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(54) Abstract Title: **Network element and method for routing data in a data communication system**

(57) A network element (310) supports packet switched (PS) data communication over a data communication system (300) comprising a cellular communication network operably coupled to the Internet (330) . The network element (310) comprises packet inspection logic (313) arranged to inspect received PS data packets that are being routed through the network element (310) and extract a first portion of PS data packets. The network element (310) further comprises routing logic (312), operably coupled to the packet inspection logic (313), for routing the first portion of PS data packets to a destination node directly over the Internet (330) and routing a remaining portion of PS data packets of the received PS data packets over the cellular communication network based on the packet inspection. In this manner, PS data may be selectively routed direct to a destination node, say directly over the Internet, or via the cellular communication network.

FIG. 3

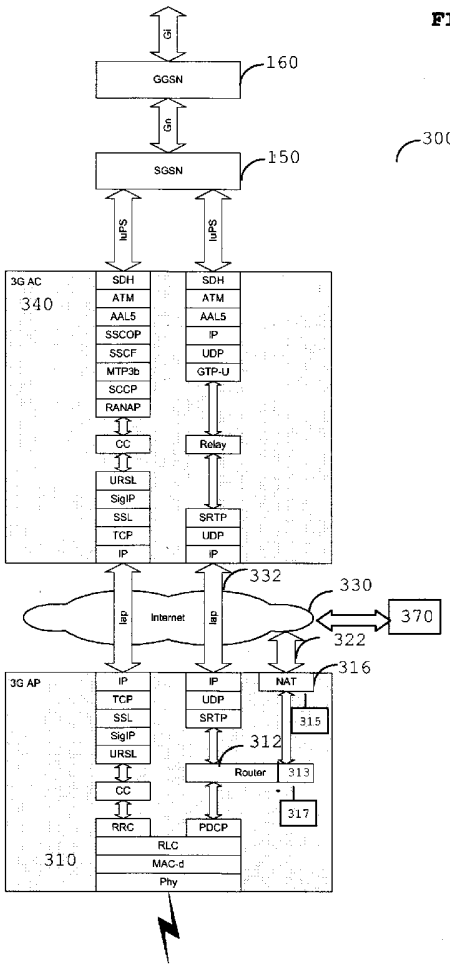

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FIG. 1 -
PRIOR ART

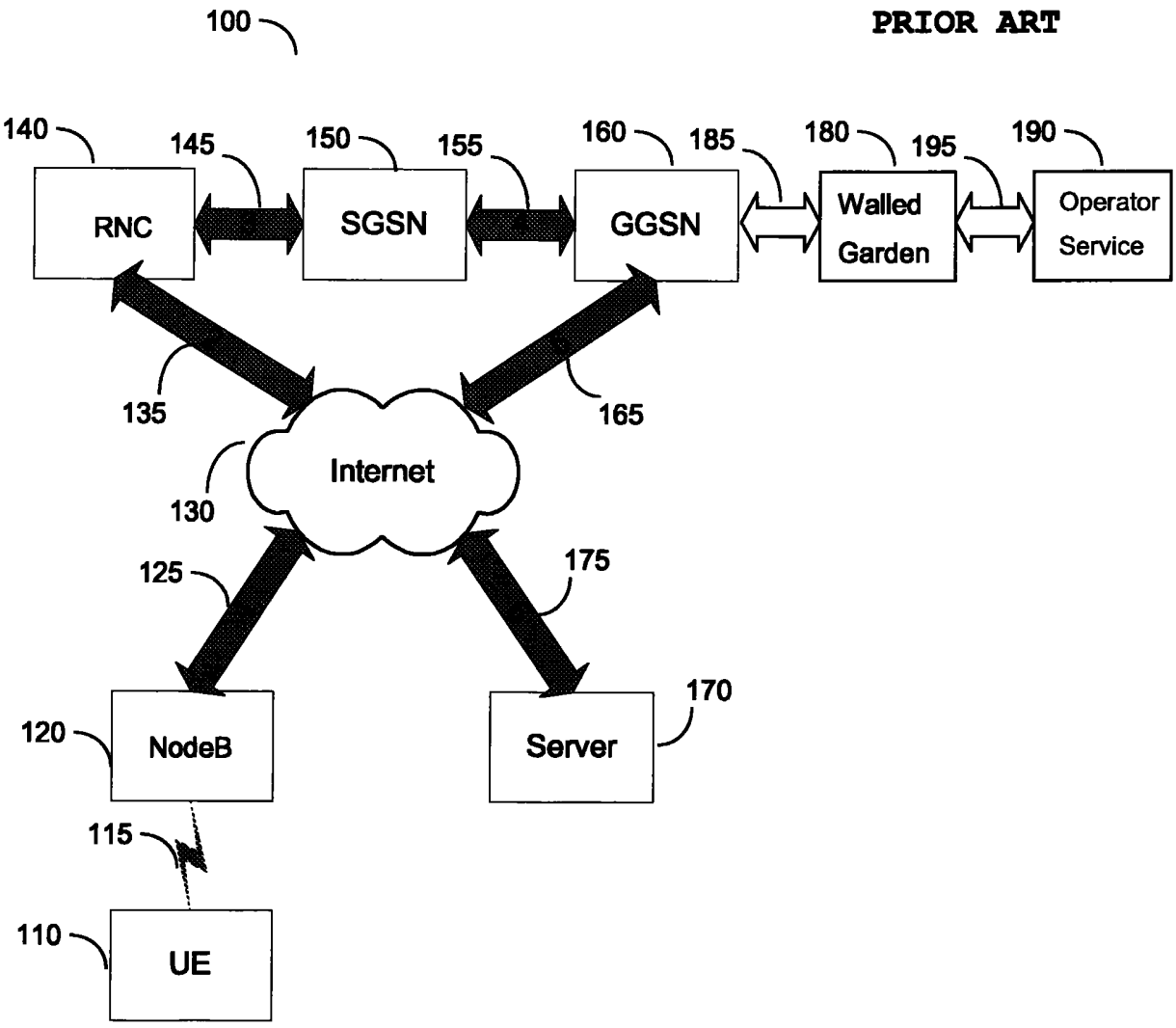


FIG. 2 – PRIOR ART

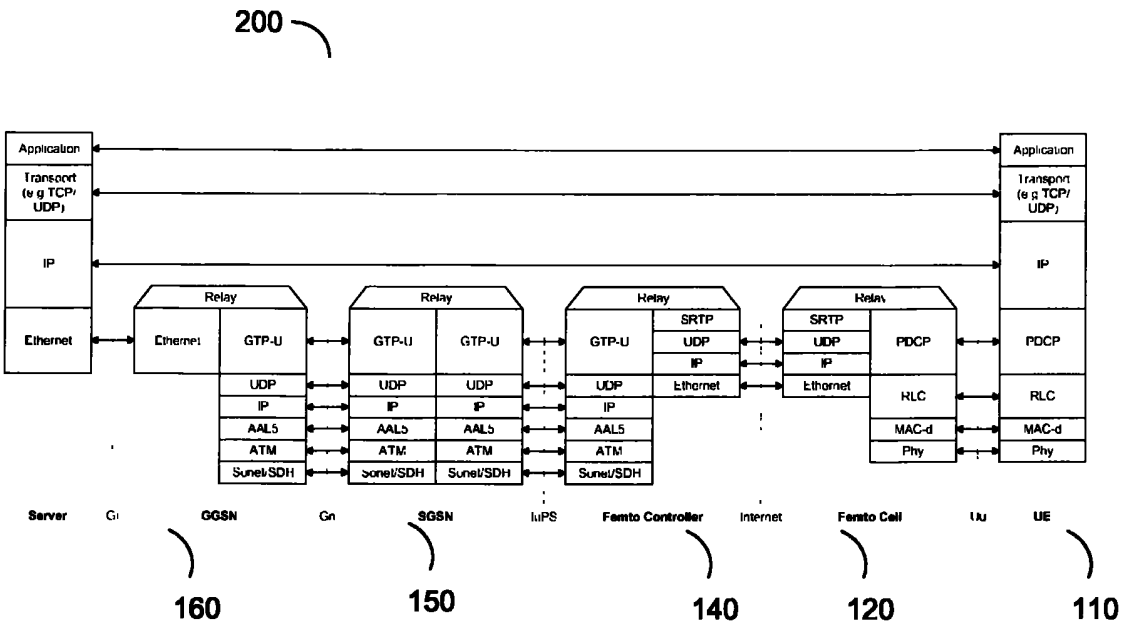


FIG. 3

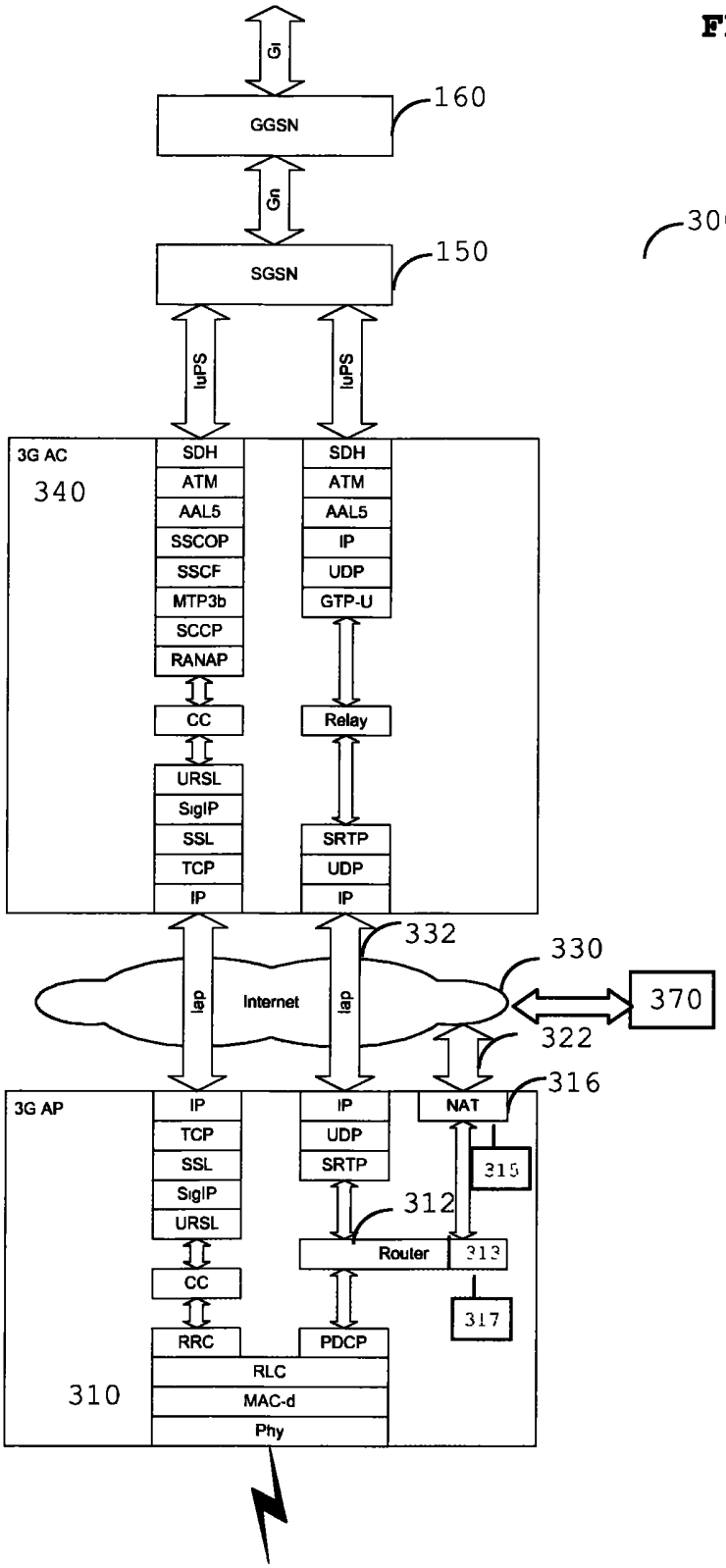

Gi
GGSN
160
Gn
SGSN
150
300
IuPS
IuPS
3G AC
340
SDH
ATM
AAL5
SSCOP
SSCF
MTP3b
SCCP
RANAP
CC
URSL
SigIP
SSL
TCP
IP
SDH
ATM
AAL5
IP
UDP
GTP-U
Relay
SRTP
UDP
IP
332
330
Iap
Internet
Iap
370
322
316
3G AP
IP
TCP
SSL
SigIP
URSL
CC
RRC
IP
UDP
SRTP
NAT
315
312
Router
313
317
PDCP
RLC
MAC-d
Phy
310

FIG. 4

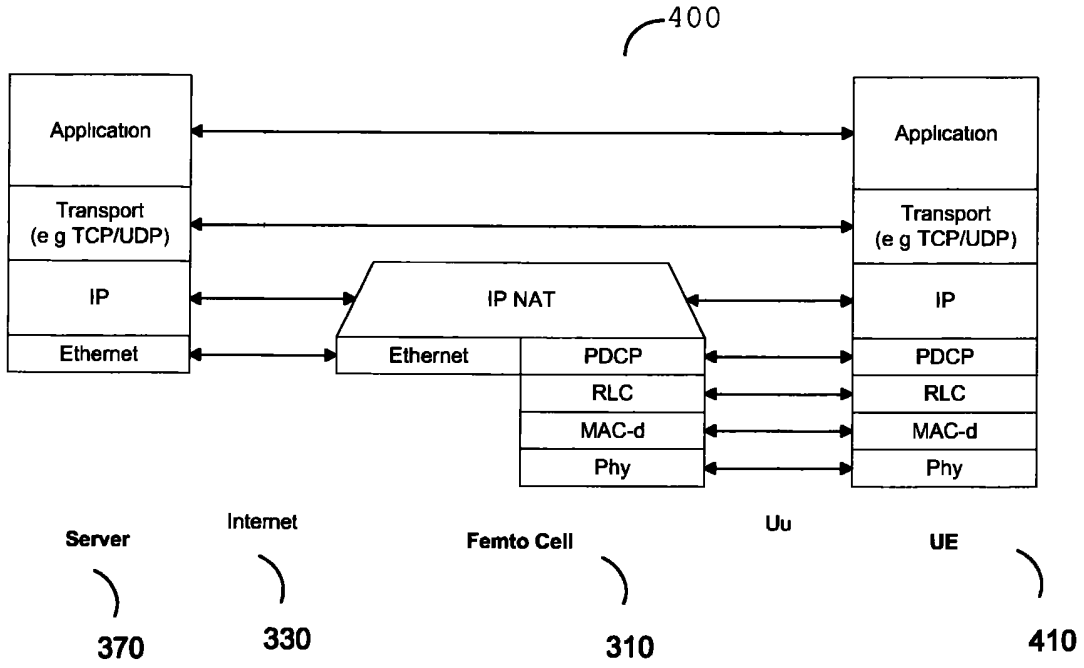

400
Application
Transport
(e g TCP/UDP)
IP
Ethernet
IP NAT
Ethernet
PDCP
RLC
MAC-d
Phy
Application
Transport
(e g TCP/UDP)
IP
PDCP
RLC
MAC-d
Phy
Server
Internet
Femto Cell
Uu
UE
370
330
310
410

FIG. 5

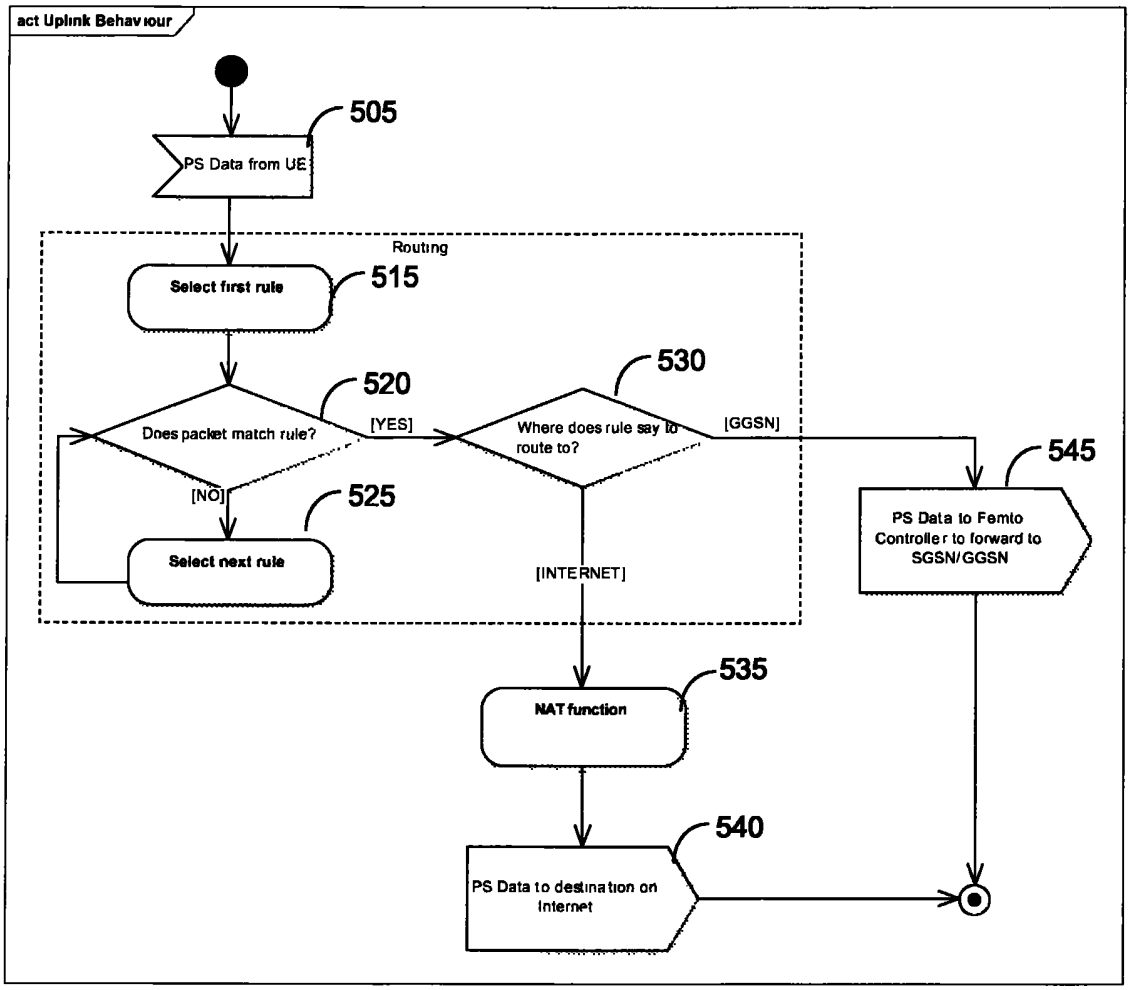

500
act Uplink Behaviour
505
PS Data from UE
Routing
Select first rule
515
520
Does packet match rule?
[YES]
530
Where does rule say to route to?
[GGSN]
545
PS Data to Femto Controller to forward to SGSN/GGSN
[NO]
525
Select next rule
[INTERNET]
535
NAT function
540
PS Data to destination on Internet

FIG. 6

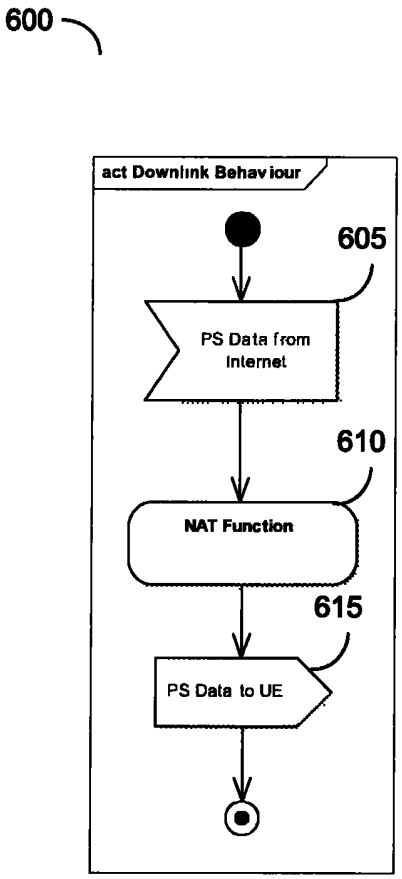
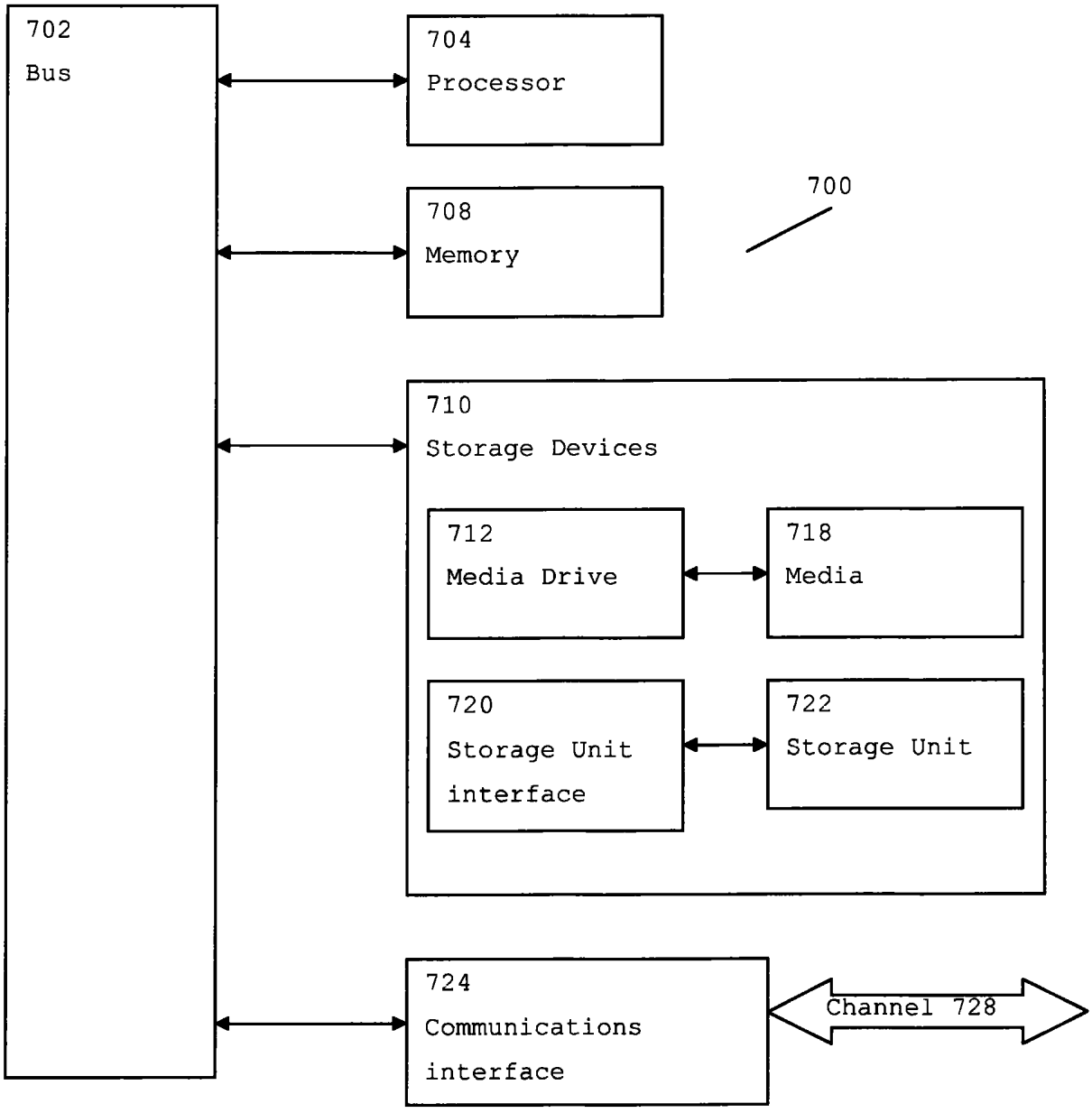

600
act Downlink Behaviour
605
PS Data from Internet
610
NAT Function
615
PS Data to UE

FIG. 7


702
Bus
704
Processor
708
Memory
700
710
Storage Devices
712
Media Drive
718
Media
720
Storage Unit
interface
722
Storage Unit
724
Communications
interface
Channel 728

NETWORK ELEMENT AND METHOD FOR ROUTING DATA IN A DATA COMMUNICATION SYSTEM

Field of the invention

The field of the invention relates to a data communication system, a communication network element and method for routing data. In particular, the field of the invention relates to a network element and method for routing data to/from in-building wireless (mobile) communication units of a femto cell communication network.

Background of the Invention

Data communication, within both wireless and wired communication systems, is performed generally using either circuit-switched (CS) or packet-switched (PS) technology. In PS technology, data is packetised, with packet switching routes established between a source node and a destination node.

In wireless communication systems, an established harmonised cellular radio communication system is the Global System for Mobile Communications (GSM), often referred to as a 2nd generation (2G) system. An enhancement to this cellular technology can be found in the Global Packet Radio System (GPRS), which supports PS data on a basic cellular platform, such as GSM. A further enhancement to such communication systems is the 3rd Generation (3G) of mobile telephone standards and technology. An example of such 3G standards and technology is the Universal Mobile Telecommunications System (UMTS), developed by the 3rd Generation Partnership Project (3GPP) (www.3gpp.org). 3G systems are intended to

provide a harmonised standard under which cellular radio communications networks and systems will provide enhanced levels of interfacing and compatibility with other types of communications systems and networks, including fixed communications systems such as the Internet. GPRS and UMTS/3GPP networks have been designed to accommodate PS data, thereby facilitating support of Internet services, such as web browsing, file sharing, email, etc.

Known techniques for routing data packets in a computer network or data communication system sometimes utilise a Network Address Translation (NAT, also known as Network Masquerading, Native Address Translation or IP Masquerading) mechanism. NAT is a technique of transceiving data through a router that involves re-writing the known source and/or destination Internet Protocol (IP) addresses and, usually, additionally the known transmission control protocol (TCP)/user datagram protocol (UDP) port numbers of IP data packets, as they pass through the router.

Most systems using NAT do so in order to enable multiple hosts on a private network to access the Internet using a single public IP address. NAT has become a standard feature in routers for home and small-office Internet connections, where the price of extra IP addresses would often outweigh the benefits. NAT also adds to security as it disguises the internal network's structure: all traffic appears to outside parties as if it originates from the gateway machine. As traffic passes from the local network to the Internet, the source address in each packet is translated 'on the fly' from the private addresses to the public address(es). The router tracks basic data about each active connection (particularly the destination

address and port). When a reply returns to the router, it uses the connection tracking data that the NAT stored during the outbound data flow to determine where on the internal network to forward the reply; the transmission control protocol (TCP) or user datagram protocol (UDP) client port numbers are used to demultiplex the packets in the case of overloaded NAT, or IP address and port number when multiple public addresses are available, on packet return. To a system on the Internet, the router itself appears to be the source/destination for this traffic.

Typically, wireless communication units, or User Equipment (UE) as they are often referred to, communicate with a Core Network (CN) of a wireless communication system via a Radio Network Subsystem (RNS). A wireless communication network typically comprises a plurality of radio network subsystems, each radio network subsystem comprising one or more cells to which UEs may attach, and thereby connect to the network.

Femto-cell or pico-cell Access Points (APs) are a recent development within the field of wireless cellular communication systems. Femto-cells or pico-cells are effectively communication coverage areas supported by low power base stations (otherwise referred to as serving communication units). These cells are able to be piggy-backed onto the more widely used macro-cellular network and support communications to UEs in a restricted, for example 'in-building', environment. Typical applications for such femto-cell or pico-cell APs include, by way of example, residential and commercial (e.g. office) locations, 'hotspots', etc, whereby an AP can be connected to a core network via, for example, the Internet using a broadband connection or the like. In this manner, femto-

cells or pico-cells can be provided in a simple, scalable deployment in specific in-building locations where, for example, network congestion at the macro-cell level is an issue.

Referring now to FIG. 1, a known architecture 100 of a 3GPP network configured for routing PS data is illustrated. The architecture 100 comprises an user equipment 110 that wishes to, say, receive or otherwise access PS data. In order to access PS data, the PS traffic would currently be received over the following data path. A server 170 transmits the desired PS data across the Internet over communication paths 175, 165 to a Gateway GPRS Support Node (GGSN) 160. The GGSN then passes the PS data to a 3rd generation access controller (3G AC) 140 via a Serving GPRS Support Node (SGSN) 150 and communication paths 155, 145. If the UE 110 is to receive the PS data, the data would then be passed from the Radio Network Controller (RNC) 140 via the Internet 130 and a NodeB (serving base station) 120 along communication paths 135, 125. The NodeB 120 would, for example, then wirelessly transmit 115 the PS data to the UE 110.

Thus, in a known 3G (macro cell) network, all of this PS data traffic must pass through the SGSN 150 and GGSN 160 in order to reach its final destination, either from the UE 110 to a destination node (such as server 170) connected to the Internet, or from a source node that is external to the wireless network to the UE 100. Typically, the final destination of the majority of this PS data will be addresses on the public Internet.

Referring now to FIG. 2 a diagrammatic representation of a known PS user plane stack that may be used in a femto cell

architecture. Of significance, when compared to a 3GPP macro cell architecture is that the Packet Data Convergence Protocol (PDCP)/radio link control (RLC)/medium access control (MAC) functions are all performed in the 3G AP. In a macro cell architecture these functions are performed in the radio network controller (RNC).

Referring back to FIG. 1, it is also known that cellular network Operators may wish to provide personal or grouped Operator Services 190 to their mobile users. In this context, walled gardens (effectively filters) 180 allow the Operator to provide private services to their subscribers that are not accessible to people on the public Internet. Possible private services include supporting email communication or sending short messages service (SMS) messages. Further walled gardens (not shown) may be used to provide a filter between the UE 110 and some public services. Examples of filters may include parental control or HTML post-processing in order to optimise the display on mobile devices.

It is currently assumed that there is no requirement to reduce a traffic load on the Operator's walled garden 180. Here, the Network Operators keep the volume of PS traffic low by charging high tariffs for PS data.

In a femto-cell network, it is envisaged that the Network Operators may wish to offer very low tariffs for PS data. As a consequence, a huge rise in the amount of PS data in the network is expected. A significant portion of this PS traffic is destined to go to computers that are accessible via the internet.

However, the size of the existing SGSNs 150 and GGSNs 160 would need to be significantly increased in order to handle the additional PS data, anticipated due to the commercial interest in femto cell technology. Such an increase in SGSN 150 and GGSN 160 capabilities, in order to support an increase in PS data traffic, is likely to be very expensive.

Thus, there exists a need for a method and apparatus for routing data, for example packet switched data, in a data communication network that comprises both fixed (e.g. Internet communication) and wireless communication, which aims to address at least some of the shortcomings of past and present techniques and/or mechanisms.

Summary of the Invention

Accordingly, the invention seeks to mitigate, alleviate or eliminate one or more of the above mentioned disadvantages singly or in any combination.

According to a first aspect of the invention, there is provided a network element for supporting packet switched (PS) data communication over a data communication system comprising a cellular communication network, such as a 3GPP core network, operably coupled to the Internet. The network element comprises packet inspection logic arranged to inspect received PS data packets being routed through the network element and extract a first portion of PS data packets. The network element further comprises routing logic, operably coupled to the packet inspection logic, for routing the first portion of PS data packets to a destination node directly over the Internet and routing a remaining portion of PS data packets of the received PS

data packets over the cellular communication network based on the packet inspection.

In this manner, the provision of routing logic in a network element, such as a 3G AP, enables a significant increase in PS data to be transmitted directly over the Internet to a destination, without a comparable increase in complexity and cost of other wireless network elements, such as SGSNs and GGSNs. In addition, the inventive concept only requires supporting functionality to be provided within, say a 3G AP, and is backward compatible with current 3GPP PS data routing. Furthermore, the inventive concept provides a significantly more efficient transferral of PS data.

In one optional embodiment of the invention, the network element may comprise, or be operably coupled to, a routing table arranged to specify at least one of: types of PS data that are to be routed over the Internet; types of PS data that are to be routed over the cellular communication network.

In one optional embodiment of the invention, the routing logic may be operably coupled to address translation logic arranged to modify at least one address of the first portion of PS data being routed over the Internet.

In one optional embodiment of the invention, the address translation logic may comprise or may be operably coupled to, a mapping table arranged to map original address and/or port information to modified address and/or port information for use by the address translation logic.

In one optional embodiment of the invention, the first portion of data packets may be user plane PS data traffic. In one optional embodiment of the invention, the remaining portion of data packets may be non-user plane PS data traffic.

In one optional embodiment of the invention, the network element may be a 3rd generation access point (3G AP) network element supporting femto cell communication.

According to a second aspect of the invention, there is provided a method for routing packet switched (PS) data over a data communication system comprising a cellular communication network operably coupled to the Internet. The method comprises receiving and inspecting PS data packets; extracting a first portion of data packets from the received PS data packets. The method further comprises routing the first portion of PS data packets to a destination node directly over the Internet and routing a remaining portion of PS data packets of the received PS data packets over the cellular communication network based on the packet inspection.

According to a third aspect of the invention, there is provided a wireless communication system comprising an aforementioned network element or adapted to support the aforementioned method of routing PS data.

According to a fourth aspect of the invention there is provided a computer-readable storage element having computer-readable code stored thereon for programming signal processing logic to perform a method for routing packet switched (PS) data over a data communication system comprising a cellular communication network operably

coupled to the Internet. The code is operable for receiving and inspecting PS data packets; extracting a first portion of data packets from the received PS data packets. The code is also operable for routing the first portion of PS data packets to a destination node directly over the Internet and routing a remaining portion of PS data packets of the received PS data packets over the cellular communication network based on the packet inspection.

These and other aspects, features and advantages of the invention will be apparent from, and elucidated with reference to, the embodiments described hereinafter.

Brief Description of the Drawings

FIG. 1 illustrates a known architecture of a 3GPP network configured for routing PS data.

FIG. 2 illustrates a diagrammatic representation of the known PS user plane stacks.

Embodiments of the invention will be described, by way of example only, with reference to the accompanying drawings, in which:

FIG. 3 illustrates an example of a wireless network adapted in accordance with an embodiment of the invention.

FIG. 4 illustrates a diagrammatic representation of the PS user plane stacks in accordance with an embodiment of the invention.

FIG. 5 illustrates a flowchart of an exemplary method of routing PS data in an uplink direction in accordance with an embodiment of the invention.

FIG. 6 illustrates a flowchart of an exemplary method of routing PS data in a downlink direction in accordance with an embodiment of the invention.

FIG. 7 illustrates a typical computing system that may be employed to implement processing functionality in embodiments of the invention.

Embodiments of the Invention

According to embodiments of the invention, a 3rd generation (3G) access point (AP) is configured to selectively handle certain PS data packets, for example user plane PS traffic, whilst leaving other user plane traffic to go via the SGSN/GGSN. In one embodiment of the invention, for example, all control plane PS traffic is routed in the current manner through a wireless communication SGSN/GGSN, whilst user plane PS traffic is extracted and routed directly to the destination node, say via the Internet. Advantageously, changes to current packet switched architecture comprise an addition of routing logic and NAT logic in the 3G AP communication unit (network element).

Thus, in this manner, a mechanism is provided that allows a femto cell network to directly route certain packet switched (PS) data directly to a final destination node, say via the internet; thereby bypassing the existing SGSN and GGSN wireless communication network elements.

Although the inventive concept utilises NAT logic, it is envisaged that any suitable address translation logic or technique may be used.

Referring now to FIG. 3, an example of a wireless network architecture 300 adapted in accordance with an embodiment of the invention is illustrated. Those skilled in the art, however, will recognize and appreciate that the specifics of this example are merely illustrative of some embodiments and that the teachings set forth herein are applicable in a variety of alternative settings. For example, since the teachings described hereafter do not depend on a particular cellular communication network conforming to any specific standard, it is envisaged that the teachings and inventive concept described therein can be applied to any type of cellular communication network, although a 3GPP femto cell network is shown in this embodiment. As such, other alternative implementations within wireless (e.g. cellular) communication networks conforming to different standards are contemplated and are considered as falling within the scope of the various teachings described.

The wireless network architecture 300 of FIG. 3 is illustrated in both a logical and a communication layer topology, to illustrate the individual functions and message types that are handled by the respective logic elements. The wireless network architecture 300 comprises a 3G Access Point (3G AP) 310 that has been adapted according to embodiments of the invention. As will be appreciated by a skilled artisan, a 3G Access Point (3G AP) is a communication element that facilities access to a communication network via, say, a femto-cell.

One application of the inventive concept described herein is where a 3G AP is purchased by a member of the public and installed in their home. The 3G AP (310) is connected to either a 3G access controller (3G AC) 340 (e.g. Femto Cell Controller) over the owner's broadband connection across the Internet 330 as described below. The 3G AC 340 is operably coupled to GGSN 160 and a SGSN 150 in the known manner.

Notably, in accordance with embodiments of the invention, the 3G AP 310 has been adapted to incorporate router logic 312, which may comprise (or be operably coupled to) packet inspection logic 313 and NAT logic 316 in a direct communication path 322 with the Internet 330. Thus, in contrast to the known mechanism described with respect to FIG. 1, of passing all PS traffic to the femto AP on to the 3G AC and thereafter on to the SGSN 150 and GGSN 160, packet inspection logic 313, router logic 312 and NAT logic 316 are incorporated into the 3G AP 310 and arranged to route PS data packets according to their data content.

In FIG. 3, the user plane traffic goes through the stacks shown on the right of the diagram. Once the packet has passed through the PDCP layer and the PDCP header has been stripped off, the data that remains is the user's IP data packet.

The IP data packet received from the UE has the source address set to the IP address assigned to the UE during one of the PDCP context activations. The IP data packet also comprises a destination address, based on the intended destination server. User data packets are then routed based on the source address the destination address, and the protocol. For each (or a number of)

received data packet(s) a decision is made by packet inspection logic 313 as to whether to route the data packet straight into the Internet 330, or to forward it to the SGSN 150 of the wireless communication network, based on the inspected data content.

In particular, according to one embodiment of the invention, packet inspection logic 313 of the 3G AP 310 is arranged to examine the packet switched data and extract a first portion of the PS data, for example user plane PS traffic destined for the SGSN 150 and GGSN 160, from the PS user plane traffic.

In accordance with embodiments of the invention, the extraction and re-routing of a first portion of PS data packet is envisaged as encompassing at least the following: extracting and re-routing one or more PS data packet(s) from a series of multiple PS data packets, and extracting and re-routing one or more portions of a single PS data packet. Hereinafter, for simplicity purposes only, references to portions of PS data will refer to the former aspect of extracting and re-routing one or more PS data packet(s) from a series of multiple PS data packets.

Routing logic 312 is then arranged to route this user plane traffic to NAT logic 316. Thus, in one embodiment of the invention, based on the source and destination IP address, together with port information and the protocol being used, the routing logic 313 determines whether to route 332 the first portion of PS data packets to the SGSN 150 and GGSN 160 or whether to route 322 the first portion of PS data packets directly onto the Internet 330 and onto an destination node 370.

For PS data packets routed from the UE source directly onto the Internet 330, the NAT logic 316 is arranged to modify the source Internet Protocol (IP) address to the address of the 3G AP 310, in contrast to the IP source address of the UE. As well as updating the source IP address, NAT logic 316 also modifies the source port number, as would be understood by a skilled artisan. These changes to the PS data packet ensure that any replies to the directly routed PS data are correctly routed back directly to the 3G AP 310, rather than coming back through the existing wireless communication network elements, i.e. SGSN 150 and GGSN 160.

Notably, NAT logic 316 is operably coupled to (or comprises) a mapping table 315 that is used by the NAT logic 316 to relate the original source address and source port to the modified source address and modified source port.

On receiving PS data packets from the Internet 330 destined for the UE, the NAT logic 316 within the 3G AP 310 then looks up the destination address and port number in the mapping table 315 to locate the original source address and original port, thereby performing a reverse NAT function to set the destination IP address back to the IP address of the UE.

The 3G AP 310 also comprises a memory element comprising a routing table 317 that specifies which traffic should be sent to the internet and which traffic should be sent to the SGSN 150 and GGSN 160. It is envisaged that the routing table 317 may employ any number of rules, for example rules according to an ordered sequence, as will be appreciated by a skilled artisan. In one example, it is

envisaged that the ordered sequence of rules could be as simple as:

(i) All PS data packets that are destined for servers with a fixed range of IP addresses are sent to the SGSN 150 and GGSN 160;

(ii) All other PS data packets are sent direct to the destination node 370 via the internet 330.

One simple example of a configuration of a routing table 317 is illustrated in Table 1:

Table 1:

Source Address	Destination Address	Route To
10.1.*.*	192.168.*.*	SGSN/GGSN
10.2.*.*	*.*.*.*	SGSN/GGSN
Default Route		Internet

This routing table 317 states that any packet with a source address starting '10.1' and a destination address starting '192.168' is routed to the GGSN. Any user plane PS data packet with a source address starting '10.2' is routed to the GGSN. All other user plane PS data packets are routed directly to the Internet.

It is envisaged that the routing table 317 employed by the 3GAP may be configured to route user plane PS data according to any of a number of factors. For example, the routing table 317 may route user plane PS data according to:

(i) Source IP Address: Here, it is envisaged that the UE may simultaneously connect to multiple networks through multiple GGSNs. In this manner, the UE will be

assigned a different IP address by each GGSN. Hence, routing based on the source IP address facilitates the option to employ different routes for each GGSN.

(ii) Destination IP Address: Some of the Network Operator services that the UE may want to use are only accessible via the GGSN; they are not accessible from the Internet. For example a Blackberry™ email server is likely to be only accessible via the GGSN. If the Network Operator services are all grouped on one network, then routing on the destination IP address is useful.

(iii) The Protocol being used (based, for example, on the destination port): This routing based option may be used, for example, in a scenario when all UE email goes to the GGSN 160 and all hyper text transfer protocol (HTTP) messages are sent direct to the destination node 370 via the Internet 330. In most cases it is possible to determine the protocol using the destination port. However, in some embodiments of the invention, it is envisaged that for some protocols the user plane PS data packet may need to be examined in more detail to determine the protocol being used.

In one embodiment of the invention, it is envisaged that when the UE initiates a packet switched session, the signalling messages (control plane PS data) are sent as normal to the SGSN 150 and GGSN 160.

In an alternative embodiment of the invention, it is envisaged that the 3G AP is also arranged to examine non-user plane PS data as well as, or in contrast to, user plane PS data. Thus, in this embodiment, it is envisaged that either non-user plane PS data is routed direct to the destination node 370, or that both non-user plane PS data and user plane PS data is routed direct to the destination

node 370. However, it is noted that examining and handling the signalling messages, as well as the user plane, requires a number of other issues to be addressed. For example, in this embodiment, keys that are used to set up encryption, which are stored in the core network and are accessible by the SGSN 150, need to be additionally accessible by the 3G AP 310, in order to secure the data.

Referring now to FIG. 4, a diagrammatic representation of the PS user plane stacks for packets offloaded directly to the Internet is illustrated, in accordance with an embodiment of the invention. As can be seen from FIG. 4, the protocol stack is much simpler than in the example shown in FIG. 2. When processing packets from the UE, the 3G AP, after removing the PDCP header, is able to send the packet straight to its destination instead of going via the 3G AC, SGSN and GGSN. This reduces the volume of traffic handled by the SGSN and GGSN and, hence, reduces their cost. This also provides the user with a more responsive service, as the round-trip-time between the UE and the destination is reduced.

Referring now to FIG. 5, a flowchart 500 of an exemplary method of routing PS data in an uplink direction (namely from a UE as a source node to a destination node via the Internet) is illustrated, in accordance with an embodiment of the invention. The flowchart commences in step 505 with PS data being received from a UE at a 3G AP. The 3G AP comprises routing logic or a signal processor performing a routing operation, arranged to make routing decisions, in step 510. In step 515, the 3G AP routing logic, or signal processor selects a first routing rule to be employed. The routing logic, or signal processor, then determines, in step 520, whether the received PS data

packet matches the selected rule. If the received PS data packet does not match the selected rule in step 520, the routing logic or signal processor selects the next rule in step 525, and the method returns to the packet inspection step 520.

If the received PS data packet matches the selected rule in step 520, the routing logic or signal processor determines in step 530, based on the content of the PS data packet, whether to route the PS data packet to the GGSN, in the known manner, or whether to route the PS data packet direct to the Internet. If the routing logic or signal processor determines, in step 530, to route the PS data packet to the GGSN, the PS data is routed to the 3G AC to forward on to the SGSN and GGSN, as shown in step 545. However, if the routing logic or signal processor determines, in step 530, to route the PS data packet direct to the Internet, the PS data is routed to NAT logic in the 3G AP in step 535, and thereon to the Internet in step 540.

Referring now to FIG. 6, a flowchart 600 of an exemplary method of routing PS data in a downlink direction (namely from a source node to the UE as a destination node) is illustrated, in accordance with an embodiment of the invention. Here, in the 3G AP, PS data is received from the Internet in step 605. The PS data is routed to the NAT logic, in step 610, to determine the original source address and the associated port number. The PS data is then routed to the corresponding UE, as shown in step 615.

It will be appreciated that, for clarity purposes, the above description has described embodiments of the invention with reference to different functional units,

logical elements and signal processors. However, it will be apparent to a skilled artisan that any suitable distribution of functionality between different functional units, logical elements or signal processors, for example with respect to the 3G network element, may be used without detracting from the inventive concept. For example, it is envisaged that functionality illustrated to be performed by separate signal processors or logic elements may be performed by the same signal processor or logic element. Hence, references to specific functional units are only to be seen as references to suitable means for providing the described functionality, rather than indicative of a strict logical or physical structure or organization.

It is envisaged that aspects of the invention may be implemented in any suitable form including hardware, software, firmware or any combination of these. The invention may optionally be implemented, at least partly, as computer software running on one or more data processors and/or digital signal processors. Thus, the elements and components of an embodiment of the invention may be physically, functionally and logically implemented in any suitable way. Indeed, the functionality may be implemented in a single unit, in a plurality of units or as part of other functional units.

It is envisaged that the aforementioned inventive concept aims to provide one or more of the following advantages:

The provision of routing logic in a network element, such as a 3G AP, enables a significant increase in PS data to be transmitted over the Internet, without a comparable increase in complexity and cost of SGSNs and GGSNs.

The inventive concept only requires supporting functionality to be provided within a 3G AP, and is backward compatible with current 3GPP PS data routing.

The inventive concept provides a significantly more efficient transferral of PS data.

The inventive concept enables Network Operators to offer very low (possibly free) tariffs for usage of PS data by end users.

FIG. 7 illustrates a typical computing system 700 that may be employed to implement processing functionality in embodiments of the invention. Computing systems of this type may be used in 3G APs or 3G ACs (in particular, processing logic in a 3G AP that handles PS data traffic). Those skilled in the relevant art will also recognize how to implement the invention using other computer or processing systems or architectures. Computing system 700 can include one or more processors, such as a processor 704. Processor 704 can be implemented using a general or special purpose processing engine such as, for example, a microprocessor, microcontroller or other control logic. In this example, processor 704 is connected to a bus 702 or other communications medium.

Computing system 700 can also include a main memory 708, such as random access memory (RAM) or other dynamic memory, for storing information and instructions to be executed by processor 704. Main memory 708 also may be used for storing temporary variables or other intermediate information during execution of instructions to be executed by processor 704. Computing system 700 may likewise include a read only memory (ROM) or other static storage device coupled to bus 702 for storing static information and instructions for processor 704.

The computing system 700 may also include information storage system 710, which may include, for example, a media drive 712 and a removable storage interface 720. The media drive 712 may include a drive or other mechanism to support fixed or removable storage media, such as a hard disk drive, a floppy disk drive, a magnetic tape drive, an optical disk drive, a compact disc (CD) or digital video drive (DVD) read and/or read-write drive (R or RW), or other removable or fixed media drive. Storage media 718 may include, for example, a hard disk, floppy disk, magnetic tape, optical disk, CD or DVD, or other fixed or removable medium that is read by and written to by media drive 744. As these examples illustrate, the storage media 718 may include a computer-readable storage medium having stored therein particular computer software or data.

In alternative embodiments, information storage system 710 may include other similar components for allowing computer programs or other instructions or data to be loaded into computing system 700. Such components may include, for example, a removable storage unit 722 and an interface 720, such as a program cartridge and cartridge interface, a removable memory (for example, a flash memory or other removable memory module) and memory slot, and other removable storage units 722 and interfaces 720 that allow software and data to be transferred from the removable storage unit 718 to computing system 700.

Computing system 700 can also include a communications interface 724. Communications interface 724 can be used to allow software and data to be transferred between computing system 700 and external devices. Examples of

communications interface 724 can include a modem, a network interface (such as an Ethernet or other NIC card), a communications port (such as for example, a universal serial bus (USB) port), a PCMCIA slot and card, etc. Software and data transferred via communications interface 724 are in the form of signals which can be electronic, electromagnetic, and optical or other signals capable of being received by communications interface 724. These signals are provided to communications interface 724 via a channel 728. This channel 728 may carry signals and may be implemented using a wireless medium, wire or cable, fiber optics, or other communications medium. Some examples of a channel include a phone line, a cellular phone link, an RF link, a network interface, a local or wide area network, and other communications channels.

In this document, the terms 'computer program product' 'computer-readable medium' and the like may be used generally to refer to media such as, for example, memory 708, storage device 718, or storage unit 722. These and other forms of computer-readable media may store one or more instructions for use by processor 704, to cause the processor to perform specified operations. Such instructions, generally referred to as 'computer program code' (which may be grouped in the form of computer programs or other groupings), when executed, enable the computing system 700 to perform functions of embodiments of the present invention. Note that the code may directly cause the processor to perform specified operations, be compiled to do so, and/or be combined with other software, hardware, and/or firmware elements (e.g., libraries for performing standard functions) to do so.

In an embodiment where the elements are implemented using software, the software may be stored in a computer-readable medium and loaded into computing system 700 using, for example, removable storage drive 44, drive 712 or communications interface 724. The control logic (in this example, software instructions or computer program code), when executed by the processor 704, causes the processor 704 to perform the functions of the invention as described herein.

It will be appreciated that, for clarity purposes, the above description has described embodiments of the invention with reference to different functional units and processors. However, it will be apparent that any suitable distribution of functionality between different functional units, processors or domains may be used without detracting from the invention. For example, functionality illustrated to be performed by separate processors or controllers may be performed by the same processor or controller. Hence, references to specific functional units are only to be seen as references to suitable means for providing the described functionality, rather than indicative of a strict logical or physical structure or organization.

Aspects of the invention may be implemented in any suitable form including hardware, software, firmware or any combination of these. The invention may optionally be implemented, at least partly, as computer software running on one or more data processors and/or digital signal processors. Thus, the elements and components of an embodiment of the invention may be physically, functionally and logically implemented in any suitable way. Indeed, the functionality may be implemented in a

single unit, in a plurality of units or as part of other functional units.

Although the invention has been described in connection with some embodiments, it is not intended to be limited to the specific form set forth herein. Rather, the scope of the present invention is limited only by the claims. Additionally, although a feature may appear to be described in connection with particular embodiments, one skilled in the art would recognize that various features of the described embodiments may be combined in accordance with the invention.

Furthermore, although individually listed, a plurality of means, elements or method steps may be implemented by, for example, a single unit or processor. Additionally, although individual features may be included in different claims, these may possibly be advantageously combined, and the inclusion in different claims does not imply that a combination of features is not feasible and/or advantageous. Also, the inclusion of a feature in one category of claims does not imply a limitation to this category, but rather the feature may be equally applicable to other claim categories, as appropriate.

Furthermore, the order of features in the claims does not imply any specific order in which the features must be performed and in particular the order of individual steps in a method claim does not imply that the steps must be performed in this order. Rather, the steps may be performed in any suitable order. In addition, singular references do not exclude a plurality. Thus, references to 'a', 'an', 'first', 'second', etc. do not preclude a plurality.

Thus, a method and apparatus for routing PS data has been described, which substantially addresses at least some of the shortcomings of past and present techniques and/or mechanisms.

CLAIMS

1. A network element (310) for supporting packet switched (PS) data communication over a data communication system (300) comprising a cellular communication network operably coupled to the Internet (330), wherein the network element (330) comprises:

packet inspection logic (313) arranged to inspect received PS data packets that are being routed through the network element (310) and extract a first portion of PS data packets;

wherein the network element (310) is characterised by:

routing logic (312), operably coupled to the packet inspection logic (313), for routing the first portion of PS data packets to a destination node directly over the Internet (330) and routing a remaining portion of PS data packets of the received PS data packets over the cellular communication network based on the packet inspection.

2. The network element (310) of Claim 1 further characterised in that the routing logic (312) comprises, or is operably coupled to, a routing table (317) arranged to specify at least one of: types of PS data that are to be routed to a destination node directly over the Internet (330); types of PS data that are to be routed over the cellular communication network.

3. The network element (310) of Claim 1 or Claim 2 further characterised in that the routing logic (312) is operably coupled to address translation logic (316) arranged to modify at least one address of the first portion of PS data being routed directly over the Internet (330).

4. The network element (310) of Claim 3 further characterised in that the address translation logic (316) comprises or is operably coupled to a mapping table (315) arranged to map original address and/or port information to modified address and/or port information for use by the address translation logic (316).

5. The network element (310) of any preceding Claim wherein the first portion of data packets or the remaining portion of data packets is user plane PS data traffic.

6. The network element (310) of any of preceding Claims 1 to 4 wherein the first portion of data packets or the remaining portion of data packets is non-user plane PS data traffic.

7. The network element (310) of any preceding Claim wherein the network element (310) is a 3rd generation access point (3G AP) network element supporting femto cell communication.

8. A method (500) for routing packet switched (PS) data over a data communication system (300) comprising a cellular communication network operably coupled to the Internet (330), wherein the method (500) comprises:

receiving and inspecting PS data packets;

extracting a first portion of data packets from the received PS data packets;

wherein the method (500) is characterised by:

routing the first portion of PS data packets to a destination node directly over the Internet (330) and routing a remaining portion of PS data packets of the

received PS data packets over the cellular communication network based on the packet inspection.

9. The method (500) for routing packet switched (PS) data over a data communication system (300) of Claim 8 further characterised by modifying at least one address of the first portion of PS data being routed to a destination node directly over the Internet (330).

10. The method (500) for routing packet switched (PS) data over a data communication system (300) of Claim 8 or Claim 9 further characterised by mapping original address and/or port information to modified address and/or port information such that requested PS data can be returned to a correct address.

11. The method (500) for routing packet switched (PS) data over a data communication system (300) of any of preceding Claims 8 to 10 further characterised in that the first portion of data packets is user plane PS data traffic.

12. A wireless communication system adapted to support the network element of any of preceding Claims 1 to 7 or adapted to facilitate the method steps of any of preceding Claims 8 to 11.

13. A computer-readable storage element (570) having computer-readable code stored thereon for programming signal processing logic to perform a method for method (500) for routing packet switched (PS) data over a data communication system (300) comprising a cellular communication network operably coupled to the Internet

(330), wherein the computer-readable code comprises code operable for:

receiving and inspecting PS data packets;

extracting a first portion of data packets from the received PS data packets;

wherein the computer-readable code is characterised by code operable for:

routing the first portion of PS data packets to a destination node directly over the Internet (330) and routing a remaining portion of PS data packets of the received PS data packets over the cellular communication network based on the packet inspection.

14. The computer-readable storage element of Claim 13, wherein the computer readable storage medium comprises at least one of a hard disk, a CD-ROM, an optical storage device, a magnetic storage device, a ROM (Read Only Memory), a PROM (Programmable Read Only Memory), a EPROM (Erasable Programmable Read Only Memory), a EEPROM (Electrically Erasable Programmable Read Only Memory) and a Flash memory.

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Application No: GB0801634.7 **Examiner:** Mr Richard Howe

Claims searched: 1-14 **Date of search:** 26 May 2008

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
A	1	GB2432479 A TynTec Limited - see abstract
A	1	US2005/0190755 A1 Singh et al - see abstract

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
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Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC[X] :

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H04L; H04Q

The following online and other databases have been used in the preparation of this search report

Online : wpi ; epodoc

International Classification:

Subclass	Subgroup	Valid From
H04L	0012/56	01/01/2006
H04L	0029/06	01/01/2006
H04Q	0007/22	01/01/2006