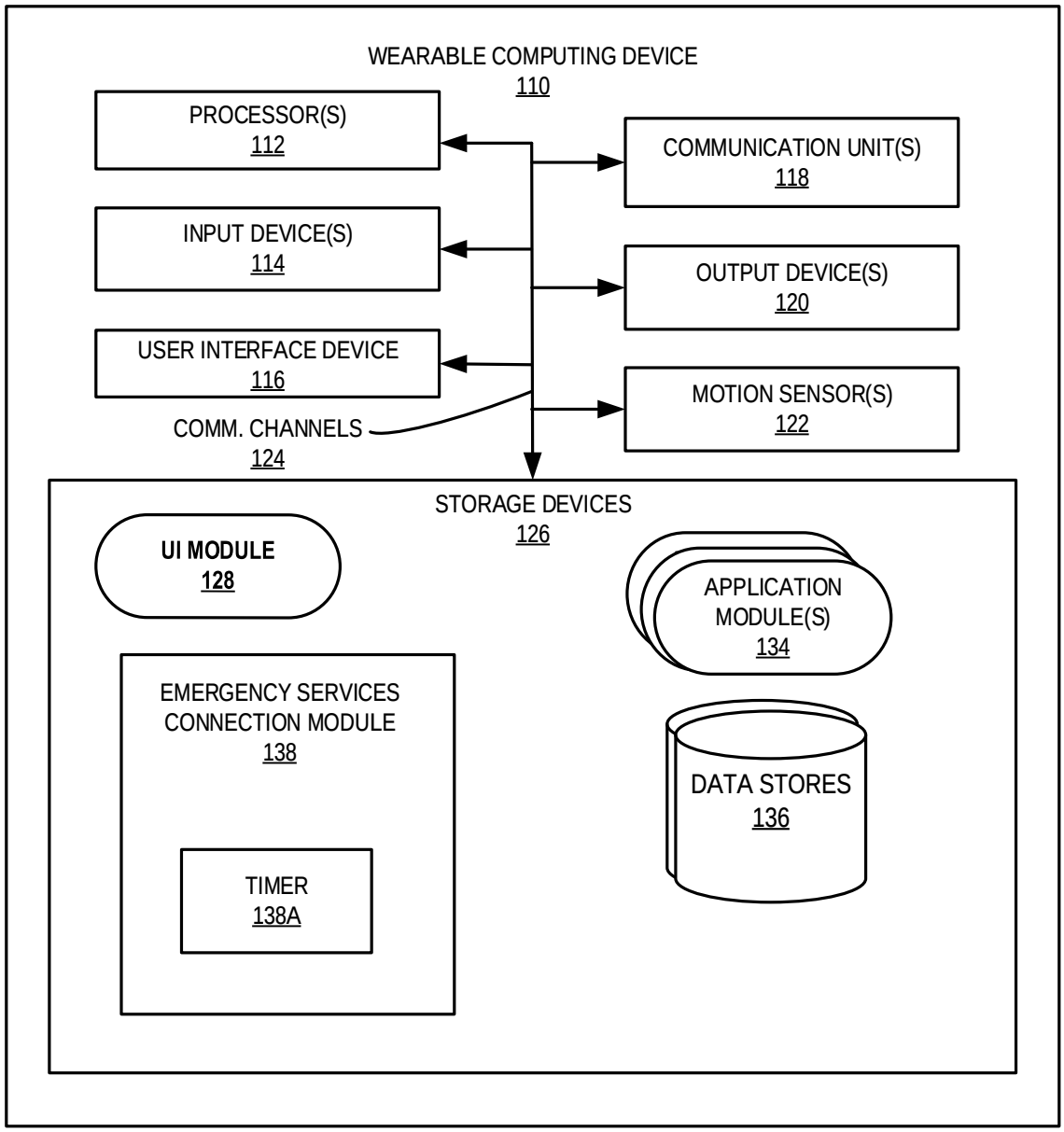

FIG. 1

Other components of wearable computing device 110 perform various other functions. Input devices 114 (e.g., touch-sensitive screen) receive various inputs from the user and communicate the inputs to other components in the device 110. Output device 120 (e.g., speaker, display) generates the output from the device for the user to receive. UI device 116 may include functionality of the input devices 114 and output devices 120 and generates a graphical user

interface (GUI) for the user. Motion sensors 122 in wearable computing device 110 detect nearby movement or absence of movement and communicate the data to other components of wearable computing device 110.

Storage devices 126 may store information for processing during the operation of wearable computing devices 110. Storage devices 126 may include several modules, including user interface (UI) module 128, one or more application modules 134, and one or more data stores 136. UI module 128 communicates with and receives data from UI device 116, input devices 114, and output devices 120. Application modules 134 include applications that wearable computing device 110 may execute. Application modules 134 may include both stand-alone applications as well as applications that are integrated with one another. Data stores 136 receives and stores data from other components of wearable computing device 110. Other components of wearable computing device 110 may retrieve and use data stored in data stores 136.

Emergency services connection module 138 may connect to emergency services. Emergency services connection module 138 may make packet based connections (e.g., IP Multimedia Core Network Subsystem (IMS), Voice over LTE (VoLTE), Voice over New Radio (VoNR), Wi-Fi Calling (VoWiFi etc.) and/or circuit switched (CS) connections to emergency services, such as 911. The connections may use processors 112 and communication units 118. The emergency services connection module 138 may be part of the operating system (OS).

Emergency services connection module 138 may include a timer 138A to allow the Emergency services connection module 138 sufficient time to make an emergency call. The timer 138A may ensure that a low computing power wearable device has enough time after leaving airplane mode to power up and find a suitable emergency services connection. Airplane Mode may turn off all the Bluetooth, Wi-Fi, cellular, and data connections on the device, and it

may take some time to reboot these connections after the airplane mode is turned off. The time expectations of the emergency system may be such that low computing power wearable devices have difficulty making an emergency services connection in the expected time period, which may result in multiple failed connection attempts. For instance, emergency services connection module 138 may attempt to place an emergency call before the cellular radio has completed rebooting. The timer 138A may allow the low computing power wearable device time to get to a state where it may make the emergency services connection.

To protect emergency Packet Data Network (PDN)/Packet Data Unit (PDU) requests, an E1 timer at a communication unit 118 is typically run. PDN connection is used by VoLTE, and PDU session is used by VoNR. The timer 138A may effectively avoid the expiration of this E1 timer by not triggering a request into communication unit 118 until the communication unit 118 is ready.

FIG 2 below shows an example where the timer 138A, labeled as TimerRadioOnCompleted, gives the wearable computing device 110 enough time to power up and find a suitable cell with IP Multimedia Subsystem (IMS) Emergency services, such as using LTE/4G, NR/5G, and WiFi.

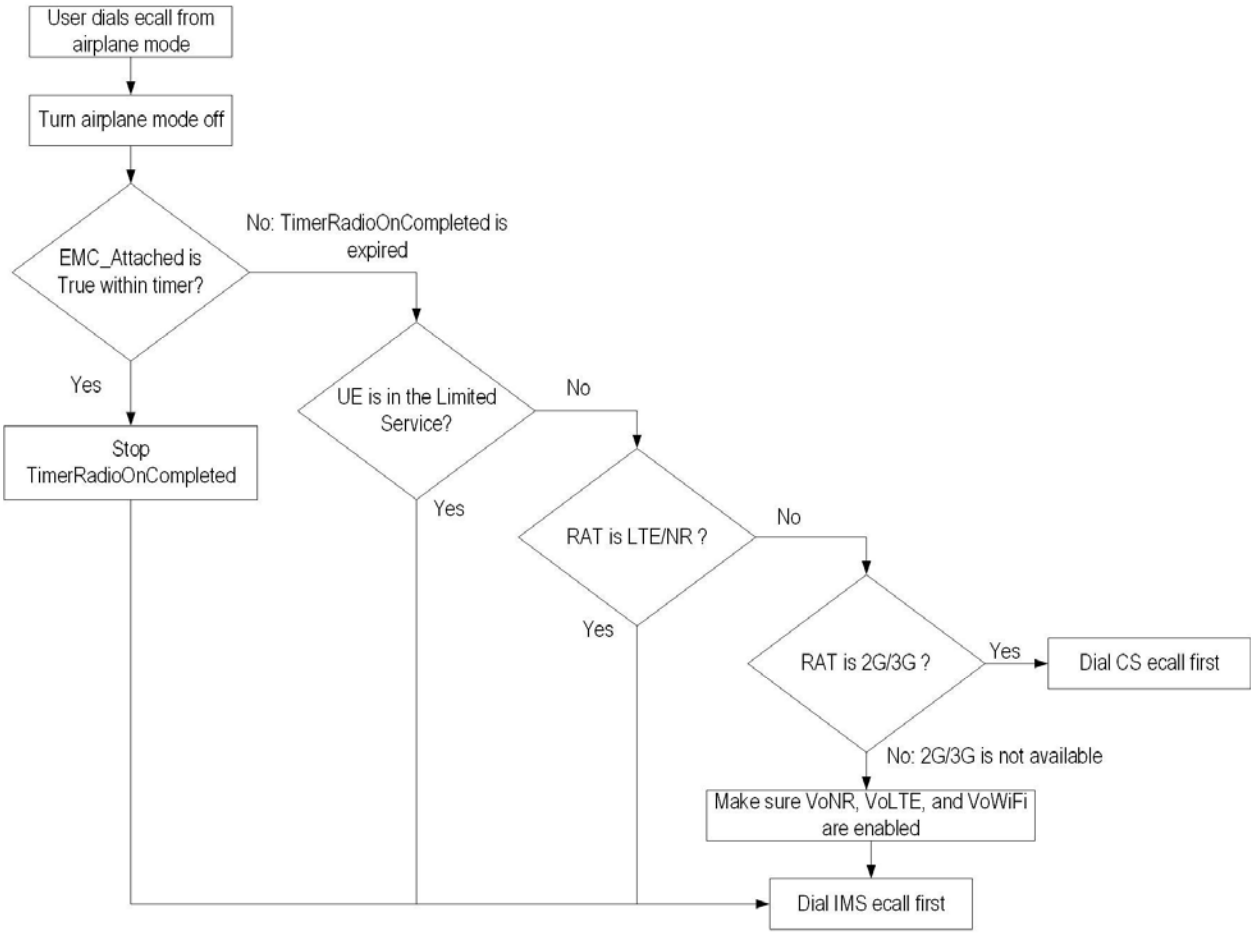

FIG. 2

When a user attempts to make an emergency call (ecall) from airplane mode, the airplane mode is turned off. In this example, the availability of an emergency connection is given by an EMC_Attached value. The EMC_Attached value is reset to false at the start of the process.

The timer 138A, such as TimerRadioOnCompleted, is started after turning airplane mode off. The timer 138A may run for a preset time period. This preset time period may be selectable based on the device's capacities. For a wearable device with low computing power, a preset time period of 5-20 seconds may be used. If the preset time period is set to 0, the described improvement is disabled, which would be appropriate for a device with high performance hardware.

While timer 138A is running, if the wearable computing device 110 finds a connection with an available IMS Emergency service, it will report EMC_Attached as True, and the wearable computing device 110 sends a first dial request (Emergency call over IMS) to the communication units 118 based on the current wireless environment.

In this example, the EMC_Attached value may be true under several conditions. For Long-Term Evolution (LTE), if Attach Accept with EMC_BS != 0 is received, EMC_Attached is true. For 5G NR (New Radio), if Registration Accept with EMC != 0 or EMF != 0 is received, EMC_Attached will be true. For VoWifi (Voice over Wi-Fi) emergency calls with IMS or ims APN, if IMS is registered over WiFi, EMC_Attached will be set true. For VoWifi (Voice over Wi-Fi) emergency calls with SOS or sos APN, If VoWiFi is available (WiFi-AP is connected with internet access, and VoWiFi emergency call is supported on UE), EMC_Attached is set true.

After the timer 138A, such as TimerRadioOnCompleted, expires, wearable computing device 110 may further attempt to connect to emergency services. The timer 138A may have allowed the wearable computing device 110 sufficient time to prepare to connect to emergency services.

If the wearable computing device 110 is in the Limited Service status, the wearable computing device 110 sends a first dial request (Emergency call over IMS) to the communication unit 118. If the current Radio Access Technology (RAT) is LTE or NR, the wearable computing device 110 sends a first dial request (Emergency call over IMS) to the communication unit 118. If the current RAT is 2G or 3G, the wearable computing device 110 sends a first dial request (Emergency call over CS) to the communication unit 118.

If 2G or 3G is unavailable, the wearable computing device 110 may make sure VoNR, VoLTE, and VoWiFi are enabled. If the wearable computing device 110 supports VoNR, the wearable computing device 110 may be given a chance to make a VoNR emergency call. If NR is disabled as part of network mode selection, the wearable computing device 110 may enable NR. If VoNR is disabled, wearable computing device 110 may enable VoNR.

If the wearable computing device 110 supports VoLTE, the wearable computing device 110 is given a chance to make a VoLTE emergency call. If LTE is disabled as part of network mode selection, the wearable computing device 110 may enable LTE. If VoLTE is disabled, the wearable computing device 110 may enable VoLTE.

If the wearable computing device 110 supports VoWiFi, the wearable computing device 110 may be given a chance to make a VoWiFi emergency call. If WiFi is disabled, the wearable computing device 110 may enable WiFi. If VoWiFi is disabled, the wearable computing device 110 may enable VoWiFi.

Then, the wearable computing device 110 may send a first dial request (Emergency call over IMS) to the communication unit 118.

The timer 138A was found to speed up the connection to emergency services up to five times faster when calling from airplane mode. In a test of a low computing power wearable device when the timer 138A was used, it only took 14 seconds to set up an IMS emergency call on the first emergency call dial request. In this test, a user made an emergency call from airplane mode. The wearable computing device 110 sent a dial request (Emergency call over IMS) because an emergency call could be made within 13 seconds.

In a test of a low computing power device when the timer 138A was not used, it took 73 seconds to set up an IMS emergency call on the fifth emergency call (Ecall) re-dial request. A

user made an emergency call from airplane mode. The wearable computing device 110 sent multiple dial requests (Emergency call over CS). In this test, a three second E1 timer repeatedly expired during the emergency Packet Data Network (PDN) establishment process on communication unit 118.

The low computing power device without the timer would take more than 7.5 seconds to complete the emergency PDN procedure after turning airplane mode off. In this scenario, the low computing power device without the timer needs to find a network with IMS Emergency services and also set up an emergency PDN/PDU connection within the E1 timer period (3 seconds). After 71 seconds, the low computing power device without the timer had camped on Limited Service (there was no network device with IMS-emergency available), and the communication unit 118 retired the emergency call over LTE in Limited Service mode.

The communication unit 118 performed an Emergency Attach as the low computing power device was in Limited service, so emergency IMS Registration was not required. Then, an anonymous emergency call was started over PDN. The use of such an anonymous emergency call may be a problem since, in some countries such as Japan, anonymous emergency calls without Subscriber Identity Module (SIM) identification are not allowed.

The following shows some network indicators that the network may use to control emergency connections. Emergency over LTE may be controlled by the network using EMC BS bit in Attach Accept [3GPP TS 24.301].

Emergency bearer services indicator (EMC BS) (octet 3, bit 2)

Bit	
2	
0	emergency bearer services in S1 mode not supported
1	emergency bearer services in S1 mode supported

Emergency over NR may be controlled by the network, using EMC and EMF bits in Registration Accept [3GPP TS 24.501].

Emergency service support indicator for 3GPP access (EMC) (octet 3, bit 3 and bit 4)
These bits indicate the support of emergency services in 5GS for 3GPP access (see NOTE 1).
Bits

4	3	
0	0	Emergency services not supported
0	1	Emergency services supported in NR connected to 5GCN only
1	0	Emergency services supported in E-UTRA connected to 5GCN only
1	1	Emergency services supported in NR connected to 5GCN and E-UTRA connected to 5GCN

Emergency services fallback indicator for 3GPP access (EMF) (octet 3, bit 5 and bit 6)
These bits indicate the support of emergency services fallback for 3GPP access (see NOTE 1).
Bits

6	5	
0	0	Emergency services fallback not supported
0	1	Emergency services fallback supported in NR connected to 5GCN only
1	0	Emergency services fallback supported in E-UTRA connected to 5GCN only
1	1	Emergency services fallback supported in NR connected to 5GCN and E-UTRA connected to 5GCN

It is noted that the techniques of this disclosure may be combined with any other suitable technique or combination of techniques. As one example, the techniques of this disclosure may be combined with the techniques described in US Patent Application Publication 2018/0352514 A1. As another example, the techniques of this disclosure may be combined with the techniques described in US Patent Application Publication 2021/0227437 A1. As yet another example, the techniques of this disclosure may be combined with the techniques described in PCT Published Application WO 2016/144424 A1. As yet another example, the techniques of this disclosure may be combined with the techniques described in US Patent Application Publication 2013/0244608 A1.