



(51) International Patent Classification:
H04W 28/02 (2009.01)

(21) International Application Number:
PCT/EP2017/078574

(22) International Filing Date:
08 November 2017 (08.11.2017)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
1619640.4 21 November 2016 (21.11.2016) GB

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(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,
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).

Published:

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

(54) Title: VEHICLE TELEMATICS MESSAGING

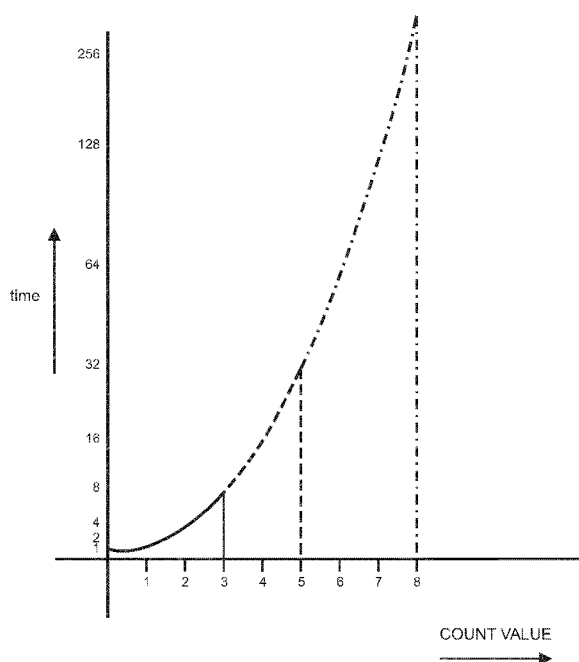


Figure 4

(57) Abstract: A load dispersion method for vehicle telematics messaging comprises generating variable retry delay periods for resending failed messages. The method comprises maintaining a count of failed send attempts for individual telematics messages so as to generate a count parameter; generating an interim retry delay parameter by inputting the count parameter into an exponential function; generating a final retry delay parameter by selecting a random number between a delay lower threshold parameter and the interim retry delay parameter; using the final retry delay parameter to determine a retry delay period for resending said failed message. In some embodiments, the method additionally comprises determining a quality of service category of the failed message and varying the parameters used in generating the retry delay periods in response.

VEHICLE TELEMATICS MESSAGING

TECHNICAL FIELD

The present disclosure relates to vehicle telematics messaging. Aspects of the invention relate to a load dispersion method for vehicle telematics messaging, a load dispersion controller for a vehicle telematics unit, a telematics unit for a vehicle, a vehicle comprising a telematics unit, and a vehicle telematics system.

BACKGROUND

Many modern vehicles incorporate telematics units. Such units are operable to collect information from multiple vehicle systems indicative of the condition and/or performance of said systems. Many telematics units are operable to send telematics message containing said information to an external vehicle telematics server. Messages received by the telematics server can be logged and analysed to enable monitoring of the condition and/or performance of vehicles.

Telemetry data messages are generated during vehicle operation. Accordingly, there are distinct increases in message activity during peak commuting hours when more vehicles are in use. Accordingly, vehicle telematics servers need to take account of peak message demand. One option is to provide a vehicle telematics server with sufficient bandwidth to accommodate peak message demand. This minimises message processing delays but increases expense. Additionally, it is relatively inefficient as most of the bandwidth is unused outside peak times.

An alternative option is to provide more limited vehicle telematics server bandwidth where, in order to avoid loss of service during demand peaks, each telematics unit is operable to implement a basic resend strategy in the event that message delivery fails. The presently known resend strategy is a constant delay retry strategy, which entails resending a failed message after a fixed retry delay period (say 10 seconds). In the event that delivery fails again, message sending is retried after the fixed retry delay period. This strategy does allow the telematics server to operate despite having insufficient bandwidth to accommodate all messages during demand peaks and is less expensive than matching server bandwidth to peak demand. Nevertheless, this load dispersion strategy is limited in its ability to distribute messaging demands exceeding bandwidth. In prolonged periods of messaging demand exceeding bandwidth, a combination of messages resent on multiple occasions and new messages generate an avalanche effect leading to long delays in processing messages.

It is an aim of the present invention to address disadvantages associated with the prior art.

SUMMARY OF THE INVENTION

Aspects of the invention are defined in the appended claims.

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Aspects and embodiments of the invention provide a load dispersion method for vehicle telematics messaging, a load dispersion controller for a vehicle telematics unit, a telematics unit for a vehicle, a vehicle comprising a telematics unit, and a vehicle telematics system as claimed in the appended claims.

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According to an aspect of the invention, there is provided a load dispersion method for messaging, the method comprising: maintaining a count of failed send attempts for individual messages so as to generate a count parameter; selecting a retry delay period randomly from a range of possible retry delay periods that increases with the count parameter.

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As a result of the above selection of retry delay periods from an increasing range, resend attempts for failed messages are dispersed over a longer period than in the known constant delay retry strategy. This allows for continued operation of a telematics system with a given bandwidth at higher demand peaks than is possible using the known constant delay retry strategy.

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In some embodiments the above method may be applied to vehicle telematics messaging.

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According to another aspect of the invention, there is provided a load dispersion method for messaging, the method comprising: maintaining a count of failed send attempts for individual messages so as to generate a count parameter; generating an interim retry delay parameter by inputting the count parameter into an exponential function; generating a final retry delay parameter between a delay lower threshold parameter and the interim retry delay parameter; and using the final retry delay parameter to determine a retry delay period for resending said failed message. The count of failed send attempts for a message is periodically reset after a threshold count value is exceeded.

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In this method the retry delay period is randomly selected from within a range that increases exponentially with the count of failed send attempts for each individual message. As a result resend attempts for failed messages are dispersed over a longer period than in the known constant delay retry strategy. This allows for continued operation of a telematics system with a given bandwidth at higher demand peaks than is possible using the known constant delay

retry strategy. Additionally, for data with high importance or priority, resetting the count parameter allows the corresponding message to be reprioritised relatively quickly, by causing the message retry delay to be, statistically, much likelier to be lower.

- 5 In some embodiments the above method may be applied to vehicle telematics messaging.

In some embodiments, the method may include determining a quality of service category of a failed message. The quality of service category may be determined by a look up based on an identifier code within the message. Determining the quality of service category allows
10 variation in the priority accorded to resending message. For example, this can enable messages in higher quality of service categories to be the subject of earlier or more frequent resend attempts. In some embodiments, the method may include resending messages in the highest quality of service category after a fixed retry delay period and resending messages in lower quality of service categories after a retry delay period determined by the final retry
15 delay parameter.

The exponential function may be any suitable function whereby the rate of growth of the output is directly proportional to the value of the output. In particular, the exponential function may be based upon the natural exponential function.

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In some embodiments, generating the interim retry delay parameter may include calculating the sum of the output of the exponential function and an interim threshold parameter. The interim threshold parameter may be a constant. The summing of the exponential function and the interim threshold parameter ensures that the interim retry delay parameter is greater
25 than a minimum value. Accordingly, the final delay parameter and hence the retry delay period will also exceed a minimum value. The interim threshold parameter may vary for messages in different quality of service categories. For example, this can enable longer minimum retry delay periods for messages in lower quality of service categories.

30 In some embodiments, the count parameter may be equal to the count of failed send attempts for a message. In other embodiments, the count parameter may be equal to the modulus of the count of failed send attempts for a message with respect to a threshold count value. In this manner, an upper limit is placed upon the interim delay parameter and hence upon the maximum retry delay period. The threshold count value may vary for messages in
35 different quality of service categories. For example, this would enable shorter maximum retry delay periods for messages in higher quality of service categories.

In some embodiments, the delay lower threshold parameter may have a fixed value. In other embodiments, the delay lower threshold parameter may vary for messages in different quality of service categories. For example, this would enable shorter minimum retry delay periods for messages in higher quality of service categories. In some embodiments, the
5 delay lower threshold parameter may be zero.

In some embodiments, the final retry delay parameter may be generated by selecting a random number between a delay lower threshold parameter and the interim retry delay parameter. In some embodiments, the final retry delay parameter may be equal to the
10 selected random number. In other embodiments, the final retry delay parameter may be equal to the sum of the selected random number and an offset parameter. The summing of the selected random number and the offset parameter ensures that the final retry delay parameter is greater than a minimum value. Accordingly, the retry delay period will also exceed a minimum value. The offset parameter may vary for messages in different quality of
15 service categories. For example, this can enable longer minimum retry delay periods for messages in lower quality of service categories.

In some embodiments, the numerical value of the final retry delay parameter may directly equal the numerical value of the retry delay period. In other embodiments, the numerical
20 value of the final retry delay parameter may be converted to the numerical value of the retry delay period by use of a suitable scale factor.

According to yet another aspect of the invention, there is provided a load dispersion controller for messaging, the load dispersion controller comprising: means for counting
25 operable to maintain a count of failed send attempts for individual messages and thereby generate a count parameter; means for generating a final retry delay period by selecting a retry delay period from a range of possible retry delay periods that increases with the count parameter. The means for counting is operable to reset periodically the count of failed send attempts for a message after a threshold count value is exceeded.

As a result of the above selection of retry delay periods from an increasing range, resend attempts for failed messages are dispersed over a longer period than in the known constant delay retry strategy. This allows for continued operation of a telematics system with a given
30 bandwidth at higher demand peaks than is possible using the known constant delay retry strategy. Additionally, for data with high importance or priority, resetting the count parameter allows the corresponding message to be reprioritised relatively quickly, by causing the message retry delay to be, statistically, much likelier to be lower.

In some embodiments the above load dispersion controller may be a load dispersion controller for vehicle telematics messaging.

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According to another aspect of the invention, there is provided a load dispersion controller for a messaging unit, the load dispersion controller comprising: means for counting operable to maintain a count of failed send attempts for individual messages and thereby generate a count parameter; means for generating an interim retry delay parameter operable to generate an interim retry delay parameter by inputting the count parameter into an exponential function; means for generating a final retry delay parameter operable to generate a final retry delay parameter between a delay lower threshold parameter and the interim retry delay parameter; and means for timing operable to delay the resending of said failed messages for a retry delay period determined by the final retry delay parameter. The means for counting is operable to reset periodically the count of failed send attempts for a message after a threshold count value is exceeded.

The above load dispersion controller is thus operable to provide a retry delay period randomly selected from a range that increases exponentially with the count of failed send attempts for each individual message. As a result resend attempts for failed messages are dispersed over a longer period than in the known constant delay retry strategy. This allows for continued operation of a telematics system with a given bandwidth at higher demand peaks than is possible using the known constant delay retry strategy. Additionally, for data with high importance or priority, resetting the count parameter allows the corresponding message to be reprioritised relatively quickly, by causing the message retry delay to be, statistically, much likelier to be lower.

In some embodiments the above load dispersion controller may be a load dispersion controller for vehicle telematics messaging.

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A system for as described above, wherein:

said load dispersion controller comprises an electronic processor having an electrical input for receiving details of failed message attempts; and

an electronic memory device electrically coupled to the electronic processor having instructions stored therein;

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said load dispersion controller comprises the processor being configured to access the memory device and execute the instructions stored therein such that it is operable to:

maintain a count of failed send attempts for individual messages and thereby generate a count parameter; generate an interim retry delay parameter by inputting the count into an exponential function; generate a final retry delay parameter between a delay lower threshold parameter and the final retry delay parameter; and delay the resending of said failed messages for a retry delay period determined by the final retry delay parameter. The means for counting is operable to reset periodically the count of failed send attempts for a message after a threshold count value is exceeded.

In some embodiments, the load dispersion controller may comprise means for determining the quality of service category of a failed message. The means for determining the quality of service category of a failed message may be operable to determine the quality of service category of the failed message by a look up based on an identifier code within the message. Determining the quality of service category allows variation in the priority accorded to resending message. For example, this can enable messages in higher quality of service categories to be the subject of earlier or more frequent resend attempts. In some embodiments, the means for timing may be operable in dependence on a determination by the means for determining the quality of service category of a failed message that a failed message is in the highest quality of service category to resend the message after a fixed retry delay period and operable in dependence on a determination by the means for determining the quality of service category of a failed message that a failed message is in a lower quality of service category to resend the message after a retry delay period determined by the final retry delay parameter.

A system for as described above, wherein:

Said means for determining the quality of service category of a failed message comprises an electronic processor having an electrical input for receiving details of an identifier code within the message; and

an electronic memory device electrically coupled to the electronic processor having instructions stored therein;

said means for determining the quality of service category of a failed message comprises the processor being configured to access the memory device and execute the instructions stored therein such that it is operable to: determine the quality of service category of the failed message by a look up based on an identifier code within the message.

In some embodiments, the means for generating an interim retry delay parameter may be operable to calculate the sum of the output of the exponential function and an interim threshold parameter. The interim threshold parameter may be a constant. The summing of

the exponential function and the interim threshold parameter ensures that the interim retry delay parameter is greater than a minimum value. Accordingly, the final delay parameter and hence the retry delay period will also exceed a minimum value. The means for generating an interim retry delay parameter may be operable to vary the threshold parameter for messages in different quality of service categories. For example, this can enable longer minimum retry delay periods for messages in lower quality of service categories.

The means for counting may be operable to generate the count parameter by looking up the value of the count of failed send attempts for a message. In some embodiments, the means for counting may be operable to periodically reset the count of failed send attempts for a message after a threshold count value is exceeded. In other embodiments, the means for counting may be operable to generate the count parameter by calculating the modulus of the count of failed send attempts for a message with respect to a threshold count value. In this manner, an upper limit is placed upon the interim delay parameter and hence upon the maximum retry delay period. The means for counting may be operable to vary the threshold count value for messages in different quality of service categories. For example, this would enable shorter maximum retry delay periods for messages in higher quality of service categories.

In some embodiments, the means for generating a final retry delay parameter may be operable to use a fixed value of the delay lower threshold parameter. In other embodiments, the means for generating a final retry delay parameter may be operable to vary the value of the delay lower threshold parameter for messages in different quality of service categories. For example, this would enable shorter minimum retry delay periods for messages in higher quality of service categories.

In some embodiments, the means for generating a final retry delay parameter may be operable to generate a final retry delay period by selecting a retry delay period randomly from a range of possible retry delay periods that increases with the count parameter. In some embodiments, the means for generating a final retry delay parameter may be operable to calculate the final retry delay parameter as equal to the selected random number. In other embodiments, the means for generating a final retry delay parameter may be operable to calculate the final retry generating parameter by summing of the selected random number and an offset parameter. The summing of the selected random number and the offset parameter ensures that the final retry delay parameter is greater than a minimum value. Accordingly, the retry delay period will also exceed a minimum value. The means for generating a final retry delay parameter may be operable to vary the offset parameter for

messages in different quality of service categories. For example, this can enable longer minimum retry delay periods for messages in lower quality of service categories.

In some embodiments, the means for timing may be operable such that the numerical value of the final retry delay parameter directly equals the numerical value of the retry delay period. In other embodiments, the means for timing may be operable such that the numerical value of the final retry delay parameter may be converted to the numerical value of the retry delay period by use of a suitable scale factor.

According to a further aspect of the invention, there is provided a vehicle telematics unit comprising a load dispersion controller in accordance with the preceding aspect of the invention.

The vehicle telematics unit may comprise means for receiving signals from one or more vehicle systems indicative of the state of said systems. The vehicle telematics unit may comprise means for message generation operable in dependence on the received signals to generate telematics messages for transmission.

A system for as described above, wherein:

said vehicle telematics unit comprises an electronic processor having an electrical input for receiving said signals indicative of the state of said vehicle systems; and

an electronic memory device electrically coupled to the electronic processor having instructions stored therein;

said means for message generation comprises the processor being configured to access the memory device and execute the instructions stored therein such that it is operable to: receive said signals indicative of the state of vehicle systems and generate telematics messages in dependence thereon.

The vehicle telematics unit may comprise a communication unit operable to enable the sending of telematics messages to an external vehicle telematics server.

The vehicle telematics unit may comprise means for storing messages waiting to be sent by the communication unit. The means for storing message may be operable to store both new messages waiting to be sent by the communication unit and failed messages waiting to be resent by the communication unit. The means for storing messages may be an electronic memory device.

According to another further aspect of the invention, there is provided a vehicle comprising a vehicle telematics unit according to the preceding aspect of the invention.

5 The vehicle may comprise a motor vehicle. The vehicle may comprise a road vehicle. The vehicle may be a car.

According to a still further aspect of the invention, there is provided a vehicle telematics system comprising: one or more vehicle telematics units according to the preceding aspect of the invention; and a vehicle telematics server operable to receive telematics messages
10 from the vehicle telematics unit.

Within the scope of this application it is expressly intended that the various aspects, embodiments, examples and alternatives set out in the preceding paragraphs, in the claims and/or in the following description and drawings, and in particular the individual features
15 thereof, may be taken independently or in any combination. That is, all embodiments and/or features of any embodiment can be combined in any way and/or combination, unless such features are incompatible. The applicant reserves the right to change any originally filed claim or file any new claim accordingly, including the right to amend any originally filed claim to depend from and/or incorporate any feature of any other claim although not originally
20 claimed in that manner.

BRIEF DESCRIPTION OF THE DRAWINGS

One or more embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

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Figure 1 is a schematic diagram of an embodiment of a vehicle telematics system in accordance with an embodiment of the invention;

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Figure 2 is a schematic diagram of an embodiment of a vehicle telematics unit in accordance with an embodiment of the invention;

Figure 3 is a schematic diagram of an embodiment of a load dispersion controller for a vehicle telematics unit in accordance with an embodiment of the invention;

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Figure 4 shows a graph illustrating how the maximum value of the count parameter may be limited;

Figure 5 is a flowchart describing a load dispersion method;

Figure 6 is a schematic flow diagram illustrating the operation of load dispersion method for vehicle telematics messaging in accordance with an embodiment of the invention;

Figure 7 is a schematic comparison of the retry delay period generated by a load dispersion method for vehicle telematics messaging in accordance with an embodiment of the invention and the linear retry strategy of the prior art; and

Figure 8 is a schematic comparison of the average message processing time resulting from a retry delay period generated by a load dispersion method for vehicle telematics messaging in accordance with an embodiment of the invention and the linear retry strategy of the prior art.

DETAILED DESCRIPTION

Figure 1 illustrates schematically a vehicle telematics system 1, operable to provide telematics monitoring services to a plurality of vehicles V1-VN. In the system 1, each vehicle V1-VN is fitted with a telematics unit 10. Each telematics unit 10 is operable to generate telematics messages indicative of the state of one or more vehicle systems (see figure 2). Telematics messages are sent over a wireless data connection, such as a cellular data network 3 to a vehicle telematics server 4. Received messages can be monitored and analysed by the service provider 5 as desired or required.

Turning now to figure 2, the telematics unit 10 comprises means 11 in the form of an electronic processor for receiving signals from one or more vehicle systems 9 indicative of the state of said systems 9. In dependence on the received signals, a means for message generation 12 is operable to generate telematics messages to be sent to the vehicle telematics server 4. The means for message generation may be in the form of an electronic processor which may be separate to or part of the processor embodying the means 11 for receiving signals from one or more vehicle systems. The messages are sent to the vehicle telematics server 4 by a communication unit 13, the communication unit being adapted to send messages via a suitable data connection. Optionally, the vehicle telematics unit 10 may also comprise means 14, such as an electronic memory device, operable to store messages waiting to be sent by the communication unit 13 and failed messages waiting to be resent by

the communication unit 13. In order to provide for the event that attempts to send message fail, the vehicle telematics unit 10 is provided with a load dispersion controller 20.

The load dispersion controller 20 is operable to control the timing of attempts to resend messages. In particular, the load dispersion controller 20 is operable to determine a variable retry delay period for each failed message randomly selected from a range that, in an embodiment of the invention, increases exponentially with the count of failed send attempts for each individual message. This disperses resend attempts for failed messages over a longer period than in the known constant delay retry strategy and thus allows for continued operation of a telematics system with a given bandwidth.

Turning to figure 3, the load dispersion controller 20 comprises means for counting 21, means for generating an interim retry delay parameter 22, means for generating a final retry delay parameter 23, and means for timing 24. Each of the means for counting 21, means for generating an interim retry delay parameter 22, means for generating a final retry delay parameter 23 and means for timing 24 can be embodied by an individual electronic processor. Alternatively, each may be embodied by single electronic processor.

The means for counting 21 is operable to maintain a count of failed send attempts for individual telematics messages. This count value is used to generate a count parameter. In turn, the count parameter is used to vary the retry delay period for attempting to resend the failed message. The means for counting 21 is operable to generate the count parameter by calculating the modulus of the count of failed send attempts for a message with respect to a threshold count value. This limits the maximum value of the count parameter. In alternative embodiments, it is possible for the count parameter to equal the count of failed send attempts for a message. In either case, the maximum value of the count parameter may be limited by periodically resetting the count value after the threshold count value is exceeded.

The means for generating an interim retry delay parameter 22 is operable to generate an interim retry delay parameter for use in determining the retry delay period. The interim retry delay parameter is generated by inputting the count parameter into an exponential function. The interim retry delay parameter thus increases in value exponentially with an increase in the count parameter.

Optionally, the means for generating an interim retry delay parameter 22 is additionally operable to sum the output of the exponential function and an interim threshold parameter to

generate the interim retry delay parameter. The benefit of such summing is that the interim retry delay parameter does not drop below a desired minimum value.

The means for generating a final retry delay parameter 23 is operable to generate a final
5 retry delay for use in determining the retry delay period. The final retry delay parameter is generated by selecting a random number between a delay lower threshold parameter and the interim retry delay parameter. The final retry delay parameter may be equal to the selected random number or may be equal to the sum of the selected random number and an offset parameter.

10 The means for timing 24 is operable to control the delay the resending of said failed messages in dependence on the generated final retry delay parameter. In one embodiment, the means for timing 24 is operable to determine a retry delay period equal to the numerical value of the generated final retry delay parameter. Optionally, there may be a different scale
15 factor used to generate the retry delay period from the numerical value of the generated final retry delay parameter.

Optionally, as is shown in figure 3, the load dispersion controller may also comprise a means for determining the quality of service category of a failed message 25. The determination of
20 the quality of service category of the failed message can be achieved by a look up based on an identifier code within the failed message. The means for determining the quality of service category of a failed message 25 may be embodied by a dedicated electronic processor or may be embodied in an electronic processor configured to implement any one or more of the means for counting 21, means for generating an interim retry delay parameter 22, means for
25 generating a final retry delay parameter 23, and means for timing 24.

Figure 4 shows a graph illustrating how the maximum value of the count parameter may be limited by periodically resetting the count value after the threshold count value is exceeded, for situations where different threshold count values are used for messages in different
30 quality of service categories. In other words, in dependence on the determination of the quality of service category, it is possible to provide variation in the priority accorded to resending individual messages. In this example embodiment, the means for counting 21 is operable in dependence on the means for determining the quality of service category of a failed message 25 to vary the threshold count value at which the count of failed send
35 attempts for a message is reset.

Looking at figure 4, the unbroken lines represent a threshold count value of 3 for a best quality of service level category message, so that after 3 failed attempts to send the message, the count parameter is reset. This effectively shortens a delay period for sending the message on the fourth attempt, and so gives higher priority to this message. This lower threshold count value represents a best quality of service, and can be used for critical messages. In figure 4, the longest wait allowed before the count threshold value for critical messages reset is 8 units of time, but that is merely an illustration, and the exact time will need to be evaluated based on each application.

The dashed lines represent a threshold count value of 5 for a medium quality of service level category message, so that after 5 failed attempts to send the message, the count parameter is reset. This effectively shortens a delay period for sending the message on the sixth attempt when compared with no resetting, and so at that time gives higher priority to this message, allowing the message effectively to rise up the hierarchy of priorities. This medium threshold count value represents a medium quality of service, and can be used for live data, or real-time data, messages. In figure 4, the longest wait allowed before the count threshold value for medium priority messages reset is 32 units of time, but that is merely an illustration, and the exact time will need to be evaluated based on each application.

The dotted and dashed lines represent a threshold count value of 8 for a lowest quality of service level category message, so that after 8 failed attempts to send the message, the count parameter is reset. This effectively shortens a delay period for sending the message on the fourth attempt when compared with no resetting, and so gives higher priority to this message. This lowest threshold count value represents a lowest quality of service, and can be used for logging messages. In figure 4, the longest wait allowed before the count threshold value for logging messages reset is 256 units of time, but that is merely an illustration, and the exact time will need to be evaluated based on each application.

Figure 4 shows an exponential curve, but this is merely an illustration because the actual delay parameter between message resends will vary between gradually increasing time windows.

In one variation, the means for counting is operable to reset the threshold count value for messages in all but the lowest quality of service category.

Figure 5 is a flowchart describing a load dispersion method 500.

The method comprises:

At step S510: maintaining a count of failed send attempts for individual messages so as to generate a count parameter.

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At step S520: generating an interim retry delay parameter by inputting the count parameter into a non-linear function.

At step S530: generating a final retry delay parameter between a delay lower threshold parameter and the interim retry delay parameter.

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At step S540: using the final retry delay parameter to determine a retry delay period for resending said failed message.

At step S550: periodically resetting the count parameter after a threshold count value is exceeded.

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In another example, the means for generating an interim retry delay parameter 22 is operable in dependence on the means for determining the quality of service category of a failed message 25 to vary the interim threshold parameter summed together with the exponential function of the count. In a further example, the means for generating a final retry delay parameter 23 is operable in dependence on the means for determining the quality of service category of a failed message 25 to vary the delay lower threshold parameter.

20

Turning now to figure 6, the load dispersion method implemented by the load dispersion controller 20 is illustrated schematically. As described above, load dispersion is achieved by calculating an appropriate retry delay period.

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At S1, the quality of service category of the message is determined. If at S1 the message is determined to be in a low quality of service category, the means for counting 21 is operable to determine the count of failed send attempts for the message at S2. Subsequently, the means for counting 21 is operable to generate the count parameter by calculating the modulus of the count with respect to a threshold count value at S3. The threshold count value is fixed for a given quality of service category but may vary between quality of service categories.

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At S4, the interim delay parameter generating means 22 is operable to input the count parameter into an exponential function. In some embodiments, the output of the exponential function may be used directly as the interim delay parameter.

5 In the embodiment of figure 6, the interim delay parameter generating means 22 is additionally operable to generate an interim threshold parameter at S5. The value of the interim threshold parameter is fixed for a given quality of service category but may vary between quality of service categories. Subsequently, at S6, the interim threshold parameter is summed with the output of the exponential function to generate the interim delay
10 parameter.

At S7, the means for generating a final retry delay parameter 23 is operable to select a random number between a delay lower threshold parameter and the interim retry delay parameter. In the example of figure 6, the delay lower threshold parameter may have a fixed
15 value of 1, but in other embodiments, different values of the delay lower threshold parameter are possible. In particular, in such embodiments, the value of the interim threshold parameter may vary between quality of service categories.

At S8, the means for generating a final retry delay parameter 23 is operable to generate an
20 offset parameter. The value of the offset parameter may vary between quality of service categories. At S9, the means for generating a final retry delay parameter 23 is subsequently operable to sum the selected random number and the offset parameter to generate the final retry delay parameter.

25 At S10, the means for timing 24 is operable to generate a retry delay period for resending the message. The retry delay period may be generated by direct conversion of the value of final retry delay parameter to a value of the retry delay period in seconds. Alternatively, a suitable scale factor may be used to convert the value of final retry delay parameter to a value of the retry delay period in seconds.

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If at S1 the message is determined to be in a high quality of service category then S2-S7 may be omitted. Accordingly, the final delay parameter is generated directly from the fixed offset parameter. In effect, this allows these highest priority message to be resent on a linear
35 retry strategy whilst still providing for lower priority messages to be sent on a variable retry strategy described herein.

Turning now to figure 7, this is a plot illustrating the difference between the retry delay periods generated by the linear retry strategy of the prior art (and optionally applied to high quality of service messages herein) and retry delay periods generated by the variable retry strategy. In the figure, number of failed message send attempts is plotted on the horizontal axis and retry delay period is plotted on the vertical axis. Using the linear retry strategy of the prior art, all resend requests have a fixed retry delay period illustrated by line 101. Using the variable retry strategy, each resend attempt would have retry delay period within the cross hatched area 102. In particular, the retry delay period would be randomly selected from within the vertical extent of the cross hatched area 102 corresponding to the number of failed resend attempts.

Figure 8 shows a a plot which illustrates the difference in average message processing time between the message resent using the retry delay periods generated by the linear retry strategy of the prior art (and optionally applied to high quality of service messages herein) and messages resent using retry delay periods generated by the variable retry strategy. In the figure, time of day is plotted on the horizontal axis (from 00:00 to 23:59) and average message processing delay is plotted on the vertical axis. New message request are illustrated by line 201. As can be seen, the new message requests have two peaks in the morning and evening commuting periods, which correspond to maximum vehicle activity. Consequently, due to increased message activity, average processing time per message increases as the sending of many messages fails due to restrictions on server bandwidth. Above a threshold illustrated by line 202 the number of attempts to resend messages becomes a significant fraction of the total message load. When using a linear retry strategy for resending all failed messages as illustrated by line 203, this results in the average processing time for each message rising very rapidly. When instead a variable retry strategy is used for resending all failed messages as illustrated by line 204, this results in the average processing time for each message rising much less rapidly and a much lower maximum value of the average processing time.

CLAIMS

1. A load dispersion method for messaging, the method comprising:
 - maintaining a count of failed send attempts for individual messages so as to
 - 5 generate a count parameter;
 - generating an interim retry delay parameter by inputting the count parameter into an non-linear function;
 - generating a final retry delay parameter between a delay lower threshold parameter and the interim retry delay parameter;
 - 10 using the final retry delay parameter to determine a retry delay period for resending said failed message; and
 - wherein the count of failed send attempts for a message is periodically reset after a threshold count value is exceeded.
- 15 2. A load dispersion method as claimed in 1 wherein the non-linear function comprises an exponential function.
3. A load dispersion method as claimed in claim 1 or claim 2 wherein the method includes determining the quality of service category of a failed message.
- 20 4. A load dispersion method as claimed in any preceding claim wherein generating the interim retry delay parameter includes calculating the sum of the output of the non-linear function and an interim threshold parameter.
- 25 5. A load dispersion method as claimed in claim 4, when dependent upon claim 3, wherein the interim threshold parameter is varied for messages in different quality of service categories.
6. A load dispersion method as claimed in any preceding claim wherein the count
- 30 parameter is equal to the count of failed send attempts for a message.
7. A load dispersion method as claimed in any one of claims 1 to 5 wherein the count parameter is equal to the modulus of the count of failed send attempts for a message with respect to a threshold count value.
- 35 8. A load dispersion method as claimed in any preceding claim, when dependent directly or indirectly upon claim 3, wherein the threshold count value is varied for messages in different quality of service categories.

9. A load dispersion method as claimed in any preceding claim, when dependent directly or indirectly upon claim 3, wherein the threshold count value is periodically reset for messages in all but a lowest quality of service category.

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10. A load dispersion method as claimed in any one of claims 3 to 9 wherein the delay lower threshold parameter varies for messages in different quality of service categories.

11. A load dispersion method as claimed in any preceding claim wherein the method includes generating a final retry delay parameter by selecting a random number between a delay lower threshold parameter and the interim retry delay parameter.

12. A load dispersion method as claimed in any preceding claim wherein the final retry delay parameter is equal to the sum of the selected random number and an offset parameter.

13. A load dispersion method as claimed in claim 12, when dependent directly or indirectly upon claim 3, wherein the offset parameter varies for messages in different quality of service categories.

20

14. A load dispersion controller for a messaging unit, the load dispersion controller comprising:

means for counting operable to maintain a count of failed send attempts for individual messages and thereby generate a count parameter;

25 means for generating an interim retry delay parameter operable to generate an interim retry delay parameter by inputting the count parameter into a non-linear function;

means for generating a final retry delay parameter operable to generate a final retry delay parameter between a delay lower threshold parameter and the interim retry delay parameter;

30 means for timing operable to delay the resending of said failed messages for a retry delay period determined by the final retry delay parameter;

wherein the means for counting is operable to reset periodically the count of failed send attempts for a message after a threshold count value is exceeded.

35 15. A load dispersion controller as claimed in 14 wherein the non-linear function comprises an exponential function.

16. A load dispersion controller as claimed in claim 14 or 15 wherein the load dispersion controller comprises means for determining the quality of service category of a failed message operable to determine the quality of service category of the failed message by a look up based on an identifier code within the message.

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17. A load dispersion controller as claimed in claim 15 or claim 16 wherein the means for generating an interim retry delay parameter is operable to calculate the sum of the output of the non-linear function and an interim threshold parameter.

10 18. A load dispersion controller as claimed in claim 17, when dependent upon claim 16, wherein the means for generating an interim retry delay parameter is operable to vary the threshold parameter for messages in different quality of service categories.

15 19. A load dispersion controller as claimed in any one of claims 15 to 18 wherein the means for counting is operable to generate the count parameter by looking up the value of the count of failed send attempts for a message.

20 20. A load dispersion controller as claimed in any one of claims 15 to 18 wherein the means for counting is operable to generate the count parameter by calculating the modulus of the count of failed send attempts for a message with respect to a threshold count value.

21. A load dispersion controller as claimed in any of claims 14 to 20, when dependent directly or indirectly upon claim 16, wherein the means for counting is operable to vary the threshold count value for messages in different quality of service categories.

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22. A load dispersion method as claimed in any of claims 14 to 21, when dependent directly or indirectly upon claim 16, wherein the means for counting is operable to reset the threshold count value for messages in all but a lowest quality of service category.

30 23. A load dispersion controller as claimed in any one of claims 16 to 22 wherein the means for generating a final retry delay parameter is operable to vary the value of the delay lower threshold parameter for messages in different quality of service categories.

35 24. A load dispersion controller as claimed in any one of claims 14 to 23 wherein the final retry delay parameter means is operable to generate a final retry delay parameter by selecting a random number between a delay lower threshold parameter and the interim retry delay parameter.

25. A load dispersion controller as claimed in any one of claims 14 to 23 wherein the means for generating a final retry delay parameter is operable to calculate the final retry generating parameter by summing of the selected random number and an offset parameter.

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26. A load dispersion controller as claimed in claim 25, when dependent directly or indirectly upon claim 16, wherein the means for generating a final retry delay parameter is operable to vary the offset parameter for messages in different quality of service categories.

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27. A load dispersion controller as claimed in any one of claims 14 to 26 wherein the means for timing is operable such that the numerical value of the final retry delay parameter directly equals the numerical value of the retry delay period.

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28. A vehicle telematics unit comprising a load dispersion controller as claimed in any one of claims 14 to 27.

29. A vehicle comprising the vehicle telematics unit as claimed in claim 28.

20

30. A vehicle telematics system comprising: one or more vehicle telematics units according to claim 28; and a vehicle telematics server operable to receive telematics messages from the vehicle telematics units.

25

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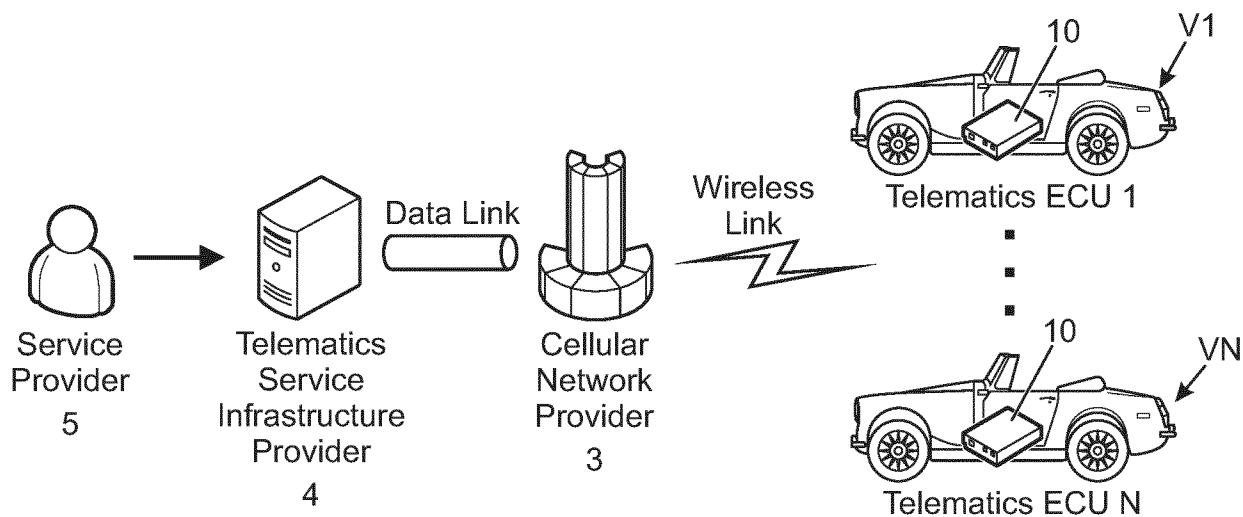


Figure 1

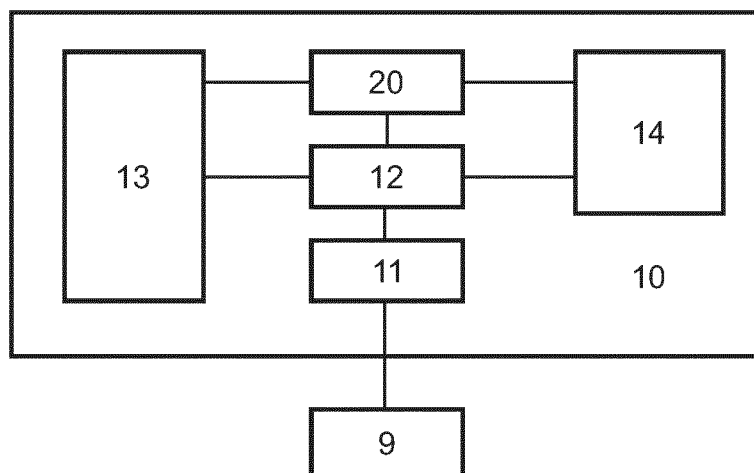


Figure 2

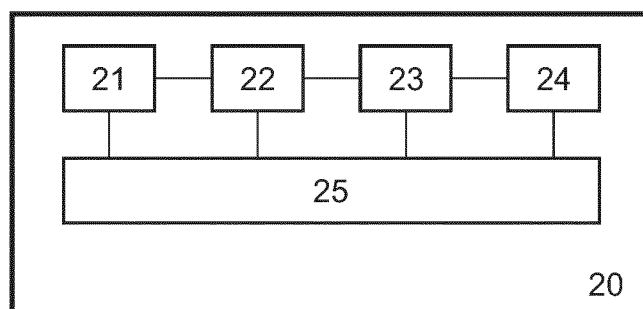


Figure 3

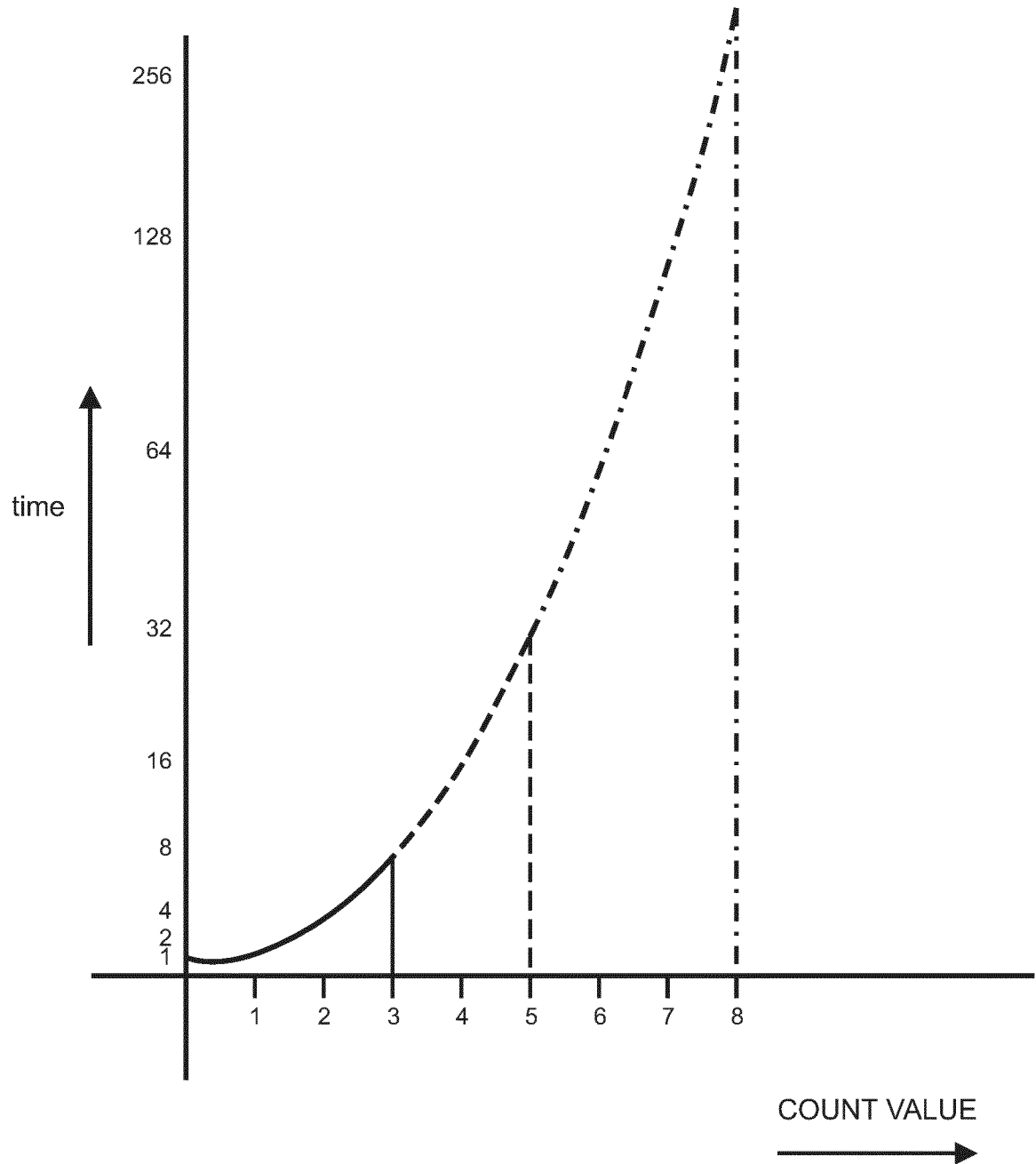


Figure 4

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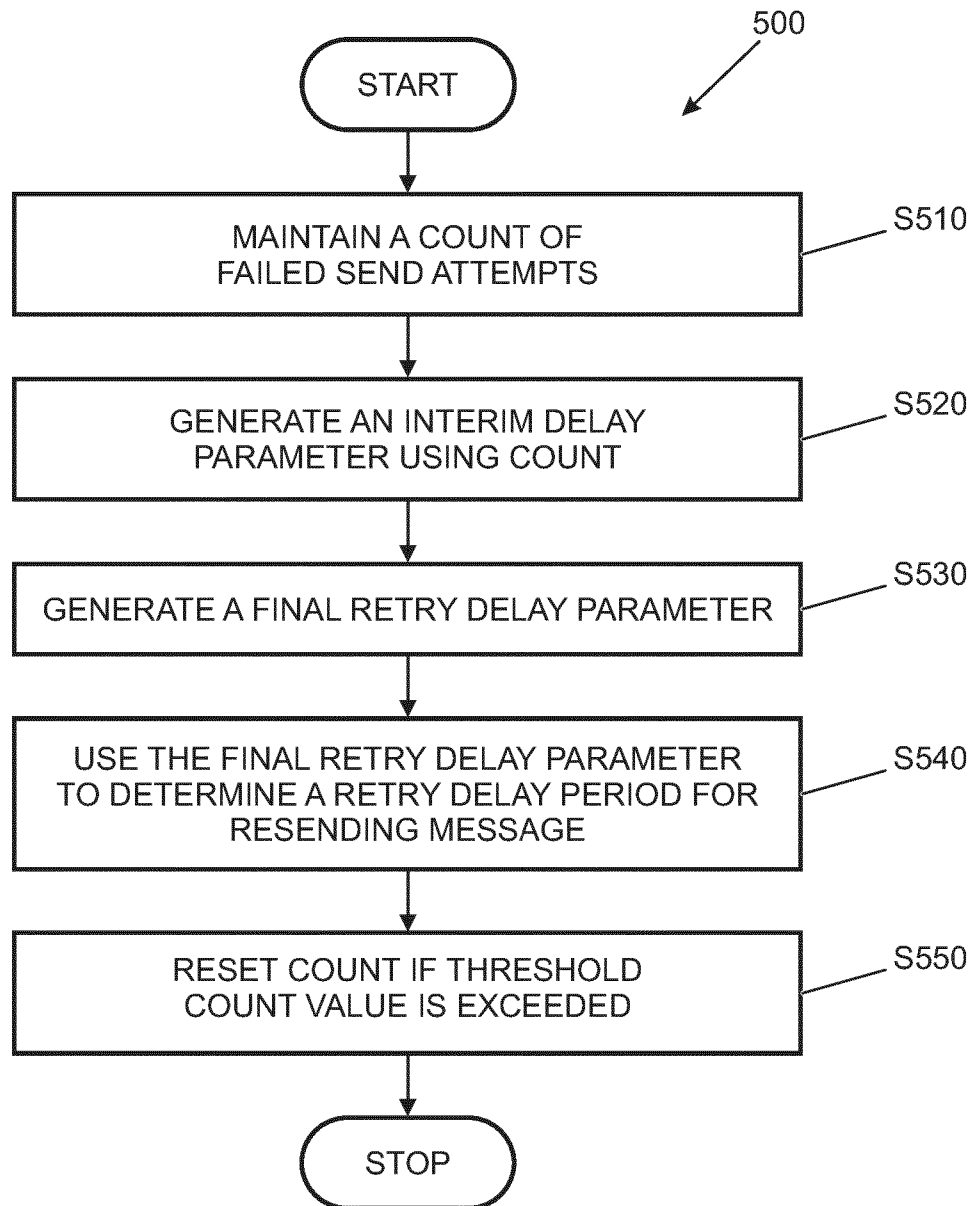


Figure 5

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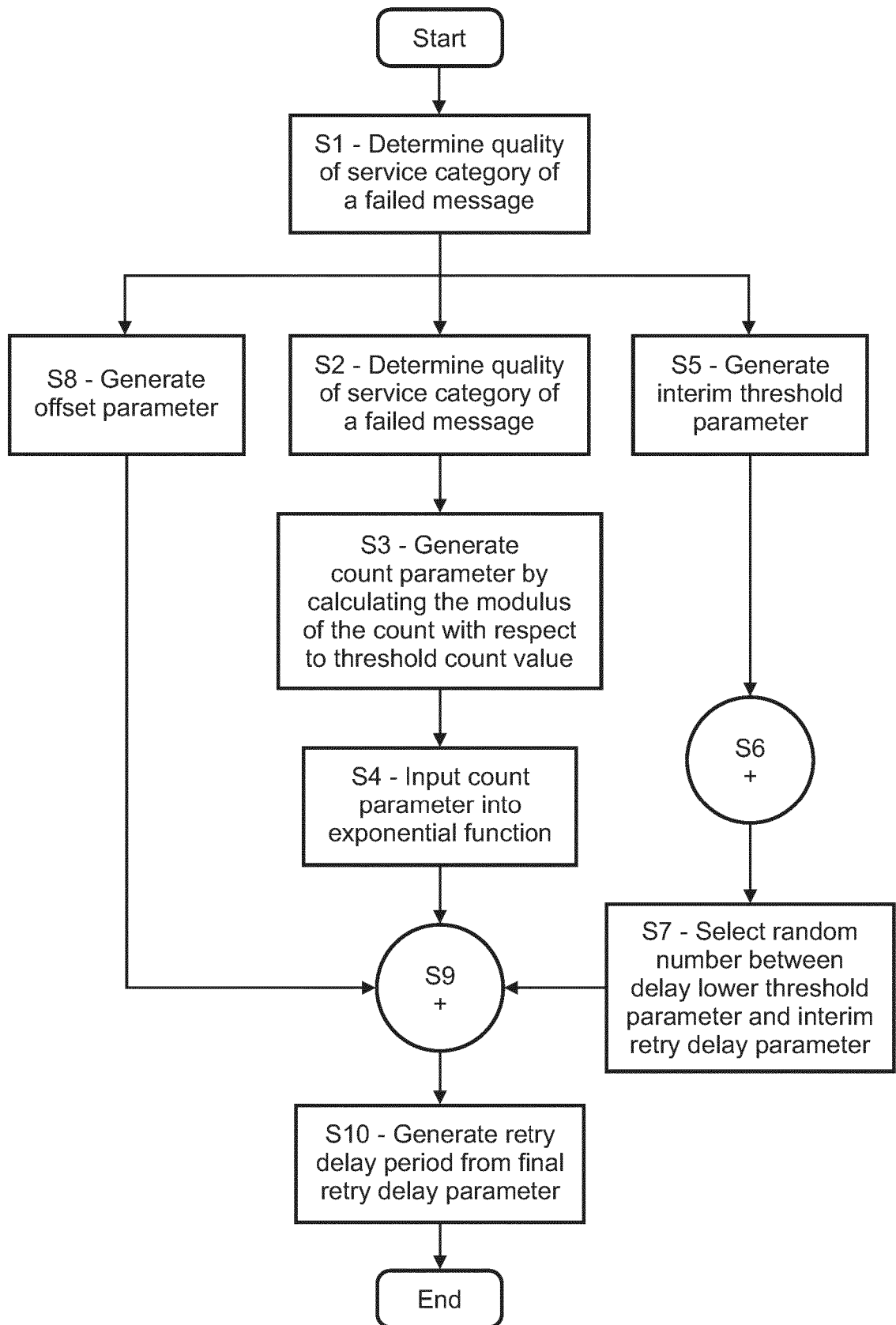


Figure 6

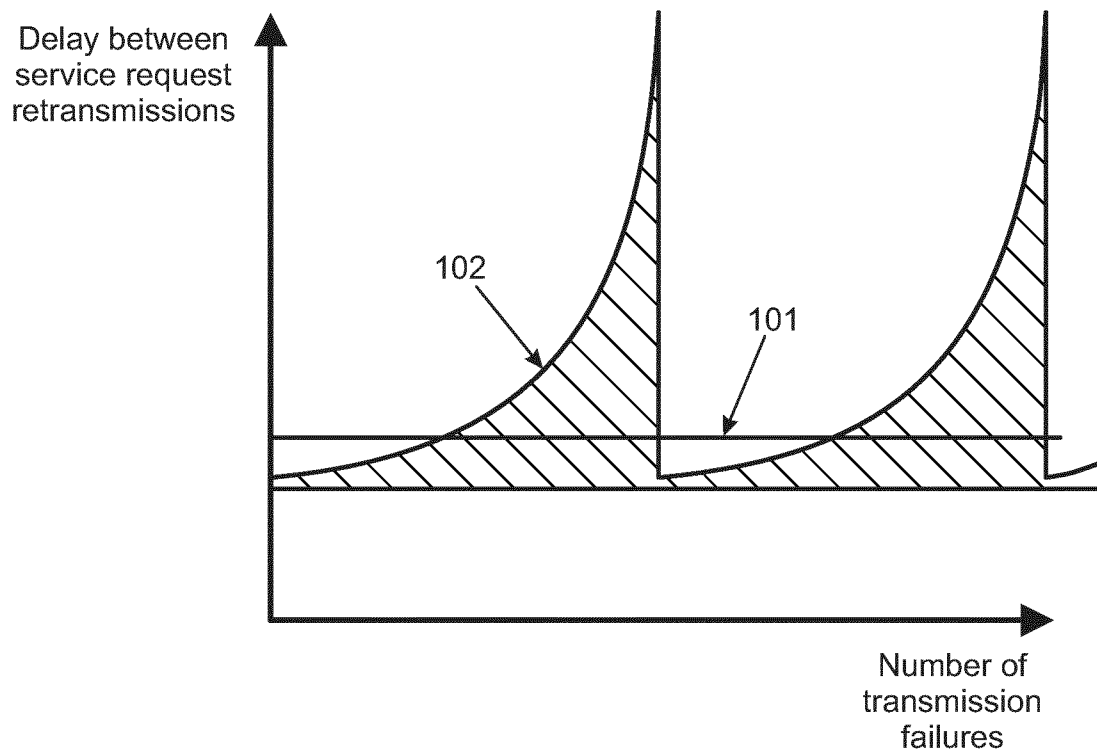


Figure 7

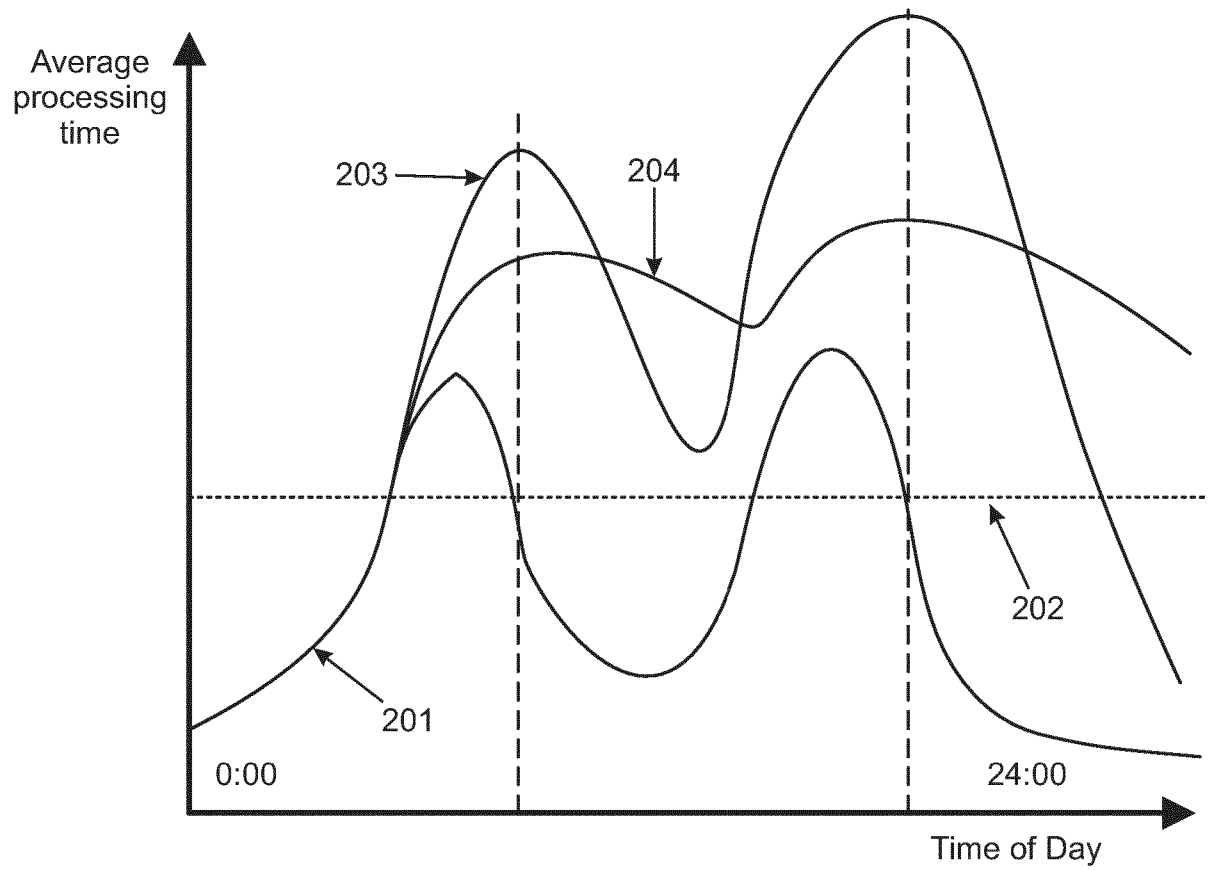


Figure 8

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/078574

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W28/02
ADD.

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)
H04W

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

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

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	US 5 822 538 A (KRISHNA GOPAL [US] ET AL) 13 October 1998 (1998-10-13) figures 2A, 2B, 3, 4 column 1, lines 18-31, 39-59 column 2, lines 2-64 column 4, line 26 - column 5, line 4 column 5, line 39 - column 7, line 43 ----- -/--	1-30



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

20 February 2018

Date of mailing of the international search report

28/02/2018

Name and mailing address of the ISA/

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Authorized officer

Bouton, Eric

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2017/078574

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	MARIO E RIVERO-ANGELES ET AL: "Differentiated Backoff Strategies for Prioritized Random Access Delay in Multiservice Cellular Networks", IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY, IEEE SERVICE CENTER, PISCATAWAY, NJ, US, vol. 58, no. 1, 1 January 2009 (2009-01-01), pages 381-397, XP011225100, ISSN: 0018-9545, DOI: 10.1109/TVT.2008.918704 abstract page 2, left-hand column, line 37 - page 3, left-hand column, line 33 page 7, left-hand column, line 11 - page 8, left-hand column, line 12 page 8, right-hand column, line 29 - page 11, left-hand column, line 3 Appendix B -----	1-30
A	US 2013/181848 A1 (PICARD GILLES [FR]) 18 July 2013 (2013-07-18) figures 49-51 paragraphs [0854] - [0889] -----	1-30

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