Devices and methods for contact tracing

Field

The present invention relates to devices and methods for contact tracing. The present invention relates to devices and methods for contact tracing in order to minimise the spread of an infectious disease such as COVID-19.

Background

Contact tracing is a process of identifying people who may have come into contact with an infected person, so that the identified people may be alerted to the possible risk of infection and take action accordingly. Typically, any person who is identified as being at risk of infection would be tested for infection and, if possible, treated for the infection. The contacts of the identified people would in turn be traced in order to identify any further people who may be at risk of infection. The contact tracing process continues so that, as far as possible, all people who are at risk of infection are alerted, with the appropriate action being taken to interrupt ongoing transmission and reduce the spread of the infection.

The process of contact tracing has been followed for many years to control the spread of infectious diseases. More recently, contact tracing efforts have been critical in controlling the spread of COVID-19 to combat the COVID-19 global pandemic.

Efforts have been made to carry out contact tracing using an application installed on users' smartphones. The application uses the Bluetooth™ technology of a smartphone to detect when another user's smartphone is nearby and hence likely contact between two users. Each user's smartphone stores a record in the form of an anonymous identifier which identifies the other user's smartphone.

Using an application for contact tracing via users' smartphones is accurate and effective. However, this approach relies on users installing the application on their smartphone. The approach will not work for contact tracing users who choose not

to install the application on their smartphone or for users who do not have a smartphone.

The present invention seeks to provide devices and methods for contact tracing which alleviate at least some of the problems described herein.

Brief Description of the Drawings

So that the present invention may be more readily understood, embodiments of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a schematic diagram illustrating the exchange of data between two devices,

Figure 2 is a schematic diagram of a device of some embodiments,

Figure 3 is a graph showing the voltage drop across a battery,

Figure 4 is a graph illustrating the operation of a method of some embodiments, and

Figure 5 shows records stored in a memory of a device of some embodiments.

Detailed Description

Aspects of the present disclosure are best understood from the following detailed description when read with the accompanying figures. It is noted that, in accordance with the standard practice in the industry, various features are not drawn to scale. In fact, the dimensions of the various features may be arbitrarily increased or reduced for clarity of discussion.

The following disclosure provides many different embodiments, or examples, for implementing different features of the provided subject matter. Specific examples of components, concentrations, applications and arrangements are described below to simplify the present disclosure. These are, of course, merely examples and are not intended to be limiting. For example, the attachment of a first feature and a second feature in the description that follows may include embodiments in which the first feature and the second feature are attached in direct contact, and may also include

embodiments in which additional features may be positioned between the first feature and the second feature, such that the first feature and the second feature may not be in direct contact. In addition, the present disclosure may repeat reference numerals and/or letters in the various examples. This repetition is for the purpose of simplicity and clarity and does not in itself dictate a relationship between the various embodiments and/or configurations discussed.

Referring initially to figure 1 of the accompanying drawings, a device 1 of some embodiments is configured to communicate wirelessly with a further device 2. The device 1 is described in detail below. The further device 2 is identical to the device 1 and there may be a plurality of additional further devices which are configured to communicate with the device 1.

Each further device 2 is configured to communicate wirelessly only when the further device 2 is within a predetermined distance d from the device 1. In some embodiments, the predetermined distance d is 10 metres or less. In other embodiments, the predetermined distance d is 2 metres or less. The predetermined distance d is selected such that if the device 1 and the further device 2 are within wireless communication range such that the devices 1, 2 can communicate data between one another, users carrying the devices 1, 2 are considered to be in close contact or contact with one another. This contact between users is tracked and stored by the devices 1, 2 for contact tracing purposes, as described in more detail below.

Referring now to figure 2 of the accompanying drawings, the device 1 of some embodiments is a wearable device which is configured to be worn by a user. In some embodiments, the device 1 is in the form of a tag or dongle which may be attached to the clothing of a user or via a lanyard which is worn around the neck of a user. In other embodiments, the device 1 comprises a strap to enable the device 1 to be worn on the wrist or leg of a user.

In some embodiments, the device 1 is a highly portable and lightweight device

having a thin form factor. In some embodiments, the device 1 is waterproof. In some embodiments, the device 1 is hermetically sealed to minimise the risk of liquid or dust entering the device and potentially disrupting the operation of the device.

The device 1 is a device for contact tracing which may be used instead of an application installed on a smartphone. The device 1 can therefore be used by anyone, without users needing to install an application on their smartphone and by users who do not have a smartphone.

The device 1 comprises a computing device which incorporates a processing unit 3 which is coupled for communicating data via a data bus 4. A volatile memory 5 in the form of a random access memory is also coupled for communication with the data bus 4. A non-volatile memory 6, such as a flash memory, is also coupled for communication with the data bus 4. In some embodiments, some or all of the electronic components of the device 1 are integrated with one another, for instance in a microchip.

The non-volatile memory 6 is a computer-readable medium which stores executable instructions which are executed by the processor 3 to provide the functionality of the device 1. As will be described in more detail below, the non-volatile memory 6 also stores records for the purposes of contact tracing. The volatile memory 5 stores data temporarily during the operation of the device 1.

The device 1 further comprises a communication module 7 having an antenna 8. The communication module 7 is coupled for communication with the data bus 4. The communication module 7 is configured to transmit and receive data wirelessly via the antenna 8. In some embodiments, the communication module 7 is configured to transmit signals at a frequency of between 2GHz and 3.5 GHz. In other embodiments, the communication module 7 is configured to transmit signals at a frequency of between 2.4 GHz and 2.5GHz. In some embodiments, the communication module 7 is a Bluetooth™ module which is configured to transmit and receive Bluetooth™ signals.

In the embodiment shown in figure 1, the device 1 comprises a user input arrangement 9, such as a button or a switch to enable a user to provide a user input to control the device 1. However, in other embodiments the user input arrangement 9 is omitted such that the device 1 does not incorporate buttons, switches or other manually operable user input arrangements.

In some embodiments, the device 1 is configured to communicate wirelessly (e.g. via Bluetooth™) with an external computing device, such as a smartphone. This functionality enables data to be extracted from the device 1 and, in some embodiments, for the device to be controlled wirelessly from the external computing device.

The device 1 further comprises a battery holder 10 which is configured to hold a battery to enable the battery to power the device 1. In some embodiments, the battery holder 10 is configured to hold a coin cell battery, such as a CR2032 coin cell battery. In other embodiments, the battery holder 10 is configured to hold a button cell battery, such as an LR44 A76 button cell battery.

Coin cell batteries are designed for low discharge currents (< 1 milliampere (mA) continuous), and will suffer degradation when higher currents (e.g. 10mA in a Bluetooth™ scan) are drawn.

The device 1 of some embodiments is configured to operate such that the device is optimised for use with coin or button cell batteries. The device 1 therefore seeks to prevent battery degradation and increase overall battery life.

In some embodiments, the device 1 reduces degradation of a coin cell battery powering the device 1 by implementing a spaced apart scanning pattern, with each scan being for a short period of time.

In a conventional Bluetooth™ scan, a current of approximately 10mA is drawn from

a battery over the duration of a typical 10 second Bluetooth™ scan. Figure 3 of the accompanying drawings shows a graph which illustrates, on the left hand side, the drop in battery voltage which occurs during a conventional 10 second Bluetooth™ scan. A coin cell battery requires around one minute to recover to its original voltage levels following the large voltage drop causes by a Bluetooth™ scan.

By contrast, on the right hand side of figure 3, the short (0.1s) spaced apart scans of an embodiment are shown to produce only a brief voltage drop which enables the battery voltage to recover almost immediately after the scan. In this example, each scan is for a duration of 0.1 seconds.

The method of operation of a device of one embodiment will now be described with reference to figure 4 of the accompanying drawings.

In this embodiment, the device 1 is a wearable contact tracing device which advertises itself by transmitting an advertise signal once every 87 milliseconds (87ms, where 1 millisecond = 0.001 second) for a duration of 4 minutes.

In the 5th minute, the device 1 repeats a pattern of scanning for 0.1 seconds followed by advertising every 87ms for 2.9 seconds. This pattern during the 5th minute will be repeated 20 times, totaling 1 minute.

To allow the device 1 to be detected by a further device, even if the timings of the devices are exactly synchronised, the protocol requires that a random pattern in the 20 repeated times be selected to not scan but instead advertise in the scan window.

The entire 5 minute protocol is repeated continuously (the “Advertise and Scan Protocol”) during the operation of the device 1.

The Advertise and Scan Protocol of some embodiments is as follows:

while (True)
    4 min advertise (@ 87ms interval)

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    r=randominteger ∈(1:20)
    for n=(1:20)
        if n=r
            3s advertise (@ 87ms interval)
        else
            0.1s scan, 2.9s advertise (@ 87ms interval)
        end
    end
end
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The probability of two devices successfully scanning each other is as follows:

- Discretize into 0.1s time steps for simplified analysis.
- A=Both devices' 1min scan periods are aligned. P(A)=0.1s/5min = 1/3000
- B|A=Both devices have the same random integer under the condition of a 1min scan. P(B|A)= 1/20
- P(Both devices have exactly the pattern of broadcast and are aligned) = P(A)$\cap$P(B|A) = 0.00001666 = 16.6 failure per million
- P(successful connection) = 1- 0.00001666 = 0.9999983

The protocol of some embodiments therefore guarantees an extremely high accuracy of successful scans of surrounding devices.

In some embodiments, the protocol is a computer-implemented method for contact tracing which comprises a transmission process involving transmitting, from a first device, an advertising signal for a first predetermined length of time. In some embodiments, the first predetermined length of time is 0.1 seconds. In some embodiments, the advertising signal has a frequency of between 2 GHz and 3.5 GHz. In other embodiments, the advertising signal has a frequency of between 2.4 GHz and 2.5 GHz.

The method further comprises dividing a scan time window into a plurality of discrete time windows and selecting a discrete time window of the plurality of discrete time windows. In some embodiments, the method comprises dividing the scan time window into 20 discrete time windows. In some embodiments, the discrete time window is selected at random out of the plurality of discrete time windows. In some embodiments, the duration of the scan time window is 1 minute.

In some embodiments, the duration of each time window of the plurality of time windows is 3 seconds.

For the duration of the selected discrete time window, the method comprises performing a receiving process at the first device for a second predetermined length of time. In some embodiments, the second predetermined length of time is 2.9 seconds.

The receiving process comprises scanning, at the first device, for at least one signal transmitted by at least one further device. If a signal is received at the first device a record is stored in a memory of the first device based on the signal received at the first device. The method repeats the transmission process periodically during the remainder of the selected discrete time window.

The method further comprises repeating the transmission process periodically during each of the plurality of remaining discrete time windows. Each record stored in the memory of the first device provides a record of the first device being within a predetermined distance of a respective further device such that the record may be used for tracing contact between a user carrying the first device and each user carrying a respecting further device.

In some embodiments, the period of repetition of the transmission process is 87 milliseconds.

In some embodiments, the method comprises repeating the transmission process periodically during a transmission time window (the Advertise period of the scan protocol) which occurs before the scan time window (the Scan period of the scan protocol). In some embodiments, the duration of the transmission time window is 4 minutes.

In some embodiments, the method is repeated continuously during a period of operation of the first device.

For contact tracing, a record of up to 30 surrounding devices every 5 minutes is needed. The method of some embodiments stores this data as records in the non-volatile (flash) memory 6.

Figure 5 of the accompanying drawings shows a portion of records stored in the non-volatile memory 6 of some embodiments. The parameters stored in each record of this embodiment are shown in Table 1 below.

Parameter	**Description**
Time stamp	Time packet is received
Device ID	Device identifier
RSSI	Received signal strength indicator
nRep	Number of times the device is scanned in the 1 minute scan period (every 5th minute). As the flash storage capacity is limited, nRep is therefore key in deciding which Device IDs are to be discarded if more than 30 different devices are scanned.

Table 1

In other embodiments at least the identifier (Device ID) is stored in the memory 6. The identifier is an anonymous identifier which identifies a respective further device which transmitted the signal to the device 1.

In some embodiments, the record further comprises a count indicator which indicates the number of times that the device 1 has received a signal from a respective further device.

In some embodiments, if the device 1 receives a plurality of signals from a plurality of further devices the method further comprises storing a plurality of records in the memory 6 of the device 1, for example as shown in figure 5. Each record of the plurality of records is based on the signal received at the device 1 from a respective

further device of the plurality of further devices. In this embodiment, the method comprises ranking the plurality of records based on the count indicator of each record.

In some embodiments, the method comprises storing a predetermined number of higher ranking records, such as 30 records, in the memory 6 of the device 1 and discarding any lower ranking records such that only the predetermined number of higher ranking records is stored in the memory 6. In some embodiments, the ranking occurs during the transmission time window.

In some embodiments, the record further comprises timestamp data which indicates the time at which a signal is received at the device 1 from a respective further device.

In some embodiments, the record further comprises transmit power data which indicates the transmission power of the signal transmitted by a respective further device.

In some embodiments, the record further comprises signal strength data which indicates the strength of the signal received at the device 1.

A procedure of some embodiments for storing records in the memory 6 is as follows:

Every 5th minute:

During 0.1s scan:

(a) Record all advertisements received in the data format above and store in the volatile memory 5 (microcontroller unit ("MCU") local memory).

During 2.9s advertisement:

(a) Compute nRep for each Device ID recorded

(b) Discard duplicate Device IDs (keep only 1 record with the summed nRep)

end 5th min

Every 1st to 4th minute:

a) Sort all records in descending order of their nRep values.
b) Write to non-volatile memory 6 (flash memory) 30 records with the highest nRep values.
c) Delete all records in volatile memory 5.

end 1st to 4th min

The memory storage procedure prevents memory overflow in the MCU and ensures that the likeliest close contact persons are recorded (highest nRep).

The technical benefits of some embodiments include:

1. **Reduced flash memory storage requirement**
   The protocol enables storage of up to 25 days of contact tracing records in a limited storage capacity flash memory. The maximum number of records to be stored every 5 minutes is set at 30. The device ensures that, in the event that there are more than 30 other devices being scanned, only the most likely close contacts are stored and written into flash memory.

2. **High accuracy of successful scans of surrounding devices**
   The method or some embodiments employs a spaced-out scanning pattern that guarantees an extremely high accuracy of successful scans of surrounding devices (99.99983% chance of scanning another device).

3. **Reduced power consumption**
   Some embodiments ensure reduced degradation of coin cell batteries, enabling a thin form factor and increasing overall battery life.

The foregoing outlines features of several embodiments so that those of ordinary

skill in the art may better understand various aspects of the present disclosure. Those of ordinary skill in the art should appreciate that they may readily use the present disclosure as a basis for designing or modifying other processes and structures for carrying out the same purposes and/or achieving the same advantages of various embodiments introduced herein. Those of ordinary skill in the art should also realize that such constructions do not depart from the spirit and scope of the present disclosure, and that they may make various changes, substitutions, and alterations herein without departing from the spirit and scope of the present disclosure.

Although the subject matter has been described in language specific to structural features or methodological acts, it is to be understood that the subject matter of the appended clauses is not necessarily limited to the specific features or acts described above. Rather, the specific features and acts described above are disclosed as example forms of implementing at least some of the clauses.

Various operations of embodiments are provided herein. The order in which some or all of the operations are described should not be construed to imply that these operations are necessarily order dependent. Alternative ordering will be appreciated having the benefit of this description. Further, it will be understood that not all operations are necessarily present in each embodiment provided herein. Also, it will be understood that not all operations are necessary in some embodiments.

Moreover, "exemplary" is used herein to mean serving as an example, instance, illustration, etc., and not necessarily as advantageous. As used in this application, "or" is intended to mean an inclusive "or" rather than an exclusive "or". In addition, "a" and "an" as used in this application and the appended clauses are generally be construed to mean "one or more" unless specified otherwise or clear from context to be directed to a singular form. Also, at least one of A and B and/or the like generally means A or B or both A and B. Furthermore, to the extent that "includes", "having", "has", "with", or variants thereof are used, such terms are intended to be

inclusive in a manner similar to the term "comprising". Also, unless specified otherwise, “first,” “second,” or the like are not intended to imply a temporal aspect, a spatial aspect, an ordering, etc. Rather, such terms are merely used as identifiers, names, etc. for features, elements, items, etc. For example, a first element and a second element generally correspond to element A and element B or two different or two identical elements or the same element.

Also, although the disclosure has been shown and described with respect to one or more implementations, alterations and modifications will occur to others of ordinary skill in the art based upon a reading and understanding of this specification and the annexed drawings. The disclosure comprises all such modifications and alterations, which fall within the scope of the following clauses. In particular regard to the various functions performed by the above described features (e.g., elements, resources, etc.), the terms used to describe such features are intended to correspond, unless otherwise indicated, to any features which performs the specified function of the described features falling within the scope of the following clauses. In addition, while a particular feature of the disclosure may have been disclosed with respect to only one of several implementations, such feature may be combined with one or more other features of the other implementations as may be desired and advantageous for any given or particular application.

Embodiments of the subject matter and the functional operations described herein can be implemented in digital electronic circuitry, or in computer software, firmware, or hardware, including the structures disclosed in this specification and all such modifications and alterations of the structures that fall within the scope of the following clauses, or in combinations of one or more of them.

Some embodiments are implemented using one or more modules of computer program instructions encoded on a computer-readable medium for execution by, or to control the operation of, a data processing apparatus. The computer-readable medium can be a manufactured product, such as hard drive in a computer system or an embedded system. The computer-readable medium can be acquired

separately and later encoded with the one or more modules of computer program instructions, such as by delivery of the one or more modules of computer program instructions over a wired or wireless network. The computer-readable medium can be a machine-readable storage device, a machine-readable storage substrate, a memory device, or a combination of one or more of them.

The terms “computing device” and “data processing apparatus” encompass all apparatus, devices, and machines for processing data, including by way of example a programmable processor, a computer, or multiple processors or computers. The apparatus can include, in addition to hardware, code that creates an execution environment for the computer program in question, e.g., code that constitutes processor firmware, a protocol stack, a database management system, an operating system, a runtime environment, or a combination of one or more of them. In addition, the apparatus can employ various different computing model infrastructures, such as web services, distributed computing and grid computing infrastructures.

The processes and logic flows described in this specification can be performed by one or more programmable processors executing one or more computer programs to perform functions by operating on input data and generating output.

Processors suitable for the execution of a computer program include, by way of example, both general and special purpose microprocessors, and any one or more processors of any kind of digital computer. Generally, a processor will receive instructions and data from a read-only memory or a random access memory or both. The essential elements of a computer are a processor for performing instructions and one or more memory devices for storing instructions and data. Generally, a computer will also include, or be operatively coupled to receive data from or transfer data to, or both, one or more mass storage devices for storing data, e.g., magnetic, magneto-optical disks, or optical disks. However, a computer need not have such devices. Devices suitable for storing computer program instructions and data include all forms of non-volatile memory, media and memory devices,

including by way of example semiconductor memory devices, e.g., EPROM (Erasable Programmable Read-Only Memory), EEPROM (Electrically Erasable Programmable Read-Only Memory), and flash memory devices; magnetic disks, e.g., internal hard disks or removable disks; magneto-optical disks; and CD-ROM and DVD-ROM disks.

To provide for interaction with a user, some embodiments are implemented on a computer having a display device, e.g., a CRT (cathode ray tube) or LCD (liquid crystal display) monitor, for displaying information to the user and a keyboard and a pointing device, e.g., a mouse or a trackball, by which the user can provide input to the computer. Other kinds of devices can be used to provide for interaction with a user as well; for example, feedback provided to the user can be any form of sensory feedback, e.g., visual feedback, auditory feedback, or tactile feedback; and input from the user can be received in any form, including acoustic, speech, or tactile input.

The computing system can include clients and servers. A client and server are generally remote from each other and typically interact through a communication network. The relationship of client and server arises by virtue of computer programs running on the respective computers and having a client-server relationship to each other. Embodiments of the subject matter described in this specification can be implemented in a computing system that includes a back-end component, e.g., as a data server, or that includes a middleware component, e.g., an application server, or that includes a front-end component, e.g., a client computer having a graphical user interface or a Web browser through which a user can interact with an implementation of the subject matter described is this specification, or any combination of one or more such back-end, middleware, or front-end components. The components of the system can be interconnected by any form or medium of digital data communication, e.g., a communication network. Examples of communication networks include a local area network (“LAN”) and a wide area network (“WAN”), an inter-network (e.g., the Internet), and peer-to-peer networks (e.g., ad hoc peer-to-peer networks).

In the present specification "comprise" means "includes or consists of" and "comprising" means "including or consisting of".

5 The features disclosed in the foregoing description, or the following clauses, or the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process for attaining the disclosed result, as appropriate, may, separately, or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

PREFERRED FEATURES:

1. A computer-implemented method for contact tracing, the method comprising:

a transmission process which comprises:

transmitting, from a first device, an advertising signal for a first predetermined length of time, wherein the method further comprises:

dividing a scan time window into a plurality of discrete time windows;

selecting a discrete time window of the plurality of discrete time windows and, during the selected discrete time window:

performing a receiving process at the first device for a second predetermined length of time, the receiving process comprising scanning, at the first device, for at least one signal transmitted by at least one further device and, if a signal is received at the first device, storing a record in a memory of the first device based on the signal received at the first device; and

repeating the transmission process periodically during the remainder of the selected discrete time window, wherein the method further comprises:

repeating the transmission process periodically during each of the plurality of remaining discrete time windows, wherein each record stored in the memory of the first device provides a record of the first device being within a predetermined distance of a respective further device such that the record may be used for tracing contact between a user carrying the first device and each user carrying a respecting further device.

2. The method of clause 1, wherein selecting the discrete time window comprises selecting the discrete time window at random out of the plurality of discrete time windows.

3. The method of clause 1 or clause 2, wherein the first predetermined length of time is 0.1 seconds.

4. The method of any one of the preceding clauses, wherein the second

predetermined length of time is 2.9 seconds.

5. The method of any one of the preceding clauses, wherein the duration of the scan time window is 1 minute.

6. The method of any one of the preceding clauses, wherein the duration of each time window of the plurality of time windows is 3 seconds.

7. The method of any one of the preceding clauses, wherein the method comprises dividing the scan time window into 20 discrete time windows.

8. The method of any one of the preceding clauses, wherein the period of repetition of the transmission process is 87 milliseconds.

9. The method of any one of the preceding clauses, wherein the method further comprises:

repeating the transmission process periodically during a transmission time window which occurs before the scan time window.

10. The method of clause 9, wherein the duration of the transmission time window is 4 minutes.

11. The method of any one of the preceding clauses, wherein the method is repeated continuously during a period of operation of the first device.

12. The method of any one of the preceding clauses, wherein the advertising signal has a frequency of between 2 GHz and 3.5 GHz.

13. The method of clause 12, wherein the advertising signal has a frequency of between 2.4 GHz and 2.5 GHz.

14. The method of any one of the preceding clauses, wherein the record which is

stored in the memory of the first device comprises an identifier which identifies the respective further device which transmitted the signal to the first device.

15. The method of clause 14, wherein the record further comprises a count indicator which indicates the number of times that the first device has received a signal from the respective further device.

16. The method of clause 15, wherein if the first device receives a plurality of signals from a plurality of further devices the method further comprises:

storing a plurality of records in the memory of the first device, each record of the plurality of records being based on the signal received at the first device from a respective further device of the plurality of further devices; and

ranking the plurality of records based on the count indicator of each record.

17. The method of clause 16, wherein the method further comprises:

storing a predetermined number of higher ranking records in the memory of the first device; and

discarding any lower ranking records such that only the predetermined number of higher ranking records is stored in the memory of the first device.

18. The method of clause 17, wherein the predetermined number of records is 30.

19. The method of any one of clauses 16 to 18 as dependent on clause 9 or clause 10, wherein the ranking occurs during the transmission time window.

20. The method of any one of clauses 14 to 19, wherein the record further comprises timestamp data which indicates the time at which a signal is received at the first device from a respective further device.

21. The method of any one of clauses 14 to 20, wherein the record further comprises transmit power data which indicates the transmission power of the signal

transmitted by a respective further device.

22. The method of any one of clauses 14 to 21, wherein the record further comprises signal strength data which indicates the strength of the signal received at the first device.

23. The method of any one of the preceding clauses, wherein the memory of the first device is a non-volatile memory.

24. A device for contact tracing, the device comprising:

a wireless communication module configured to transmit an advertising signal wirelessly and configured to receive at least one signal transmitted wirelessly by at least one further device;

a processor coupled for data communication with the wireless communication module;

a memory coupled for data communication with the processor, the memory storing executable instructions which, when executed by the processor, cause the processor and the wireless communication module to perform the method of any one of clauses 1 to 23.

25. The device of clause 24, wherein the device further comprises:

a battery holder configured to receive a coin cell battery or a button cell battery.

26. The device of clause 24 or clause 25, wherein the device is a wearable device.

27. A computer-readable medium storing executable instructions which, when executed by a processor coupled to a wireless communication module configured to transmit an advertising signal wirelessly and configured to receive at least one signal wirelessly, cause the processor and the wireless communication module to perform the method of any one of clauses 1 to 23.

28. A data storage method for a contact tracing device, the method comprising:

storing a plurality of records in a memory of a first device, each record comprising:

an identifier which identifies a respective further device which transmitted a signal to the first device; and

a count indicator which indicates the number of times that the first device has received a signal from the respective further device, wherein the method further comprises:

ranking the plurality of records based on the count indicator of each record;

storing a predetermined number of higher ranking records in the memory of the first device; and

discarding any lower ranking records such that only the predetermined number of higher ranking records is stored in the memory of the first device.

29. The method of clause 28, wherein the predetermined number of records is 30.

30. The method of clause 28 or clause 29, wherein the record further comprises timestamp data which indicates the time at which a signal is received at the first device from a respective further device.

31. The method of any one of clauses 28 to 30, wherein the record further comprises transmit power data which indicates the transmission power of the signal transmitted by a respective further device.

32. The method of any one of clauses 28 to 31, wherein the record further comprises signal strength data which indicates the strength of the signal received at the first device

33. The method of any one of clauses 28 to 32, wherein the memory of the first device is a non-volatile memory.

34. The method of any one of clauses 28 to 33, wherein the method is repeated continuously during a period of operation of the first device.

35. A data storage system for a contact tracing device, the system comprising:

a processor and a memory, the memory storing executable instructions which, when executed by the processor, cause the processor to perform the method of any one of clauses 28 to 34.

36. A computer-readable medium storing executable instructions which, when executed by a processor, cause the processor to perform the method of any one of clauses 28 to 34.