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(71) Applicant: **JIO PLATFORMS LIMITED** [IN/IN]; Office-101, Saffron, Nr. Centre Point, Panchwati 5 Rasta, Ambawadi, Ahmedabad - 380006, Gujarat (IN).

(72) Inventors: **BHATNAGAR, Aayush**; Tower-7, 15B, Beverly Park, Sector-14, Koper Khairane, Navi Mumbai - 400701, Maharashtra (IN). **BHATNAGAR, Pradeep Kumar**; Tower-7, 15B, Beverly Park, Sector-14, Koper Khairane, Navi Mumbai - 400701, Maharashtra (IN). **SHETTY, Manoj**; Orchard Residency, T8/604, LBS Marg, Ghatkopar West, Mumbai - 400086, Maharashtra (IN).

VENKATRAMAN, Rajeshwari; C-104, Sterling Sharada Nivas, 15th Cross, 6th Main, Indiranagar 2nd Stage, Bangalore - 560038, Karnataka (IN). **CHITALIYA, Dharmesh A**; B 204, River Retreat, Casa Rio, Palava City, Nilje Goan, Kalyan Shilphata Road, Dombivali(E), Dist - Thane, 421203, Maharashtra (IN). **KADAM, Hanumant**; 301 B Wing Shikshak Nagar CO HO Society, LBS Marg, Kurla West, Mumbai - 400070, Maharashtra (IN). **VIRKAR, Sneha**; 603, Sagarika, MBPT Officer's Quarters, Mazgaon, Mumbai - 400010, Maharashtra (IN). **KRISHNA, Neelabh**; C-142 DLF The Primus, Sector-82A, Gurugram - 122004, Haryana (IN).

(74) Agent: **D J, Solomon** et al.; De Penning & De Penning, 120 Velachery Main Road, Guindy, Chennai - 600032 (IN).

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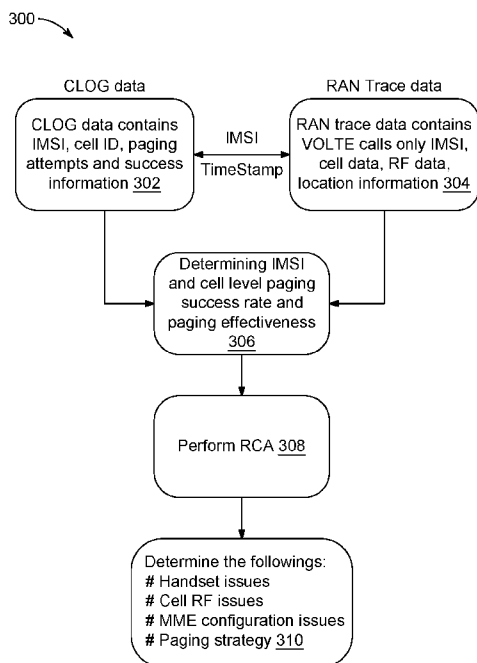


FIG. 3

(57) Abstract: A system (108) for analyzing and troubleshooting paging failures in a telecommunications network. The system comprising one or more processors (202). The system comprising a memory (204) configured to store instructions that, when executed by the one or more processors (202), cause the system (108) to (i) receive a CLOG data (302) and a radio access network (RAN) trace data (304), (ii) combine the CLOG data (302) and the RAN trace data (304) to determine an aggregated paging success rate, (iii) analyze the combined CLOG data (302) and RAN trace data (304), and (iv) identify at least one or more failures based on the analysis of the combined CLOG data (302) and RAN trace data (304).



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SYSTEM AND METHOD FOR ANALYZING AND TROUBLESHOOTING PAGING FAILURES

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15 FIELD OF INVENTION

[0002] The present disclosure generally relates to telecommunication
networks. More particularly, the present disclosure relates to a system and a method
for analyzing and troubleshooting paging failures by correlation of core paging logs
and radio access network (RAN) logs.

20

BACKGROUND OF THE INVENTION

[0003] The following description of the related art is intended to provide
background information pertaining to the field of the disclosure. This section may
include certain aspects of the art that may be related to various features of the
25 present disclosure. However, it should be appreciated that this section is used only
to enhance the understanding of the reader with respect to the present disclosure,
and not as admission of the prior art.

[0004] In a telecommunications network, paging is a crucial process that
enables the delivery of incoming calls, messages, or other network notifications to
30 specific user devices. When a network needs to establish communication with a
particular user, it initiates a paging request by broadcasting the user's identifier,

known as the international mobile subscriber identity (IMSI), across a large geographical area. The user's device, referred to as the user equipment (UE), listens for this paging message and responds accordingly.

[0005] Measuring the effectiveness of paging is crucial for network operators to ensure efficient communication and satisfactory user experience. Typically, the evaluation of paging success rate has been limited to the core network level, where the network infrastructure tracks the delivery and response of paging messages. This approach provides an overall assessment of the network's performance in terms of successful paging attempts, but it lacks visibility into the specific impact of paging on end users within smaller geographical areas or cells.

[0006] The challenge arises from the fact that the paging message is transmitted across a large area, making it difficult to pinpoint the exact success rate for a particular small geographical region or the cell serving the users. While the core network can track successful paging responses, it does not capture information about paging failures at the radio access network (RAN) side.

[0007] There is, therefore, a need in the art to provide a system and a method that can mitigate the problems associated with the prior arts.

OBJECTS OF THE INVENTION

[0008] Some of the objects of the present disclosure, which at least one embodiment herein satisfies are as listed herein below.

[0009] An object of the present disclosure is to provide a system and a method for analyzing and troubleshooting paging failures that utilizes a dataset containing information related to paging attempts and success, including international mobile subscriber identity (IMSI), cell identifier (ID), and paging success records within the telecommunications network's core network.

[0010] An object of the present disclosure is to provide a system and a method for analyzing and troubleshooting paging failures that utilizes a dataset containing information captured during Long Term Evolution (LTE) session record (LSR) trace events, specifically for Voice over LTE (Volte) calls. It includes IMSI, cell data, RF (Radio Frequency) data, and location information.

[0011] An object of the present disclosure is to provide a system and a method for analyzing and troubleshooting paging failures which combines the analyzing core log (CLOG) data and LSR trace data to determine the rate of successful paging attempts at both the IMSI and cell levels.

5 [0012] An object of the present disclosure is to provide a system and a method for analyzing and troubleshooting paging failures which identifies user devices that exhibit abnormal behavior or unauthorized activity within the telecommunications network.

[0013] An object of the present disclosure is to provide a system and a
10 method for analyzing and troubleshooting paging failures which identifies problems or anomalies that occur at the individual cell level within the telecommunications network.

[0014] An object of the present disclosure is to provide a system and a
15 method for analyzing and troubleshooting paging failures which conducts a root cause analysis to determine the underlying causes of paging failures.

SUMMARY

[0015] In an exemplary embodiment, the present invention discloses a
20 method for analyzing and troubleshooting paging failures in a telecommunications network. The method comprising receiving a core log (CLOG) data and a radio access network (RAN) trace data. The method comprising combining the CLOG data and the RAN trace data to determine an aggregated paging success rate. The method comprising analysing the combined CLOG data and the RAN trace data. The method comprising identifying at least one or more failures based on the
25 analysis of the combined CLOG data and RAN trace data.

[0016] In an embodiment, the CLOG data includes an international mobile subscriber identity (IMSI), a cell ID, paging attempts, and success records.

[0017] In an embodiment, the RAN trace data includes an international
30 mobile subscriber identity (IMSI), cell data, radio frequency (RF) data, and location information.

[0018] In an embodiment, the aggregated paging success rate is determined for an international mobile subscriber identity (IMSI) or a cell.

[0019] In an exemplary embodiment, the present invention discloses a system for analyzing and troubleshooting paging failures in a telecommunications network. The system comprising one or more processors and a memory configured to store instructions that, when executed by one or more processors, cause the system to: (i) receive a CLOG data and a radio access network (RAN) trace data, (ii) combine the CLOG data and the RAN trace data to determine an aggregated paging success rate, (iii) analyse the combined CLOG data and RAN trace data, and (iv) identify at least one or more failures based on the analysis of the combined CLOG data and RAN trace data.

[0020] In an embodiment, the CLOG data includes an international mobile subscriber identity (IMSI), a cell ID, paging attempts, and success records. In examples, the CLOG data may be associated with the specific user or subscriber.

[0021] In an embodiment, the RAN trace data includes an international mobile subscriber identity (IMSI), cell data, radio frequency (RF) data, and location information.

[0022] In an embodiment, the aggregated paging success rate is determined for an international mobile subscriber identity (IMSI) or a cell.

[0023] In an embodiment, the aggregated paging success rate indicates a performance of the telecommunications network.

[0024] In an embodiment, a user equipment (UE) is communicatively coupled with a network, the coupling comprises steps of (i) receiving, by the network, a connection request from the UE, (ii) sending, by the network, an acknowledgment of the connection request to the UE, and (iii) transmitting a plurality of signals in response to the connection request.

[0025] In an embodiment, identified one or more failures are indicative of an issue that is selected from a group comprising of an issue with a user equipment (UE), an issue with a cell radio frequency (RF), and an issue with user equipment movement configuration.

[0026] In an embodiment, the analyzed combined CLOG data and RAN trace data, and the aggregated paging success rate provide a paging strategy to improve a user experience.

[0027] In an embodiment, the one or more processors are further configured to calculate an international mobile subscriber identity (IMSI) level paging success rate using a formula: $\text{IMSI paging success rate} = (\text{sum of paging success}) / (\text{sum of paging success} + \text{sum of paging failure})$.

[0028] In an embodiment, the one or more processors are further configured to calculate a cell paging success rate using a formula: $\text{cell paging success rate} = (\text{sum of paging success}) / (\text{sum of paging success} + \text{sum of paging failure})$.

BRIEF DESCRIPTION OF DRAWINGS

[0029] The accompanying drawings, which are incorporated herein, and constitute a part of this disclosure, illustrate exemplary embodiments of the disclosed methods and systems which like reference numerals refer to the same parts throughout the different drawings. Components in the drawings are not necessarily to scale, emphasis instead being placed upon clearly illustrating the principles of the present disclosure. Some drawings may indicate the components using block diagrams and may not represent the internal circuitry of each component. It will be appreciated by those skilled in the art that disclosure of such drawings includes the disclosure of electrical components, electronic components, or circuitry commonly used to implement such components.

[0030] FIG. 1 illustrates an example network architecture for implementing a proposed system, in accordance with an embodiment of the present disclosure.

[0031] FIG. 2 illustrates an example block diagram of a proposed system (108), in accordance with an embodiment of the present disclosure.

[0032] FIG. 3 illustrates an example flow diagram for analyzing and troubleshooting paging failures, in accordance with an embodiment of the present disclosure.

[0033] FIG. 4 illustrates an example computer system in which or with which the embodiments of the present disclosure may be implemented.

[0034] FIG. 5 illustrates an exemplary flow diagram of a method for analyzing and troubleshooting paging failures, in accordance with an embodiment of the present disclosure.

[0035] The foregoing shall be more apparent from the following more detailed description of the disclosure.

LIST OF REFERENCE NUMERALS

- 100 – Network Architecture
- 102-1 – 102-N - Users
- 10 104-1 – 104-N - User Equipments (UEs)
- 106 – Network
- 108 – System
- 200 – Block diagram
- 202 – One or more processor(s)
- 15 204 – Memory
- 206 – Interface(s)
- 208 – Processing engine(s)
- 210 – Database
- 212 – Data parameter engine
- 20 300 – Flow diagram
- 400 – Computer system
- 410 – External storage device
- 420 – Bus
- 430 – Main memory
- 25 440 – Read-only memory
- 450 – Mass storage device
- 460 – Communication port(s)
- 470 – Processor

30

DETAILED DESCRIPTION

[0036] In the following description, for explanation, various specific details are outlined in order to provide a thorough understanding of embodiments of the present disclosure. It will be apparent, however, that embodiments of the present disclosure may be practiced without these specific details. Several features described hereafter can each be used independently of one another or with any combination of other features. An individual feature may not address all of the problems discussed above or might address only some of the problems discussed above. Some of the problems discussed above might not be fully addressed by any of the features described herein.

[0037] The ensuing description provides exemplary embodiments only and is not intended to limit the scope, applicability, or configuration of the disclosure. Rather, the ensuing description of the exemplary embodiments will provide those skilled in the art with an enabling description for implementing an exemplary embodiment. It should be understood that various changes may be made in the function and arrangement of elements without departing from the spirit and scope of the disclosure as set forth.

[0038] Specific details are given in the following description to provide a thorough understanding of the embodiments. However, it will be understood by one of ordinary skill in the art that the embodiments may be practiced without these specific details. For example, circuits, systems, networks, processes, and other components may be shown as components in block diagram form in order not to obscure the embodiments in unnecessary detail. In other instances, well-known circuits, processes, algorithms, structures, and techniques may be shown without unnecessary detail to avoid obscuring the embodiments.

[0039] Also, it is noted that individual embodiments may be described as a process that is depicted as a flowchart, a flow diagram, a data flow diagram, a structure diagram, or a block diagram. Although a flowchart may describe the operations as a sequential process, many of the operations can be performed in parallel or concurrently. In addition, the order of the operations may be re-arranged. A process is terminated when its operations are completed but could have additional

steps not included in a figure. A process may correspond to a method, a function, a procedure, a subroutine, a subprogram, etc. When a process corresponds to a function, its termination can correspond to a return of the function to the calling function or the main function.

5 [0040] The word “exemplary” and/or “demonstrative” is used herein to mean serving as an example, instance, or illustration. For the avoidance of doubt, the subject matter disclosed herein is not limited by such examples. In addition, any aspect or design described herein as “exemplary” and/or “demonstrative” is not necessarily to be construed as preferred or advantageous over other aspects or
10 designs, nor is it meant to preclude equivalent exemplary structures and techniques known to those of ordinary skill in the art. Furthermore, to the extent that the terms “includes,” “has,” “contains,” and other similar words are used in either the detailed description or the claims, such terms are intended to be inclusive like the term “comprising” as an open transition word without precluding any additional or other
15 elements.

[0041] Reference throughout this specification to “one embodiment” or “an embodiment” or “an instance” or “one instance” means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the present disclosure. Thus, the appearances of the
20 phrases “in one embodiment” or “in an embodiment” in various places throughout this specification are not necessarily all referring to the same embodiment. Furthermore, the particular features, structures, or characteristics may be combined in any suitable manner in one or more embodiments.

[0042] The terminology used herein is to describe particular embodiments
25 only and is not intended to be limiting the disclosure. As used herein, the singular forms “a”, “an”, and “the” are intended to include the plural forms as well, unless the context indicates otherwise. It will be further understood that the terms “comprises” and/or “comprising,” when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or
30 components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

As used herein, the term “and/or” includes any combinations of one or more of the associated listed items.

[0043] The various embodiments throughout the disclosure will be explained in more detail with reference to FIGs. 1- 5.

5 [0044] FIG. 1 illustrates an exemplary network architecture in which or with which a system (108) for managing a plurality of stale sessions in a wireless network is implemented, in accordance with embodiments of the present disclosure.

[0045] Referring to FIG. 1, the network architecture (100) includes one or more computing devices or user equipments (104-1, 104-2...104-N) associated with one or more users (102-1, 102-2...102-N) in an environment. A person of ordinary skill in the art will understand that one or more users (102-1, 102-2...102-N) may be individually referred to as the user (102) and collectively referred to as the users (102). Similarly, a person of ordinary skill in the art will understand that one or more user equipments (104-1, 104-2...104-N) may be individually referred to as the user equipment (104) and collectively referred to as the user equipment (104). A person of ordinary skill in the art will appreciate that the terms “computing device(s)” and “user equipment” may be used interchangeably throughout the disclosure. Although three user equipments (104) are depicted in FIG. 1, however any number of the user equipments (104) may be included without departing from the scope of the ongoing description.

[0046] In an embodiment, the user equipment (104) includes smart devices operating in a smart environment, for example, an Internet of Things (IoT) system. In such an embodiment, the user equipment (104) may include, but is not limited to, smart phones, smart watches, smart sensors (e.g., mechanical, thermal, electrical, magnetic, etc.), networked appliances, networked peripheral devices, networked lighting system, communication devices, networked vehicle accessories, networked vehicular devices, smart accessories, tablets, smart television (TV), computers, smart security system, smart home system, other devices for monitoring or interacting with or for the users (102) and/or entities, or any combination thereof.

30 A person of ordinary skill in the art will appreciate that the user equipment (104) may include, but is not limited to, intelligent, multi-sensing, network-connected

devices, that can integrate seamlessly with each other and/or with a central server or a cloud-computing system or any other device that is network-connected.

[0047] In an embodiment, the user equipment (104) includes, but is not limited to, a handheld wireless communication device (e.g., a mobile phone, a smart phone, a phablet device, and so on), a wearable computer device (e.g., a head-mounted display computer device, a head-mounted camera device, a wristwatch computer device, and so on), a Global Positioning System (GPS) device, a laptop computer, a tablet computer, or another type of portable computer, a media playing device, a portable gaming system, and/or any other type of computer device with wireless communication capabilities, and the like. In an embodiment, the user equipment (104) includes, but is not limited to, any electrical, electronic, electro-mechanical, or an equipment, or a combination of one or more of the above devices such as virtual reality (VR) devices, augmented reality (AR) devices, laptop, a general-purpose computer, desktop, personal digital assistant, tablet computer, mainframe computer, or any other computing device. The user equipment (104) may include one or more in-built or externally coupled accessories including, but not limited to, a visual aid device such as a camera, an audio aid, a microphone, a keyboard, and input devices for receiving input from the user (102), or the entity such as touch pad, touch enabled screen, electronic pen, and the like. A person of ordinary skill in the art will appreciate that the user equipment (104) may not be restricted to the mentioned devices and various other devices may be used.

[0048] Referring to FIG. 1, the user equipment (104) communicates with a system (108), for example, a state session management system, through a network (106). In an embodiment, the network (106) includes at least one of a Fifth Generation (5G) network, 6G network, or the like. The network (106) enables the user equipment (104) to communicate with other devices in the network architecture (100) and/or with the system (108). The network (106) includes a wireless card or some other transceiver connection to facilitate this communication. In another embodiment, the network (106) is implemented as, or include any of a variety of different communication technologies such as a wide area network (WAN), a local area network (LAN), a wireless network, a mobile network, a

Virtual Private Network (VPN), the Internet, the Public Switched Telephone Network (PSTN), or the like.

[0049] Referring to FIG. 1, the network architecture (100) may include the user equipment (UE) (104), the network (106) and the system (108). The UE (104)
5 may be communicatively coupled with the network (106). The communicatively coupling comprises of receiving, from the UE (104), a connection request by the network (106), sending an acknowledgment of the connection request, and transmitting a plurality of signals in response to the connection request.

[0050] In another exemplary embodiment, the system (108) includes or
10 comprise, by way of example but not limitation, one or more of: a stand-alone server, a server blade, a server rack, a bank of servers, a server farm, hardware supporting a part of a cloud service or system, a home server, hardware running a virtualized server, one or more processors executing code to function as a server, one or more machines performing server-side functionality as described herein, at
15 least a portion of any of the above, some combination thereof.

[0051] In an embodiment, the system (108) may receive one or more inputs
from the one or more computing devices (104) associated with the one or more users (104). The one or more inputs may be based on combined logs (CLOGS) data and LSR trace data associated with the one or more computing devices. The CLOG
20 data may include international mobile subscriber identity (IMSI), cell identifier (ID), paging attempts, and success information and the LSR trace data may include IMSI, cell data, radio frequency (RF) data, and location information for Voice over LTE (VoLTE) calls.

[0052] In an embodiment, the system (108) may combine the CLOG data
25 and the LSR data to determine an aggregated paging success rate at IMSI and cell levels. In examples, the system (108) obtaining tracing logs from RAN and event logs from core network elements such as the user equipment movement configuration in 4G, 5G or beyond. Further, exemplary metrics such as paging attempts and paging responses are analyzed. The system (108) processes the logs
30 to extract information such as timestamps, paging message identifiers, and success and failure indicators. The system (108) may filter out irrelevant log entries and

correlate the paging attempts with their corresponding responses and ensuring that each paging attempt from the core is matched with the response (or lack thereof) in the RAN. Further, the aggregated paging success rate is determined at least based on the matching and other calculating factors.

5 [0053] In an embodiment, the system (108) may identify rogue computing devices impacting paging performance based on the combined data.

[0054] In an embodiment, the system (108) may conduct analysis to determine the cause of paging failures.

10 [0055] In an embodiment, the system (108) may analyze handset issues and mobility management entity configuration issues and paging strategy to identify factors affecting paging performance.

[0056] In an embodiment, the system (108) may arrange the combined data and determine a record from the RAN occurring before the paging failure from CLOG.

15 [0057] In an embodiment, the system (108) may count the number of records where paging fails in the CLOG data having corresponding records in the RAN trace data.

[0058] In an embodiment, the system (108) may associate the paging failures with the “End Cell” of the last RAN trace record for the same IMSI.

20 [0059] In an embodiment, the system (108) may check the RAN trace log for mobile terminated access (“MT Access”) in establishment cause and verify that VoLTE evolved radio access bearer (eRAB) attempts are not blank for all successful paging attempts associated with an IMSI. In aspects, the MT Access in establishment cause may indicate paging attempt towards the UE/Subscriber.
25 Furthermore, the eRAB attempts are not blank points to voice calls since missing paging is experienced by user in voice calls.

[0060] Although FIG. 1 shows exemplary components of the network architecture (100), in other embodiments, the network architecture (100) may include fewer components, different components, differently arranged components,
30 or additional functional components than depicted in FIG. 1. Additionally, or alternatively, one or more components of the network architecture (100) may

perform functions described as being performed by one or more other components of the network architecture (100).

[0061] FIG. 2 illustrates an example block diagram (200) of a system (108), in accordance with an embodiment of the present disclosure. The system (108) is designed to correlate CLOG and radio access network (RAN) trace logs to enhance paging performance and troubleshoot failures within a telecommunications network.

[0062] The system (108) may include one or more processor(s) (202). The one or more processor(s) (202) may be implemented as one or more microprocessors, microcomputers, microcontrollers, digital signal processors, central processing units, logic circuitries, and/or any devices that process data based on operational instructions. Among other capabilities, the one or more processor(s) (202) may be configured to fetch and execute computer-readable instructions stored in a memory (204) of the system (108).

[0063] The memory (204) may be configured to store one or more computer-readable instructions or routines in a non-transitory computer-readable storage medium, which may be fetched and executed to create or share data packets over a network service. The memory (204) may comprise any non-transitory storage device including, for example, volatile memory such as random-access memory (RAM), or non-volatile memory such as erasable programmable read-only memory (EPROM), flash memory, and the like.

[0064] In an embodiment, the system (108) may include an interface(s) (206). The interface(s) (206) may comprise a variety of interfaces, for example, interfaces for data input and output devices (I/O), storage devices, and the like. The interface(s) (206) may facilitate communication through the system (108). The interface(s) (206) may also provide a communication pathway for one or more components of the system (108). Examples of such components include, but are not limited to, processing engine(s) (208) and a database (210).

[0065] Further, the processing engine(s) (208) may include a data parameter engine (212) and other engine(s). In an embodiment, the other engine(s) may

include, but are not limited to, a data ingestion engine, an input/output engine, and a notification engine.

[0066] The processing engine(s) (208) may be implemented as a combination of hardware and programming (for example, programmable instructions) to implement one or more functionalities of the processing engine(s) (208). Such combinations of hardware and programming may be implemented in several different ways. For example, the programming for the processing engine(s) (208) may be processor-executable instructions stored on a non-transitory machine-readable storage medium and the hardware for the processing engine(s) (208) may comprise a processing resource (for example, one or more processors) to execute such instructions.

[0067] In some examples, the machine-readable storage medium may store instructions that, when executed by the processing resource, implement the processing engine(s) (208). In such examples, the system may comprise the machine-readable storage medium storing the instructions and the processing resource to execute the instructions, or the machine-readable storage medium may be separate but accessible to the system and the processing resource. In other examples, the processing engine(s) (208) may be implemented by electronic circuitry.

[0068] In an embodiment, the processor (202) may receive one or more inputs via the data parameter engine (212). The one or more inputs may be received from the one or more computing devices (104) associated with the one or more users (104). The one or more inputs may be based on combined logs (CLOG) data and LSR trace data associated with the one or more computing devices. The CLOG data may include IMSI, cell ID, paging attempts, and success information, and the LSR trace data may include IMSI, cell data, RF data, and location information for Voice over LTE (VoLTE) calls.

[0069] In an embodiment, the processor (202) may combine the CLOG data and the LSR data to determine paging success rate at IMSI and cell levels. Combination of this data allows the processor (202) to provide a comprehensive view of paging performance and identify areas needing improvement.

[0070] In an embodiment, the processor (202) may identify rogue computing devices impacting paging performance based on the combined data. By evaluating the combined CLOG data and LSR data, the system (108) can pinpoint specific devices that contribute to paging failures or inefficiencies.

5 [0071] In an embodiment, the processor (202) may conduct analysis to determine the cause of paging failures. This involves examining the combined data to identify patterns or anomalies indicating underlying issues affecting paging success.

[0072] In an embodiment, the processor (202) may analyse handset issues
10 and user equipment movement configuration issues and paging strategy to identify factors affecting paging performance. This analysis helps in understanding the broader issues beyond individual device problems that impact overall paging efficiency.

[0073] In an embodiment, the processor (202) may arrange the combined
15 data and determine a record from the RAN trace occurring before the paging failure from the CLOG. When a record from RAN trace is within a configurable time interval (+/- X seconds) before or after a paging fail record from the CLOG, the system assumes that the location of the one or more computing devices (104) (IMSI) is the same during paging fail and during the LSR record.

20 [0074] In an embodiment, the processor (202) may count the number of records where paging failures in the CLOG data have corresponding records in the RAN trace data. The processor (202) may associate the paging failures with the “End Cell” of the last RAN trace record for the same IMSI through a root cause analysis (RCA).

25 [0075] In an embodiment, the processor (202) may check the RAN trace log for “MT Access” in establishment cause and verify that VoLTE eRAB attempts are not blank for all successful paging attempts associated with an IMSI.

[0076] Although FIG. 2 shows exemplary components of the system (108),
30 in other embodiments, the system (108) may include fewer components, different components, differently arranged components, or additional functional components than depicted in FIG. 2. Additionally, or alternatively, one or more components of

the system (108) may perform functions described as being performed by one or more other components of the system (108).

[0077] FIG. 3 illustrates an example flow diagram (300) for analyzing and troubleshooting paging failures, in accordance with an embodiment of the present disclosure. The system (108) is designed to correlate CLOG (302) and radio access network (RAN) trace data (304) logs to enhance paging performance and troubleshoot failures within a telecommunications network.

[0078] As illustrated in FIG. 3, the following steps may be implemented by the system (108) for analyzing and troubleshooting paging failures:

10 [0079] In an embodiment, the system (108) receives the CLOG data (302) and the RAN trace data (304). The CLOG data (302) includes IMSI, cell ID, paging attempts, and success records. The RAN trace data (304) includes IMSI, cell data, radio frequency (RF) data, and location information specifically for VoLTE calls.

15 [0080] In an embodiment, the system (108) combines the CLOG data (302) and RAN trace data (304) to determine paging success rates at IMSI and cell levels at step (306). The combined data allows the system (108) to analyze and correlate the information from both sources to provide a comprehensive view of paging performance.

20 [0081] In an embodiment, the system (108) identifies rogue computing devices impacting paging performance based on the combined data. By evaluating the combined CLOG data (302) and the RAN trace data (304), the system (108) can pinpoint specific devices that are contributing to paging failures or inefficiencies.

25 [0082] In an embodiment, the system (108) conducts analysis to determine the root cause of paging failures at step (308). This involves examining the combined data to identify patterns or anomalies that may indicate underlying issues affecting paging success.

30 [0083] In an embodiment, the system (108) arranges the combined data to determine a record from the RAN trace (304) occurring before the paging failure from the CLOG data (302). When a record from RAN trace (304) is within a configurable time interval (+/- X seconds) before or after a paging fail record from the CLOG (302), the system (108) assumes that the location of the one or more

computing devices (104) (IMSI) during paging fail is same as during the LSR record.

[0084] In an embodiment, the system (108) counts the number of records where paging failures in the CLOG data (302) have corresponding records in the RAN trace data (304) and associates the paging failures with the “End Cell” of the last RAN trace record for the same IMSI through the RCA (308).

[0085] In an embodiment, the system (108) checks the RAN trace log (304) for “MT Access” in establishment cause and verifies that VoLTE eRAB attempts are not blank for all successful paging attempts associated with an IMSI (306).

[0086] In an embodiment, the IMSI paging success rate and cell paging success rate are calculated using the formulas: IMSI paging success rate = (sum of paging success) / (sum of paging success + sum of paging failure) and cell paging success rate = (sum of paging success) / (sum of paging success + sum of paging failure).

[0087] In an embodiment, by combining the CLOG data (302) and RAN trace data (304), the system (108) determines paging success rates at IMSI and cell levels. This combined data helps to identify rogue computing devices impacting paging performance and allows the system to conduct analysis to determine the cause of paging failures (308).

[0088] The system (108) also identifies various factors impacting paging performance, including handset issues, cell RF issues, user equipment movement configuration issues, and paging strategy (310).

[0089] In an exemplary embodiment, the present invention discloses a method for analyzing and troubleshooting paging failures in a telecommunications network. The method comprising receiving a CLOG data and a radio access network (RAN) trace data. The method comprising combining the CLOG data and the RAN trace data to determine an aggregated paging success rate. The method comprising analysing the combined CLOG data and the RAN trace data. The method comprising identifying at least one or more failures based on the analysis of the combined CLOG data and RAN trace data.

[0090] In an embodiment, the CLOG data includes an international mobile subscriber identity (IMSI), a cell ID, paging attempts, and success records. In aspects, the CLOG data is associated with corresponding UE or subscriber.

5 [0091] In an embodiment, the RAN trace data includes an international mobile subscriber identity (IMSI), cell data, radio frequency (RF) data, and location information.

[0092] In an embodiment, the aggregated paging success rate is determined for an international mobile subscriber identity (IMSI) or a cell.

10 [0093] In an embodiment, a user equipment (UE) is communicatively coupled with a network, the coupling comprises steps of (i) receiving, by the network, a connection request from the UE, (ii) sending, by the network, an acknowledgment of the connection request to the UE, and (iii) transmitting a plurality of signals in response to the connection request.

15 [0094] In an exemplary embodiment, the present invention discloses a system for analyzing and troubleshooting paging failures in a telecommunications network. The system comprising one or more processors and a memory configured to store instructions that, when executed by one or more processors, cause the system to: (i) receive a CLOG data and a radio access network (RAN) trace data, (ii) combine the CLOG data and the RAN trace data to determine an aggregated
20 paging success rate, (iii) analyse the combined CLOG data and RAN trace data, and (iv) identify at least one or more failures based on the analysis of the combined CLOG data and RAN trace data.

[0095] In an embodiment, the CLOG data includes an international mobile subscriber identity (IMSI), a cell ID, paging attempts, and success records.

25 [0096] In an embodiment, the RAN trace data includes an international mobile subscriber identity (IMSI), cell data, radio frequency (RF) data, and location information.

[0097] In an embodiment, the aggregated paging success rate is determined for an international mobile subscriber identity (IMSI) or a cell.

30 [0098] In an embodiment, the aggregated paging success rate indicates a performance of the telecommunications network.

[0099] In an embodiment, identified one or more failures are indicative of an issue that is selected from a group comprising of an issue with a user equipment (UE), an issue with a cell radio frequency (RF), and an issue with a user equipment movement configuration.

5 [00100] In an embodiment, the analyzed combined CLOG data and RAN trace data, and the aggregated paging success rate provide a paging strategy to improve a user experience. In examples, the paging strategy may provide information on issue related to current paging strategy and solutions to rectify the issues.

10 [00101] In an embodiment, the one or more processors are further configured to calculate an international mobile subscriber identity (IMSI) level paging success rate using a formula: $\text{IMSI paging success rate} = (\text{sum of paging success}) / (\text{sum of paging success} + \text{sum of paging failure})$.

[00102] In an embodiment, the one or more processors are further configured
15 to calculate a cell paging success rate using a formula: $\text{cell paging success rate} = (\text{sum of paging success}) / (\text{sum of paging success} + \text{sum of paging failure})$.

[00103] FIG. 4 illustrates an example computer system (400) in which or with which the embodiments of the present disclosure may be implemented.

[00104] As shown in FIG. 4, the computer system (400) may include an
20 external storage device (410), a bus (420), a main memory (430), a read-only memory (440), a mass storage device (450), a communication port(s) (460), and a processor (470). A person skilled in the art will appreciate that the computer system (400) may include more than one processor and communication ports. The processor (470) may include various modules associated with embodiments of the
25 present disclosure. The communication port(s) (460) may be any of an RS-232 port for use with a modem-based dialup connection, a 10/100 Ethernet port, a Gigabit or 10 Gigabit port using copper or fiber, a serial port, a parallel port, or other existing or future ports. The communication ports(s) (460) may be chosen
30 depending on a network, such as a Local Area Network (LAN), Wide Area Network (WAN), or any network to which the computer system (400) connects.

[00105] In an embodiment, the main memory (430) may be Random Access Memory (RAM), or any other dynamic storage device commonly known in the art. The read-only memory (440) may be any static storage device(s) e.g., but not limited to, a Programmable Read Only Memory (PROM) chip for storing static
5 information e.g., start-up or basic input/output system (BIOS) instructions for the processor (470). The mass storage device (450) may be any current or future mass storage solution, which can be used to store information and/or instructions. Exemplary mass storage solutions include, but are not limited to, Parallel Advanced Technology Attachment (PATA) or Serial Advanced Technology Attachment
10 (SATA) hard disk drives or solid-state drives (internal or external, e.g., having Universal Serial Bus (USB) and/or Firewire interfaces).

[00106] In an embodiment, the bus (420) may communicatively couple the processor(s) (470) with the other memory, storage, and communication blocks. The bus (420) may be, e.g. a Peripheral Component Interconnect PCI / PCI Extended
15 (PCI-X) bus, Small Computer System Interface (SCSI), Universal Serial Bus (USB), or the like, for connecting expansion cards, drives, and other subsystems as well as other buses, such a front side bus (FSB), which connects the processor (470) to the computer system (400).

[00107] In another embodiment, operator and administrative interfaces, e.g.,
20 a display, keyboard, and cursor control device may also be coupled to the bus (420) to support direct operator interaction with the computer system (400). Other operator and administrative interfaces can be provided through network connections connected through the communication port(s) (460). Components described above are meant only to exemplify various possibilities. In no way should
25 the aforementioned exemplary computer system (400) limit the scope of the present disclosure.

[00108] FIG. 5 illustrates an exemplary flow diagram of a method for analyzing and troubleshooting paging failures, in accordance with an embodiment of the present disclosure.

30 [00109] At step (502), the method receives a CLOG data (302) and a radio access network (RAN) trace data (304).

[00110] At step (504), the method combines the CLOG data (302) and the RAN trace data (304) to determine an aggregated paging success rate.

[00111] At step (506), the method analyses the combined CLOG data (302) and the RAN trace data (304).

5 [00112] At step (508), the method identifies at least one or more failures based on the analysis of the combined CLOG data (302) and the RAN trace data (304).

[00113] While considerable emphasis has been placed herein on the preferred embodiments, it will be appreciated that many embodiments can be made and that
10 many changes can be made in the preferred embodiments without departing from the principles of the disclosure. These and other changes in the preferred embodiments of the disclosure will be apparent to those skilled in the art from the disclosure herein, whereby it is to be distinctly understood that the foregoing descriptive matter is to be implemented merely as illustrative of the disclosure and
15 not as a limitation.

ADVANTAGES OF THE INVENTION

[00114] The present disclosure provides a system and a method for analyzing and troubleshooting paging failures that allows combing of IMSI and cell-level data
20 from both CLOG and LSR trace data enabling granular analysis of paging success rates and effectiveness and providing insights into specific IMSIs and cells that may be experiencing issues.

[00115] The present disclosure provides a system and a method for analyzing and troubleshooting paging failures that combine the CLOG and the LSR trace data
25 for identification of rogue user devices exhibiting abnormal behavior or unauthorized activity within the network.

[00116] The present disclosure provides a system and a method for analyzing and troubleshooting paging failures that analyzes the combined data for allowing
30 network operators to uncover problems specific to individual cells, such as RF issues or configuration problems, and address them promptly.

[00117] The present disclosure provides a system and a method for analyzing and troubleshooting paging failures that conducts an analysis to determine the underlying causes of paging failures.

5 [00118] The present disclosure provides a system and a method for analyzing and troubleshooting paging failures that utilizes a temporal relationship between RAN trace records and paging failure records to assume the location of the UE during paging failures. This helps narrow down the potential problem areas and facilitates targeted troubleshooting.

CLAIMS

WE CLAIM:

- 5 1. A system (108) for analyzing and troubleshooting paging failures in a telecommunications network, said system (108) comprising:
one or more processors (202);
a memory (204) configured to store instructions that, when executed
by the one or more processors (202), cause the system (108) to:
- 10 receive a core log (CLOG) data (302) and a radio access network (RAN) trace data (304);
combine the CLOG data (302) and the RAN trace data (304)
to determine an aggregated paging success rate;
analyse the combined CLOG data (302) and RAN trace data
15 (304); and
identify at least one or more failures based on the analysis of
the combined CLOG data (302) and the RAN trace data (304).
2. The system (108) as claimed in claim 1, wherein the CLOG data (302)
20 includes an international mobile subscriber identity (IMSI), a cell ID,
paging attempts, and success records associated with a subscriber.
3. The system (108) as claimed in claim 1, wherein the RAN trace data (304)
includes an international mobile subscriber identity (IMSI), cell data, radio
frequency (RF) data, and location information.
- 25 4. The system (108) as claimed in claim 1, wherein the aggregated paging
success rate is determined for an international mobile subscriber identity
(IMSI) or a cell.
5. The system (108) as claimed in claim 1, wherein the aggregated paging
success rate indicates a performance of the telecommunications network.

6. The system (108) as claimed in claim 1, wherein the identified one or more failures are indicative of an issue that is selected from a group comprising of an issue with a user equipment (UE), an issue with a cell radio frequency (RF), and an issue with a user equipment movement configuration.
- 5 7. The system (108) as claimed in claim 1, wherein the analyzed combined CLOG data (302) and RAN trace data (304), and the aggregated paging success rate provide a paging strategy to enhance a user experience.
8. The system (108) as claimed in claim 1, wherein the one or more processors (202) are further configured to calculate an international mobile subscriber identity (IMSI) level paging success rate using a formula: IMSI paging success rate = (sum of paging success) / (sum of paging success + sum of paging failure).
- 10
9. The system (108) as claimed in claim 1, wherein the one or more processors (202) are further configured to calculate a cell paging success rate using a formula: the cell paging success rate = (sum of paging success) / (sum of paging success + sum of paging failure).
- 15
10. A method (500) for analyzing and troubleshooting paging failures in a telecommunications network, said method (500) comprising:
- receiving (502) a core log (CLOG) data (302) and a radio access network (RAN) trace data (304);
- 20 combining (504) the CLOG data (302) and the RAN trace data (304) to determine an aggregated paging success rate;
- analysing (506) the combined CLOG data (302) and the RAN trace data (304); and
- 25 identifying (508) at least one or more failures based on the analysis of the combined CLOG data (302) and the RAN trace data (304).

11. The method (500) as claimed in claim 10, wherein the CLOG data (302) includes an international mobile subscriber identity (IMSI), a cell ID, paging attempts, and success records associated with a subscriber.
12. The method (500) as claimed in claim 10, wherein the RAN trace data (304) includes an international mobile subscriber identity (IMSI), cell data, radio frequency (RF) data, and location information.
13. The method (500) as claimed in claim 10, wherein the aggregated paging success rate is determined for an international mobile subscriber identity (IMSI) or a cell.
14. A user equipment (UE) (104) communicatively coupled with a network (106), the coupling comprises steps of:
receiving, by the network (106), a connection request from the UE (104);
sending, by the network (106), an acknowledgment of the connection request to the UE (104); and
transmitting a plurality of signals in response to the connection request, wherein analyzing and troubleshooting paging failures in the telecommunications network is performed by a method as claimed in claim 10.
15. A computer program product comprising a non-transitory computer-readable medium comprising instructions that, when executed by one or more processors, cause the one or more processors to
16. A method (500) for analyzing and troubleshooting paging failures in a telecommunications network, said method (500) comprising:
receiving (502) a core log (CLOG) data (302) and a radio access network (RAN) trace data (304);
combining (504) the CLOG data (302) and the RAN trace data (304) to determine an aggregated paging success rate;

analysing (506) the combined CLOG data (302) and the RAN trace data (304); and

identifying (508) at least one or more failures based on the analysis of the combined CLOG data (302) and the RAN trace data (304).

5

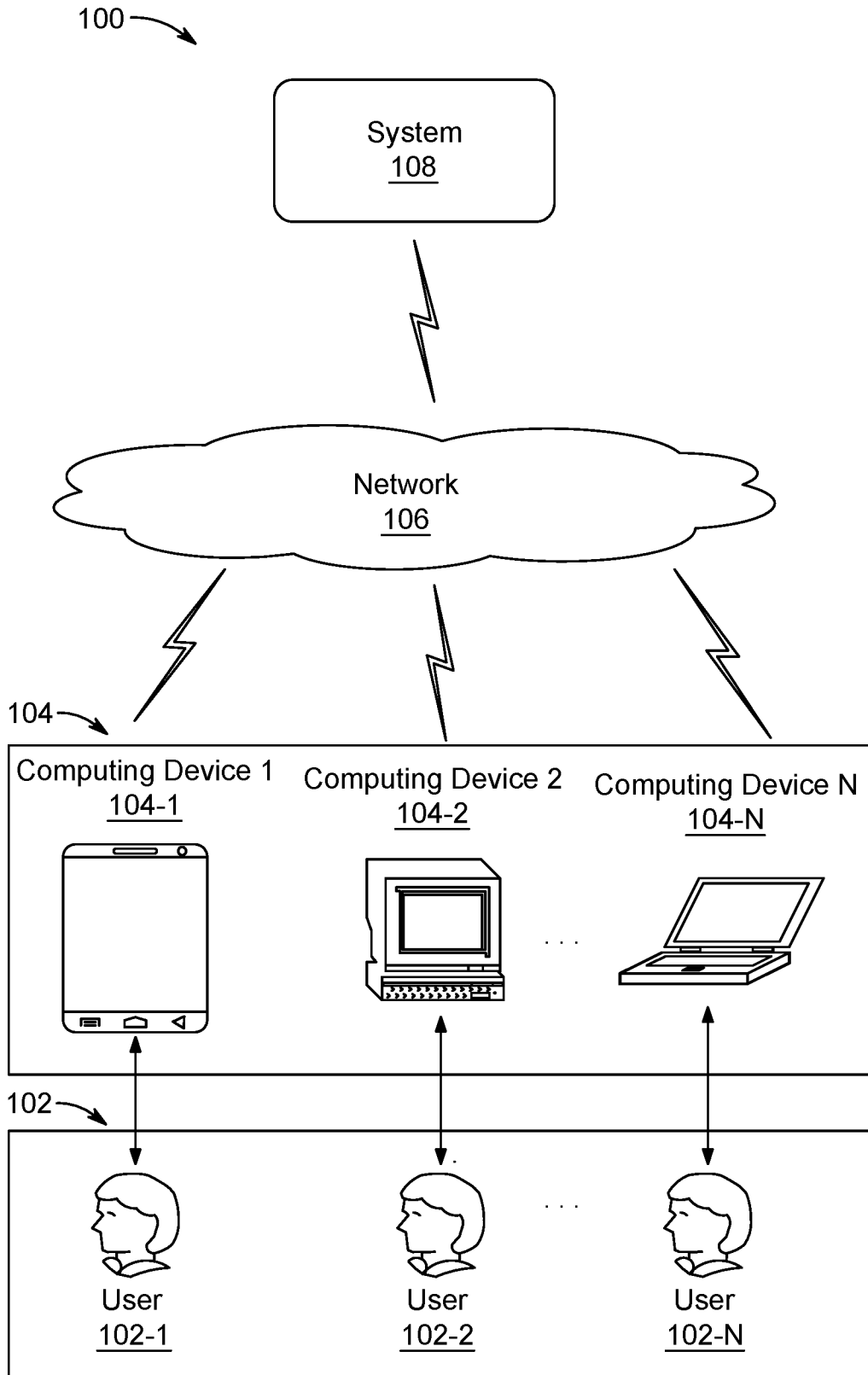


FIG. 1

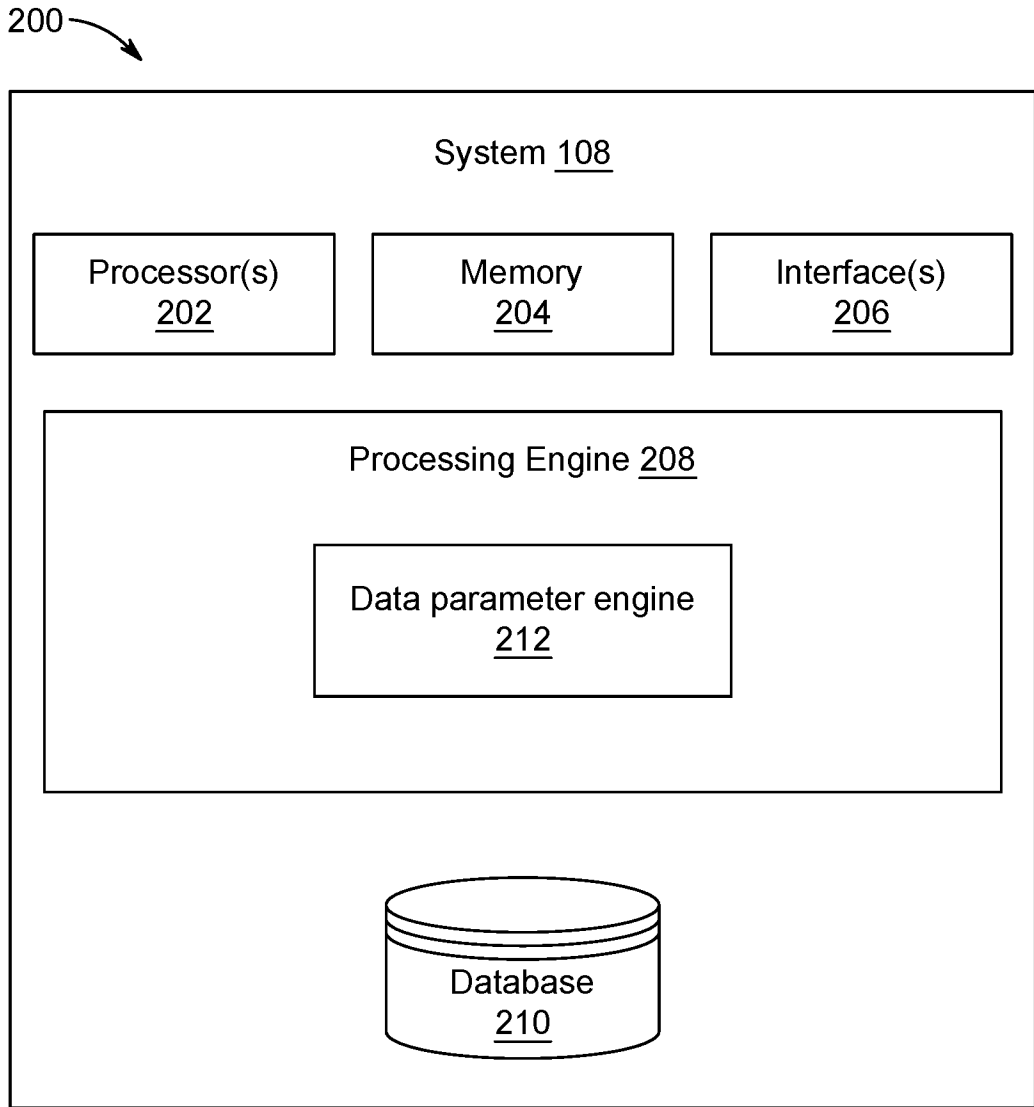


FIG. 2

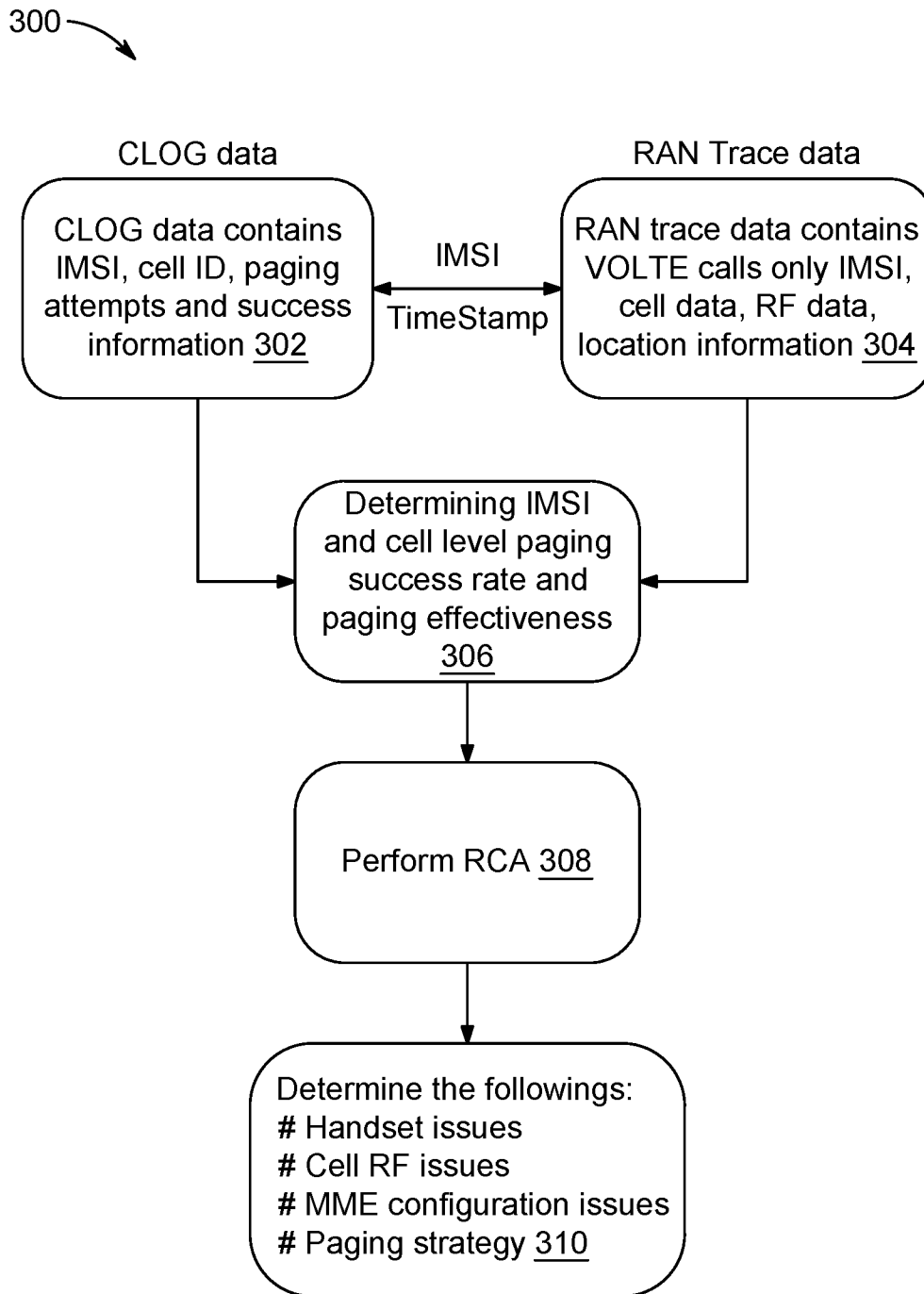


FIG. 3

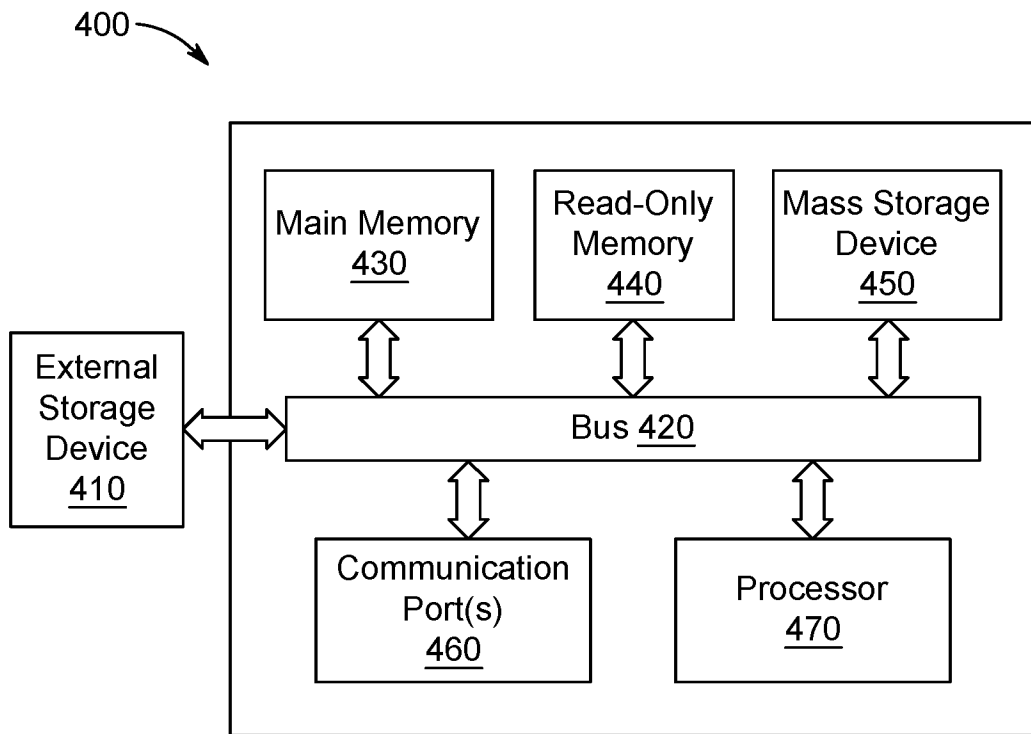


FIG. 4

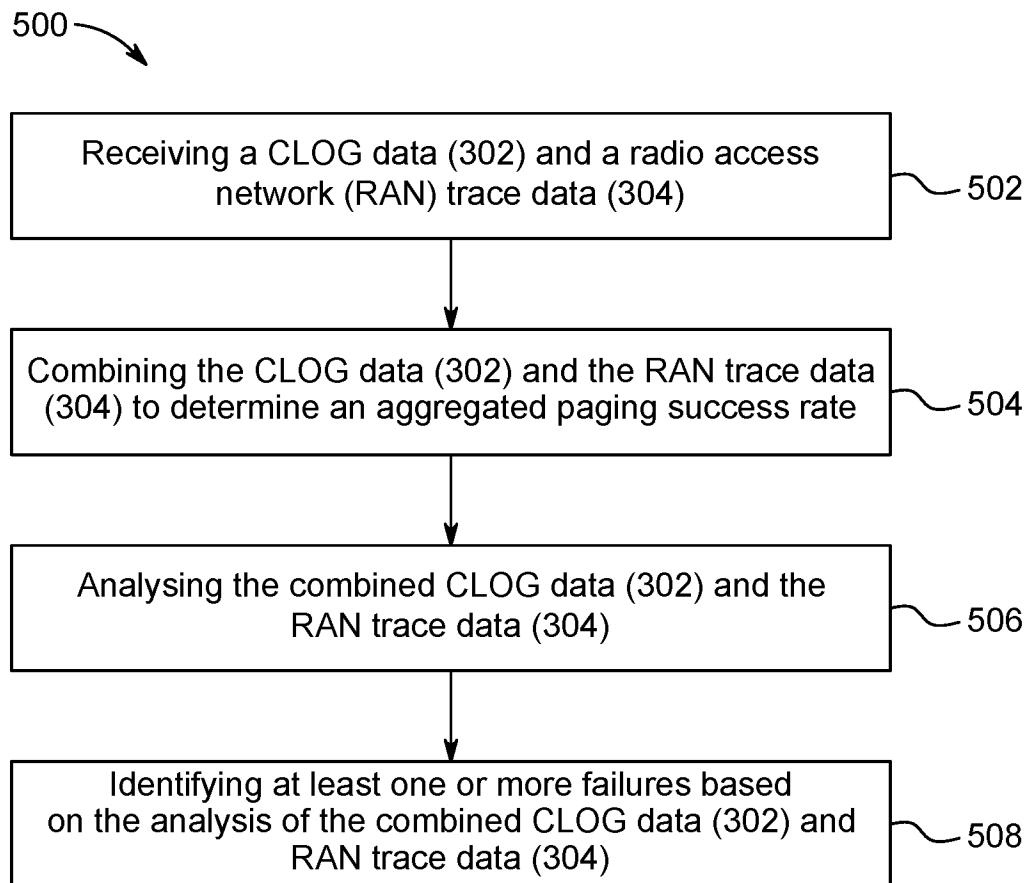


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IN2024/050675

A. CLASSIFICATION OF SUBJECT MATTER H04W68/02, H04L43/04, H04L43/08, H04L41/50, G06F17/40 Version=2024.01		
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, H04L, G06F		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic database consulted during the international search (name of database and, where practicable, search terms used) PatSeer, IPO Internal Database		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US20230119167A1 (ZTE CORPORATION) 20 APRIL 2023 (20/04/2023) Abstract, Paragraph [0004], [0005], [0020], [0028], [0031], [0149]	1-16
Y	US20210144675A1 (LENOVO BEIJING LTD.) 13 MAY 2021 (13/05/2021) Abstract, Paragraph [0054]	1-16
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "D" document cited by the applicant in the international application "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "I" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 20-09-2024		Date of mailing of the international search report 20-09-2024
Name and mailing address of the ISA/ Indian Patent Office Plot No.32, Sector 14, Dwarka, New Delhi-110075 Facsimile No.		Authorized officer Md Shahnawaz Alam Telephone No. +91-1125300200

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IN2024/050675

Citation	Pub.Date	Family	Pub.Date
US 20230119167 A1	20-04-2023	CN 116600385 A	15-08-2023
		CN 115812330 A	17-03-2023
		EP 4140210 A1	01-03-2023
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