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21912
VAN PELT, YI & JAMES LLP
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FILING RECEIPT

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Date Mailed: 07/21/2009

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Applicant(s)

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If Required, Foreign Filing License Granted: 07/17/2009

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 61/270,353**

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Early Publication Request: No

Title

Device assisted CDR creation, aggregation, mediation and billing

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U.S. PTO
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07/06/2009

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17414 U.S. PTO

ATTORNEY DOCKET NO. RALEP022+

IN THE U.S. PATENT AND TRADEMARK OFFICE
Provisional Application Cover Sheet

Commissioner for Patents
P. O. Box 1450
Alexandria, VA 22313-1450

Sir:

This is a request for filing a PROVISIONAL APPLICATION under 37 CFR 1.53(c).

INVENTOR(s)/APPLICANT(s)

Last Name	First Name, MI	Residence (City and Either State or Foreign Country)
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TITLE OF THE INVENTION

DEVICE ASSISTED CDR CREATION, AGGREGATION, MEDIATION AND BILLING

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ENCLOSED APPLICATION PARTS (check all that apply)

(X) Specification *Number of Pages* 30
(X) Drawing(s) *Number of Pages* 14
( ) Power of Attorney
( ) Additional inventors are being named on separately numbered sheets attached hereto.

METHOD OF PAYMENT

( ) A check in the amount of $220.00 to cover the filing fee is enclosed.

(X) Please charge the filing fee and at any time during the pendency of this application, please charge any fees required or credit any overpayment to Deposit Account No. 50-0685 (Order No. RALEP022+).

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Date of Deposit: July 6, 2009

I hereby certify that this is being deposited with the United States Postal Service 'Express Mail Post Office to Addressee' service under 37 CFR 1.10 on the date indicated above and is addressed to the Commissioner for Patents, P O Box 1450, Alexandria, VA 22313-1450.

By Michael J. Schallop

Respectfully submitted,

Michael J. Schallop
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Date: July 6, 2009

Telephone No.: 408-207-4762

Attorney Docket No. RALEP022+

PROVISIONAL APPLICATION FOR
UNITED STATES PATENT

DEVICE ASSISTED CDR CREATION, AGGREGATION, MEDIATION AND BILLING

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Attorney Docket No. RALEP022+

APPLICATION FOR UNITED STATES PATENT

DEVICE ASSISTED CDR CREATION, AGGREGATION, MEDIATION AND BILLING

By Inventor(s):

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DEVICE ASSISTED CDR CREATION, AGGREGATION, MEDIATION AND BILLING

CROSS REFERENCE TO OTHER APPLICATIONS

[0001] This application claims priority to U.S. Provisional Patent Application No. 61/206,354 (Attorney Docket No. RALEP001+) entitled SERVICES POLICY COMMUNICATION SYSTEM AND METHOD filed January 28, 2009, U.S. Provisional Patent Application No. 61/206,944 (Attorney Docket No. RALEP002+) entitled SERVICES POLICY COMMUNICATION SYSTEM AND METHOD filed February 4, 2009, U.S. Provisional Application No. 61/207,393 (Attorney Docket No. RALEP003+) entitled SERVICES POLICY COMMUNICATION SYSTEM AND METHOD filed February 10, 2009, and U.S. Provisional Patent Application No. _____ (Attorney Docket No. RALEP004+) entitled SERVICES POLICY COMMUNICATION SYSTEM AND METHOD filed on February 13, 2009, and U.S. Patent Applications Nos. _____ (Attorney Docket Nos. RALEP001-020), entitled _____, each filed on March 2, 2009, which are incorporated herein by reference for all purposes.

BACKGROUND OF THE INVENTION

[0002] With the advent of mass market digital communications and content distribution, many access networks such as wireless networks, cable networks and DSL (Digital Subscriber Line) networks are pressed for user capacity, with, for example, EVDO (Evolution-Data Optimized), HSPA (High Speed Packet Access), LTE (Long Term Evolution), WiMax (Worldwide Interoperability for Microwave Access), and Wi-Fi (Wireless Fidelity) wireless networks increasingly becoming user capacity constrained. Although wireless network capacity will increase with new higher capacity wireless radio access technologies, such as MIMO (Multiple-Input Multiple-Output), and with more frequency spectrum being deployed in the future, these capacity gains are likely to be less than what is required to meet growing digital networking demand.

[0003] Similarly, although wire line access networks, such as cable and DSL, can have higher average capacity per user, wire line user service consumption habits are trending toward very high bandwidth applications that can quickly consume the available capacity and degrade overall network service experience. Because some components of service provider costs go up with increasing bandwidth, this trend will also negatively impact service provider profits.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] Various embodiments are disclosed in the following detailed description and the accompanying drawings.

[0005] **Figure 1** illustrates a wireless network architecture for providing device assisted CDR creation, aggregation, mediation and billing in accordance with some embodiments.

[0006] **Figure 2** illustrates another wireless network architecture for providing device assisted CDR creation, aggregation, mediation and billing in accordance with some embodiments.

[0007] **Figure 3** illustrates another wireless network architecture for providing device assisted CDR creation, aggregation, mediation and billing in accordance with some embodiments.

[0008] **Figure 4** illustrates provisioning of a wireless network for providing device assisted CDR creation, aggregation, mediation and billing in accordance with some embodiments.

[0009] **Figure 5** illustrates a network architecture for providing device assisted CDRs in accordance with some embodiments.

[0010] **Figure 6** illustrates another network architecture for providing device assisted CDRs in accordance with some embodiments.

[0011] **Figure 7** illustrates another network architecture for providing device assisted CDRs in accordance with some embodiments.

[0012] **Figure 8** illustrates another network architecture for providing device assisted CDRs in accordance with some embodiments.

[0013] **Figure 10** provides a table summarizing various service processer 115 functional elements in accordance with some embodiments.

[0014] **Figure11** provides a table summarizing various service controller 122 functional elements in accordance with some embodiments.

[0015] **Figure 12** illustrates a device stack providing various service usage measurement from various points in the networking stack for a service monitor agent, a billing agent, and an access control integrity agent to assist in verifying the service usage measures and billing reports in accordance with some embodiments.

[0016] **Figure 13** illustrates an embodiment similar to Figure 12 in which some of the service processor is implemented on the modem and some of the service processor is implemented on the device application processor in accordance with some embodiments.

[0017] **Figure 14** illustrates various embodiments of intermediate networking devices that include a service processor for the purpose of verifiable service usage measurement, reporting, and billing reports in accordance with some embodiments.

[0018]

DETAILED DESCRIPTION

[0019] The invention can be implemented in numerous ways, including as a process; an apparatus; a system; a composition of matter; a computer program product embodied on a computer readable storage medium; and/or a processor, such as a processor configured to execute instructions stored on and/or provided by a memory coupled to the processor. In this specification, these implementations, or any other form that the invention may take, may be referred to as techniques. In general, the order of the steps of disclosed processes may be altered within the scope of the invention. Unless stated otherwise, a component such as a processor or a memory described as being configured to perform a task may be implemented as a general component that is temporarily configured to perform the task at a given time or a specific component that is manufactured to perform the task. As used herein, the term 'processor' refers to one or more devices, circuits, and/or processing cores configured to process data, such as computer program instructions.

[0020] A detailed description of one or more embodiments of the invention is provided below along with accompanying figures that illustrate the principles of the invention. The invention is described in connection with such embodiments, but the invention is not limited to any embodiment. The scope of the invention is limited only by the claims and the invention encompasses numerous alternatives, modifications and equivalents. Numerous specific details are set forth in the following description in order to provide a thorough understanding of the invention. These details are provided for the purpose of example and the invention may be practiced according to the claims without some or all of these specific details. For the purpose of clarity, technical material that is known in the technical fields related to the invention has not been described in detail so that the invention is not unnecessarily obscured.

[0021] There are many new types of digital devices where it is becoming desirable to connect these devices to wireless networks including wireless wide area networks (WWAN, such as 3G and 4G) and wireless local area (WLAN) networks. These devices include consumer electronics devices, business user devices and machine to machine devices that benefit from flexible wide area data connections and Internet. Example devices include netbooks, notebooks, mobile Internet devices, personal navigation (e.g., GPS enabled) devices, music and multimedia

players, eReaders, industrial telemetry, automotive emergency response and diagnostics, 2-way home and industrial power metering and control, vending machines, parking meters, and many other devices. It is highly advantageous to offer service usage and service billing plans for such devices that are more optimal for each type of device and each type of desired user experience. To accomplish this, more sophisticated service usage measuring and service usage billing systems must be created as compared to the conventional network based techniques in existence today. By providing more flexibility in service measurement and billing, more advantageous and cost effective service plans can be created for the new WWAN connected devices cited above for all three markets (consumer, business and machine to machine) that still maintain the necessary profit margins for the WWAN carriers to be successful with these service businesses.

[0022] Accordingly, various embodiments are disclosed herein provide for a new and flexible augmentation or replacement for existing carrier network service usage measurement, service usage accounting and service usage billing systems.

[0023] A charging data record (CDR) is a term that defines a formatted measure of device service usage information, typically generated by one or more network functions that supervise, monitor and/or control network access for the device. CDRs typically form the basis for recording device network service usage, and often form the basis for billing for such usage. Various embodiments are provided for device assisted CDR creation, mediation and billing. There are many limitations to the capabilities of service usage recording, aggregation and/or billing when CDRs are generated exclusively by network based functions or equipment. By either augmenting network based service usage measures with device based service usage measures, or by replacing network based service usage measures with device based service usage measures, it is possible to create a CDR generation, aggregation, mediation and/or billing solution that has superior or more desirable capabilities/features. In theory, many of the service usage measures that can be evaluated on a device can also be evaluated in the network data path using various network equipment technologies including but not limited to deep packet inspection (DPI), there are many examples where measuring service usage at the device is either more desirable or more practical, or in some cases it is the only way to obtain the desired measure. Such examples include but are not limited to the following:

- application layer service usage measures (e.g., traffic usage categorized by application or by combinations of application, destination and/or content type),
- usage measures that do not involve user traffic but instead involve network overhead traffic (e.g., basic connection maintenance traffic, signaling traffic, network logon/AAA/authentication/monitoring traffic, service software update traffic),
- usage that is associated with services that are charged to another entity other than the end user (e.g., basic network connection service offer traffic, traffic associated with providing network access to or downloading service marketing information, traffic associated with advertiser sponsored services, traffic associated with content provider sponsored services, 911 service traffic),
- usage measures involving encrypted traffic (e.g., traffic that is run over encrypted networking protocols or between secure end points),
- Implementing service usage measure collection and/or service usage billing across multiple networks that may have different and in some cases incompatible, inaccessible (to the CDR system of record) or incomplete service usage measurement capabilities,
- Service usage measurement and/or service usage billing capabilities that are not supported by the present network gateways, routers, MWC/HLRs, AAA, CDR aggregation, CDR mediation, billing and/or provisioning systems,
- New service usage measures and/or new service usage billing capabilities that are desirable to implement in a manner that does not require major changes or upgrades to the existing network gateways, routers, MWC/HLRs, AAA, CDR aggregation, CDR mediation, billing and/or provisioning systems,
- New service usage measures and/or new service usage billing capabilities that are desirable to implement in a manner that allows for rapid definition and implementation of new service measures and/or billing plans,

- New service usage measures and/or new service usage billing capabilities that are desirable to implement in a manner that may be implemented in a manner that enables multiple device group definitions where each device group gets a customized programmable definition for service usage collection, accounting and/or billing,
- Multi device billing,
- Multi user billing,
- Intermediate device billing with single user and multi user with and without multi device,
- Content downloads from a specific source to a specific application with the content being of a specific type or even identified down to a particular content ID, and/or
- Other single event transactions used for billing purposes.

For these and other reasons, it is desirable to provide a system/process that utilizes device assisted service usage measures that provides either an enhancement of existing network based service usage CDR system capabilities and/or a replacement for network based CDR system capabilities.

[0024] In some embodiments, a system/process that utilizes device assisted service usage measures includes one or more of the following: (1) receiving a service usage measure from a device in communication with a wireless network, (2) verifying or protecting the validity of the service usage measure, (3) generating a CDR based on the service usage measure (e.g., device assisted CDR), (4) aggregate CDRs, (5) mediating the CDR with network CDRs. In some embodiments, the system/process also includes providing a design and provisioning of devices/network equipment to recognize the CDRs. In some embodiments, the system/process also includes provisioning to recognize that the device belongs to a Device Assisted Services (DAS) device group and corresponding CDRs should be accepted and mediated. In some embodiments, the device assisted CDRs are also generated using formats, network communications protocols, network device authentication and/or provisioning to allow device assisted CDRs into the network CDR system, encryption, and/or signatures as required by the

network (e.g., to comply with network generated CDR requirements or based on any other network and/or service provider requirements and/or standards).

[0025] In some embodiments, mediation rules include multi device, multi user, single user devices, and intermediate networking devices that can be single user or multi user, as described herein.

[0026] In some embodiments, a device assisted CDR generator collects device based service usage measures that are used as the basis for, or as enhancement (e.g., supplement/in addition) to, one or more (network generated) CDRs that provide one or more networking functions with properly formatted service usage reports that the network function(s) accepts as being transmitted from an authorized source, read and utilize for helping to determine the service usage of a device or group of devices. In some embodiments, he network functions that the device assisted CDR generator shares CDRs with typically include one or more of service usage/CDR aggregation and/or mediation servers, gateways, routers, communication nodes, Mobile Wireless Centers (MWCs, including HLRs), databases, AAA systems, billing interfaces and/or billing systems. For example, the process of CDR creation in the CDR generator typically includes either using one or more device based measures of service usage, or one or more device based measures of service usage in combination with one or more network based measures of service usage, possibly processing one or more of such service usage measures according to a set of CDR creation, CDR aggregation and/or CDR mediation rules to arrive at a final device usage measure that is then formatted with the proper syntax, framed, possibly encrypted and/or signed, and encapsulated in a communication protocol or packet suitable for sharing with network functions. In some embodiments, the CDR generator resides in the device. In some embodiments, the CDR generator resides in a network server function that receives the device assisted service usage measures, along with possibly network based usage measures, and then creates a CDR (e.g., in the service controller 122).

[0027] In some embodiments, the device assisted CDR generator can reside in the service processor (e.g., service processor 115), for example, in the service usage history or billing server functions. In some embodiments, the device assisted CDR generator resides in the device itself,

for example, within the service processor functions such as the billing agent or the service monitor agent.

[0028] There are several factors that are considered in the various embodiments in order to create a useful, reliable and secure device assisted CDR system, including but not limited to:

- Identification of each device based service usage measure with one or more usage transaction codes,
- Verification of the device based usage measure(s),
- Secure communication of the device based usage measures to the network,
- Efficient (e.g., low bandwidth) communication of the device based service usage measure,
- Coordination/comparison/aggregation of the device based service usage measure with network based service usage measure(s),
- Formatting the device based service usage measure into a CDR that can be properly communicated to the network functions and/or equipment that process service usage information,
- Causing the network based functions and/or equipment used for CDR collection, aggregation, mediation and/or billing to recognize, authorize and accept communications and CDRs from the device assisted CDR generator, reading and properly implementing the correct network session context for the CDR so that the CDR is properly associated with the correct device /user/session,
- Implementing the CDR aggregation rules that determine how to collect and aggregate the device assisted CDRs as they are reported up the network CDR system hierarchy,
- Implementing the mediation rules that determine how the various device based service usage transaction code measures are combined and mediated with the other device based service usage transaction code measures to result in consistent service usage information for each of the transaction code categories maintained in the network,
- Implementing the mediation rules that determine how the device assisted CDRs are combined and mediated with network based CDRs to result in consistent service usage information for each of the transaction code categories maintained in the network,

- Implementing mediation rules to reconcile the variances between network based CDR usage measures and device assisted CDR usage measures,
- Classification of one or more device groups, with each group having the capability to uniquely define the service usage collection, accounting and/or billing rules
- Collecting CDRs generated on networks other than the home network so that service usage may be measured, accounted for and/or billed for across multiple networks,
- Multi device billing,
- Multi user billing, and/or
- Intermediate device billing with single user and multi user with and without multi device.

[0029] In some embodiments, verification of the relative accuracy of the device assisted service usage measure is provided. Given that the service usage measure is often being generated on an end user device or a device that is readily physically accessed by the general public or other non-secure personnel from a network management viewpoint, in some embodiments, the device agents used in one or more of the service processor 115 agents are protected from hacking, spoofing and/or other misuse. Various techniques for protecting the integrity of the agents used for generating the device assisted service usage measures are provided.

[0030] In some embodiments, the service usage measures are verified by network based cross checks of various kinds. Network based cross checks are valuable, because it is in general not possible or extremely difficult to defeat well designed network based cross checks even if the measures used to protect the device agents are defeated or if no device protection measures are employed. Network based cross checks used to verify the device assisted service usage measures include comparing network based service usage measures (e.g. CDRs generated by service usage measurement apparatus in the network equipment such as the BTS/BSCs 125, RAN Gateways 410, Transport Gateways 420, Mobile Wireless Center/HLRs 132, AAA 121, Service Usage History/CDR Aggregation, Mediation, Feed 118, or other network equipment), sending secure query/response command sequences to the service processor 115 agents involved in device assisted CDR service usage measurement or CDR creation, sending test service usage event sequences to the device and verifying that the device properly reported the service usage, and using various other techniques.

[0031] In some embodiments, one or more of the following actions are taken if the device based service usage measure is found to be in error or inaccurate: bill the user for usage overage or an out of policy device, suspend the device, quarantine the device, SPAN the device, and/or report the device to a network administration function or person.

[0032] In some embodiments, the CDR syntax used to format the device assisted service usage information into a CDR and/or network communication protocols for transmitting CDRs are determined by industry standards (including but not limited to, for example, various versions of 3GPP TS 32.215 format and 3GPP2 TSG-X X.S0011 or TIA-835 format). In some embodiments, for a given network implementation the network designers will specify modifications of the standard syntax, formats and/or network communication/transmission protocols. In some embodiments, for a given network implementation the network designers will specify syntax, formats and/or network communication/transmission protocols that are entirely different than the standards.

[0033] In some embodiments, within the syntax and formatting for the CDR the device assisted service usage is typically categorized by a transaction code. The transaction code can be similar or identical to the codes in use by network equipment used to generate CDRs, or given that the device is capable of generating a much richer set of service usage measures, the transaction codes can be a superset of the codes used by network equipment used to generate CDRs (e.g., examples of the usage activities that can be labeled as transaction codes that are more readily supported by device assisted CDR systems as compared to purely network based CDR systems are provided).

[0034] In some embodiments, the device sends an identifier for usage activity tag, an intermediate server determines how to aggregate into CDR transaction codes and which CDR transaction code to use.

[0035] In some embodiments, the device service processor 115 compartmentalizes usage by pre-assigned device activity transaction codes (e.g., these can be sub-transactions within the main account, transactions within a given bill-by-account transaction or sub-transactions within a bill-by-account transaction). The device implements bill-by-account rules to send different usage reports for each bill-by-account function. In some embodiments, the service controller

122 programs the device to instruct it on how to compartmentalize these bill-by-account service usage activities so that they can be mapped to a transaction code.

[0036] In some embodiments, the device reports less compartmentalized service usage information and the service controller 122 does the mapping of service usage activities to CDR transaction codes, including in some cases bill-by-account codes.

[0037] In some embodiments, the CDR sent to 118 or other network equipment can consist of various types of transaction codes including but not limited to a raw device usage CDR, a bill-by-account (e.g., a sub-activity transaction code) CDR, a billing offset CDR, a billing credit CDR. The decision logic (also referred to as business rules or CDR aggregation and mediation rules) that determines how these various types of CDR transaction codes are to be aggregated and mediated by the core network and the billing system can be located in the network equipment (e.g., network element (e.g., service usage) 118), in the service controller 122 or in the billing system 123.

[0038] In some embodiments, the device assisted CDR generator uses the device assisted service usage measures to generate a CDR that includes service usage information, service usage transaction code(s) and, in some embodiments, network information context. In some embodiments, this service usage information, transaction code and/or network information context is formatted into communication framing, syntax, encryption/signature, security and/or networking protocols that are compatible with the formatting used by conventional networking equipment to generate CDRs. For example, this allows networking equipment used for CDR collection, recording, aggregation, mediation, and/or conversion to billing records to properly accept, read and interpret the CDRs that are generated with the assistance of device based service usage measurement. In some embodiments, the device assisted service measures are provided to an intermediate network server referred to as a service controller (e.g., service controller 122. In some embodiments, the service controller uses a CDR feed aggregator for a wireless network collects device generated usage information for one or more devices on the wireless network; and provides the device generated usage information in a syntax (e.g., charging data record (CDR)), and a communication protocol (e.g.,3GPP or 3GPP2, or other communication protocols)

that can be used by the wireless network to augment or replace network generated usage information for the one or more devices on the wireless network.

[0039] In some embodiments, mediation rules include multi device, multi user, single user devices, intermediate networking devices that can be single user or multi user. For example, the device assisted CDRs can be formatted by the device assisted CDR generator to include a transaction code for one user account, even though the CDRs originate from multiple devices that all belong to the same user. This is an example embodiment for a multi-user device assisted CDR billing solution. In another example embodiment for a multi-user device assisted CDR billing solution, device assisted CDRs from multiple devices and multiple users may all be billed to the same account (e.g., a family plan or a corporate account), but the bill-by-account CDR transaction records can be maintained through the billing system so that sub-account visibility is provided so that the person or entity responsible for the main account can obtain visibility about which users and/or devices are creating most of the service usage billing. This type of multi-user, multi-device device assisted CDR billing solution can also be used to track types of service usage and/or bill for types of service usage that are either impossible or very difficult to account and/or bill for with purely network based CDR systems. In some embodiments, bill-by-account CDR transaction records can be used to provide sponsored transaction services, account for network chatter, provide service selection interfaces, and other services for multi-user or multi-device service plans.

[0040] In addition to conventional single user devices (e.g., cell phones, smart phones, netbooks/notebooks, mobile internet devices, personal navigation devices, music players, electronic eReaders, etc.) device assisted service usage measurement and CDRs are very useful for intermediate networking devices (e.g., 3G/4G WWAN to WLAN bridges/routers/gateways, femto cells, DOCSIS modems, DSL modems, remote access/backup routers, etc.). In such devices, particularly with a secure manner to verify that the device assisted service usage measures are relatively accurate and/or the device service processor 115 software is not compromised or hacked, many new service provider service delivery and billing models may be supported that are new and unique. For example, in a WiFi to WWAN bridge or router device multiple user devices may be supported with the same intermediate networking device in a manner that is consistent and compatible with the central provider's CDR aggregation and/or

billing system by sending device assisted CDRs as described herein that have a service usage and/or billing code referenced to the end user and/or the particular intermediate device.

[0041] In some embodiments, the device assisted CDRs generated for the intermediate device may be associated with a particular end user out of many, with each end user being required to enter a unique log-in to the intermediate device. In this way, all devices that connect using WiFi to the intermediate device to get WWAN access generate CDRs can either get billed to a particular end user who is responsible for the master account for that device, or the CDRs can get billed in a secure manner, with verified relative usage measurement accuracy to multiple end users from the same intermediate device. In another example embodiment, an end user can have one account that allows access to a number of intermediate devices, and each intermediate device generates consistent device assisted CDRs with transaction codes for that end user regardless of which intermediate device the end user logs in on.

[0042] In some embodiments, some of the services provided by the intermediate device may be billed to a specific end user device assisted CDR transaction code, while other bill-by-account services are billed to other transaction code accounts, such as sponsored partner transaction service accounts, network chatter accounts, sponsored advertiser accounts, or service sign up accounts, etc. In this manner, embodiments are possible where intermediate devices (e.g., a WWAN to WiFi router/bridge) are sold to one user but can service and be used to bill other users (and this can be covered in the first purchasing user's service terms perhaps in exchange for a discount), or such intermediate devices may be located wherever access is desired without concern that the device will be hacked into so that services may be acquired without charge.

[0043] In some embodiments, various types of service usage transactions can be billed for on the intermediate device, to any one or more users, where the information required to bill for such services is not available to the central provider or MVNO network equipment, just as is the case with the conventional single user devices. Those skilled in the art will now readily understand that similar service models are equally applicable not just to the WWAN to WiFi intermediate devices, but also to the Femto Cell, remote access router, DOCSIS, DSL and other intermediate devices.

[0044] **Figure 1** illustrates a wireless network architecture for providing device assisted CDR creation, aggregation, mediation and billing in accordance with some embodiments. As shown, Figure 1 includes a 4G/3G/2G wireless network operated by, for example, a central provider. As shown, various wireless devices 100 are in communication with base stations 125 for wireless network communication with the wireless network, and other devices 100 are in communication with Wi-Fi Access Points (APs) or Mesh 702 for wireless communication to Wi-Fi Access CPE 704 in communication with central provider access network 109. In some embodiments, each of the wireless devices 100 includes a service processor 115 (as shown), and each service processor connects through a secure control plane link to a service controller 122. In some embodiments, the network based service usage information (e.g., CDRs) is obtained from one or more network elements. As shown, an MVNO core network 210 also includes a CDR storage, aggregation, mediation, feed 118, a MVNO billing interface 122, and a MVNO billing system 123 (and other network elements as shown in Figure 1).

[0045] As shown in Figure 1, a CDR storage, aggregation, mediation, feed 118 (e.g., service usage 118, including a billing aggregation data store and rules engine) is a functional descriptor for, in some embodiments, a device/network level service usage information collection, aggregation, mediation, and reporting function located in one or more of the networking equipment boxes attached to one or more of the sub-networks shown in Figure 1 (e.g., central provider access network 109 and/or central provider core network 110), which is in communication with the service controller 122, and a central billing interface 127. As shown in Figure 1, service usage 118 is shown as a function in communication with the central provider core network 110 n. In some embodiments, the CDR storage, aggregation, mediation, feed 118 function is located elsewhere in the network or partially located in elsewhere or integrated with/as part of other network elements. In some embodiments, CDR storage, aggregation, mediation, feed 118 functionality is located or partially located in the AAA server 121 and/or the mobile wireless center/Home Location Register(HLR) 132 (as shown, in communication with a DNS/DHCP server 126). In some embodiments, service usage 118 functionality is located or partially located in the base station, base station controller and/or base station aggregator, collectively referred to as base station 125 in Figure 1. In some embodiments, CDR storage, aggregation, mediation, feed 118 functionality is located or partially located in a networking component in the central provider access network 109, a networking component in the core

network 110, the central billing system 123, the central billing interface 127, and/or in another network component or function. This discussion on the possible locations for the network based and device based service usage information collection, aggregation, mediation, and reporting function (e.g., CDR storage, aggregation, mediation, feed 118) can be easily generalized as described herein and as shown in the other figures described herein by one of ordinary skill in the art. Also as shown in Figure 1, the service controller 122 is in communication with the central billing interface 123 (also sometimes referred to as the external billing management interface or billing communication interface) 127, which is in communication with the central billing system 123. As shown, an order management 180 and subscriber management 182 are also in communication with the central provider core network 110 for facilitating order and subscriber management of services for the devices 100 in accordance with some embodiments.

[0046] In some embodiments, the CDR storage, aggregation, mediation, feed 118 (and/or other network elements or combinations of network elements) provides a device/network level service usage information collection, aggregation, mediation, and reporting function. In some embodiments, the CDR storage, aggregation, mediation, feed 118 (and/or other network elements or combinations of network elements) collects device generated usage information for one or more devices on the wireless network (e.g., devices 100); and provides the device generated usage information in a syntax and a communication protocol that can be used by the wireless network to augment or replace network generated usage information for the one or more devices on the wireless network. In some embodiments, the syntax is a charging data record (CDR), and the communication protocol is selected from one or more of the following: 3GPP, 3GPP2, or other communication protocols. In some embodiments, the CDR storage, aggregation, mediation, feed 118 (and/or other network elements or combinations of network elements) includes a service usage data store (e.g., a billing aggregator) and a rules engine for aggregating the collected device generated usage information. In some embodiments, the syntax is a charging data record (CDR), and the network device is a CDR feed aggregator, and the CDR storage, aggregation, mediation, feed 118 (and/or other network elements or combinations of network elements) also aggregates CDRs for the one or more devices on the wireless network; applies a set of rules to the aggregated CDRs using a rules engine (e.g., bill by account, transactional billing, and/or any other billing or other rules for service usage information collection, aggregation, mediation, and reporting), and communicates a new set of CDRs for the

one or more devices on the wireless network to a billing interface or a billing system (e.g., providing a CDR with a billing offset by account/service). In some embodiments, the CDR storage, aggregation, mediation, feed 118 (and/or other network elements or combinations of network elements) communicates a new set of CDRs for the one or more devices on the wireless network to a billing interface or a billing system. In some embodiments, the CDR storage, aggregation, mediation, feed 118 (and/or other network elements or combinations of network elements) communicates with a service controller to collect the device generated usage information for the one or more devices on the wireless network. In some embodiments, the CDR storage, aggregation, mediation, feed 118 (and/or other network elements or combinations of network elements) communicates with a service controller, in which the service controller is in communication with a billing interface or a billing system. In some embodiments, the CDR storage, aggregation, mediation, feed 118 (and/or other network elements or combinations of network elements) communicates the device generated usage information to a billing interface or a billing system. In some embodiments, the CDR storage, aggregation, mediation, feed (and/or other network elements or combinations of network elements) communicates with a transport gateway and/or a Radio Access Network (RAN) gateway to collect the network generated usage information for the one or more devices on the wireless network. In some embodiments, the service controller 122 communicates the device generated service usage information to the CDR storage, aggregation, mediation, feed 118 (and/or other network elements or combinations of network elements).

[0047] In some embodiments, the CDR storage, aggregation, mediation, feed 118 (and/or other network elements or combinations of network elements) performs rules for performing a bill by account aggregation and mediation function. In some embodiments, the service controller 122 in communication with the CDR storage, aggregation, mediation, feed 118 (and/or other network elements or combinations of network elements) performs a rules engine for aggregating and mediating the device generated usage information. In some embodiments, a rules engine device in communication with the CDR storage, aggregation, mediation, feed 118 (and/or other network elements or combinations of network elements) performs a rules engine for aggregating and mediating the device generated usage information.

[0048] In some embodiments, the rules engine is included in (e.g., integrated with/part of) the CDR storage, aggregation, mediation, feed 118. In some embodiments, the rules engine and associated functions, as discussed herein, is a separate function/device. In some embodiments, the service controller 122 performs some or all of these rules engine based functions, as discussed herein, and communicates with the central billing interface 127. In some embodiments, the service controller 122 performs some or all of these rules engine based functions, as discussed herein, and communicates with the central billing system 123.

[0049] In some embodiments, duplicate CDRs are sent from the network equipment to the billing system 123 that is used for generating service billing. In some embodiments, duplicate CDRs are filtered to send only those CDRs/records for devices controlled by the service controller and/or service processor (e.g., the managed devices). For example, this approach can provide for the same level of reporting, lower level of reporting, and/or higher level of reporting as compared to the reporting required by the central billing system 123.

[0050] In some embodiments, a bill-by-account billing offset is provided. For example, bill-by-account billing offset information can be informed to the central billing system 123 by providing a CDR aggregator feed that aggregates the device based service usage data feed to provide a new set of CDRs for the managed devices to the central billing interface 127 and/or the central billing system 123. In some embodiments, transaction billing is provided using similar techniques. For example, transaction billing log information can be provided to the central billing interface 127 and/or the central billing system 123.

[0051] In some embodiments, the rules engine (e.g., performed by the service usage 118 or another network element, as discussed herein) provides a bill-by-account billing offset. For example, device generated usage information (e.g., charging data records (CDRs)) includes a transaction type field (e.g., indicating a type of service for the associated service usage information). The rules engine can apply a rule or a set of rules based on the identified service associated with the device generated usage information to determine a bill-by-account billing offset (e.g., a new CDR can be generated to provide the determined bill-by-account billing offset). In some examples, the determined bill-by-account billing offset can be provided as a credit to the user's service usage account (e.g., a new CDR can be generated with a negative

offset for the user's service usage account, such as for network chatter service usage, or transactional service usage, or for any other purposes based on one or more rules performed by the rules engine).

[0052] As another example, for a transactional service, a first new CDR can be generated with a negative offset for the user's service usage account for that transactional service related usage, and a second new CDR can be generated with a positive service usage value to charge that same service usage to the transactional service provider (e.g., Amazon, eBay, or another transactional service provider). In some embodiments, the service controller 122 generates these two new CDRs, and the service usage 118 stores, aggregates, and communicates these two new CDRs to the central billing interface 127. In some embodiments, the service controller 122 generates these two new CDRs, and the service usage 118 stores, aggregates, and communicates these two new CDRs to the central billing interface 127, in which the central billing interface 127 applies rules (e.g., performs the rules engine for determining the bill-by-account billing offset).

[0053] In some embodiments, the service controller 122 sends the device generated CDRs to the rules engine (e.g., service usage 118), and the rules engine applies one or more rules, such as those described herein and/or any other billing/service usage related rules as would be apparent to one of ordinary skill in the art. In some embodiments, the service controller 122 generates CDRs similar to other network elements, and the rules (e.g., bill-by-account) are performed in the central billing interface 127. For example, for the service controller 122 to generate CDRs similar to other network elements, in some embodiments, the service controller 122 is provisioned on the wireless network and behaves substantially similar to other CDR generators on the network) as would be apparent to one of ordinary skill in the art.

[0054] In some embodiments, the service controller 122 is provisioned as a new type of networking function that is recognized as a valid and secure source for CDRs by the other necessary elements in the network (e.g., the Service Usage History/ CDR Aggregation and Mediation Server 118). In some embodiments, where the network necessary apparatus will only recognize CDRs from certain types of networking equipment (e.g. RAN Gateway 410 or Transport Gateway 420), then the Service Controller 122 can provide authentication credentials

to the other networking equipment that indicate it is one of the approved types of equipment. In some embodiments, the link between the Service Controller 122 and the necessary CDR aggregation and mediation equipment is secured, authenticated, encrypted and/or signed.

[0055] In some embodiments, the CDR storage, aggregation, mediation, feed 118 discards the network based service usage information (e.g., network based CDRs) received from one or more network elements. In these embodiments, the service controller 122 can provide the device based service usage information (e.g., device based CDRs) to the CDR storage, aggregation, mediation, feed 118 (e.g., the CDR storage, aggregation, mediation, feed 118 can just provide a store, aggregate, and communication function(s)), and the device based service usage information is provided to the central billing interface 127 or the central billing system 123.

[0056] In some embodiments, the device based CDRs and/or new CDRs generated based on execution of a rules engine as described herein is provided only for devices that are managed and/or based on device group, service plan, or any other criteria, categorization, and/or grouping.

[0057] **Figure 2** illustrates another wireless network architecture for providing device assisted CDR creation, aggregation, mediation and billing in accordance with some embodiments. As shown in Figure 2, some devices 100 are in communication with DOCSIS Head End 125 and some devices 100 are in communication with DSLAM 125, which are in communication with the central provider access network 109.

[0058] **Figure 3** illustrates another wireless network architecture for providing device assisted CDR creation, aggregation, mediation and billing in accordance with some embodiments.

[0059] As shown, Figure 3 includes a 4G/3G/2G wireless network operated by, for example, a central provider. In some embodiments, each of the wireless devices 100 includes a service processor 115 (as shown), and each service processor connects through a secure control plane link to a service controller 122. In some embodiments, the network based service usage information (e.g., CDRs) is obtained from Radio Access Network (RAN) gateway(s) 410 and/or transport gateway(s) 420.

[0060] Referring now to the 4G/3G/2G access network as shown in Figure 3, the 4G/3G and 3G/2G base stations/nodes 125 are in communication with a 4G/3G/2G Radio Access Network (RAN) gateway 410 via a radio access network 405, which are in communication with a 4G/3G/2G transport gateway 420 via an access transport network 415. The central provider core network 110 is in network communication with the access transport network 415 (e.g., via a dedicated/leased line, and as shown, via a firewall 124). The Internet 120 is available via a firewall 124 and the transport gateway(s) 420, as shown. Also, as shown, a network apparatus provisioning system 160, order management 180, and subscriber management 182 are in communication with the central provider core network 110. As shown, a AAA server 121, a mobile wireless center/Home Location Register(HLR) 132, a DNS/DHCP 126, and CDR storage, aggregation, mediation, feed 118 are also in communication with the access transport network 415. The central billing system 123 and the central billing interface 127 are shown in communication with the central provider core network 110.

[0061] **Figure 4** illustrates provisioning of a wireless network for providing device assisted CDR creation, aggregation, mediation and billing in accordance with some embodiments. As shown in Figure 4, the provisioning of various network equipment is provided as shown to recognize each other as a CDR source (e.g., this may be done by hand or in an automated manner). For example, order management 180, subscriber management, billing interface 127, billing system 123, network provisioning system 160, service controller 122, access network AAA server 121, mobile wireless center 132, and CDR storage, aggregation, mediation feed 118 communicate with each other for such provisioning, which can be implemented using various techniques. In some embodiments, the various network elements are provisioned to recognize device assisted CDRs being generated by the service controller 122, which, for example, can be provided to the billing interface 127 and/or the billing system 123. In some embodiments, network generated CDRs are provided by RAN/Access gateway 410, aggregation/transport gateway 425, and/or base station controller 125. In some embodiments, other network elements generate/receive/store device assisted CDRs, and/or in some embodiments, other network elements generate/receive/store network generated CDRs.

[0062] In some embodiments, provisioning of various network equipment is provided to recognize a given device as belonging to a device group that supports a service usage and/or billing plan that relies upon and/or utilizes device assisted CDRs.

[0063] In some embodiments, the CDR formats, transaction codes, and CDR transmission destinations are programmed for each device that generates CDRs, including the service controller 122 (e.g., in some embodiments, the service controller 122 is the intermediary for CDRs) and/or service processor 115 (e.g., in some embodiments, the device sends CDRs to network CDR aggregation or billing interface 127/billing system 123 with no intermediate server function).

[0064] **Figure 5** illustrates a network architecture for providing device assisted CDRs in accordance with some embodiments. As shown, network generated CDRs are sent from various network elements to the CDR storage, aggregation, mediation, feed 118 and the service controller 122, as shown in dashed lines with arrows in Figure 5. In some embodiments, the network generated CDRs are used for verification of device assisted service (DAS) usage and/or billing information. In some embodiments, the network generated CDRs are provided to the service controller 122, and the service controller 122 implements aggregation and/or mediation rules to examine and, in some cases, aggregate and/or mediate network generated/based CDRs with device assisted/based CDRs.

[0065] In some embodiments, device assisted CDRs are sent from the service controller 122 to CDR storage, aggregation, mediation, feed 118 and communicated to the billing system 123, as shown in solid lines with arrows in Figure 5. In some embodiments, CDR storage, aggregation, mediation, feed 118 uses DAS service usage CDRs to augment network generated/based CDRs with bill-by-account transaction codes (e.g., as similarly discussed herein). In some embodiments, CDR storage, aggregation, mediation, feed 118 implements aggregation and/or mediation rules to account for DAS CDR usage amount in a new bill-by-account transaction code and removes the same service usage amount from the bulk device account transaction code. In some embodiments, one DAS CDR is sent for the new bill by account transaction code and another DAS CDR is sent to be used as a correction (credit) the main device usage account transaction code, and CDR storage, aggregation, mediation, feed 118

implements the rules to perform this mediation. In some embodiments, one DAS CDR is used for a given bill-by-account transaction code and another is used as the main device account transaction code, in which the service controller 122 (or device) has already implemented the mediation rules so that CDR storage, aggregation, mediation, feed 118 simply passes the DAS CDRs to billing after aggregating them.

[0066] **Figure 6** illustrates another network architecture for providing device assisted CDRs in accordance with some embodiments. Figure 6 also shows the communication of device assisted CDRs and network generated CDRs using solid and dashed lines with arrows, respectively. As shown, in some embodiments, CDR storage, aggregation, mediation, feed 118 sends network based CDRs to service controller 122 for various purposes, such as those previously discussed herein.

[0067] In some embodiments, service controller 123 sends DAS CDRs to billing for various uses by the billing system 123. In some embodiments, the billing system 123 uses DAS service usage CDRs to augment network based CDRs with bill-by-account transaction codes. In some embodiments, the billing system 123 implements aggregation and/or mediation rules to account for DAS CDR usage amount in a new bill-by-account transaction code and removes the same service usage amount from the bulk device account transaction code. In some embodiments, one DAS CDR is sent for the new bill by account transaction code and another DAS CDR is sent to be used as a correction (credit) the main device usage account transaction code, and the billing system 123 implements the rules to perform this mediation. In some embodiments, one DAS CDR is used for a given bill-by-account transaction code and another is used as the main device account transaction code, in which the service controller 122 (or device) has already implemented the mediation rules so that the billing system 123 simply passes uses DAS CDRs after aggregating them.

[0068] **Figure 7** illustrates another network architecture for providing device assisted CDRs in accordance with some embodiments. Figure 7 also shows the communication of device assisted CDRs and network generated CDRs using solid and dashed lines with arrows, respectively. Figure 7 is similar to Figure 6, except as shown in Figure 7, service usage information is passed through the billing interface 127 instead of the billing CDR aggregation

interface. For example, the service usage detailed bill-by-account information and offset (credit) information can be formatted as a CDR or can be formatted in a higher level syntax as required by the billing interface 127.

[0069] **Figure 8** illustrates another network architecture for providing device assisted CDRs in accordance with some embodiments. Figure 8 also shows the communication of device assisted CDRs and network generated CDRs using solid and dashed lines with arrows, respectively. In some embodiments, as shown in Figure 8, the central provider need not modify the existing CDR storage, aggregation, mediation, feed 118, so the additional aggregation and mediation rules discussed above with respect to Figure 5 are implemented as a new layer of rules in a new network function, shown as secondary DAS CDR aggregation mediation 118A, that is located between the billing system and the CDR storage, aggregation, mediation, feed 118. This new network function (e.g., secondary DAS CDR aggregation mediation 118A) can reside in the network (as shown) or in the service processor 115, in the service controller 122, or elsewhere in the network or on the device.

[0070] **Figure 9** is a functional diagram illustrating a device based service processor 115 and a service controller 122 in accordance with some embodiments. For example, this provides relatively full featured device based service processor implementation and service controller implementation. As shown, this corresponds to a networking configuration in which the service controller 122 is connected to the Internet 120 and not directly to the access network 1610. As shown, a data plane (e.g., service traffic plane) communication path is shown in solid line connections and control plane (e.g., service control plane) communication path is shown in dashed line connections. As previously discussed, it is understood that the division in functionality between one device agent and another is based on, for example, design choices, networking environments, devices and/or services/applications, and various different combinations can be used in various different implementations. For example, the functional lines can be re-drawn in any way that the product designers see fit. As shown, this includes certain divisions and functional breakouts for device agents as an illustrative implementation, although other, potentially more complex, embodiments can include different divisions and functional breakouts for device agent functionality specifications, for example, in order to manage development specification and testing complexity and workflow. In addition, the

placement of the agents that operate, interact with or monitor the data path can be moved or re-ordered in various embodiments. For example, the functional elements shown in Figure 9 are described below with respect to Figures 10 and 11.

[0071] **Figure 10** provides a table summarizing various service processer 115 functional elements in accordance with some embodiments.

[0072] **Figure11** provides a table summarizing various service controller 122 functional elements in accordance with some embodiments.

[0073] **Figure 12** illustrates a device stack providing various service usage measurement from various points in the networking stack for a service monitor agent, a billing agent, and an access control integrity agent to assist in verifying the service usage measures and billing reports in accordance with some embodiments.

[0074] **Figure 13** illustrates an embodiment similar to Figure 12 in which some of the service processor is implemented on the modem and some of the service processor is implemented on the device application processor in accordance with some embodiments.

[0075] **Figure 14** illustrates various embodiments of intermediate networking devices that include a service processor for the purpose of verifiable service usage measurement, reporting, and billing reports in accordance with some embodiments.

[0076] Those of ordinary skill in the art will appreciate that various other rules can be provided for the rules engine as described herein. Those of ordinary skill in the art will also appreciate that the functions described herein can be implemented using various other network architectures and network implementations (e.g., using various other networking protocols and corresponding network equipment).

[0077] Although the foregoing embodiments have been described in some detail for purposes of clarity of understanding, the invention is not limited to the details provided. There are many alternative ways of implementing the invention. The disclosed embodiments are illustrative and not restrictive.

[0078] WHAT IS CLAIMED IS:

CLAIMS

1. A system, comprising:

a processor of a network device in communication with a wireless network, wherein the processor is configured to:

collect device generated usage information for one or more devices on the wireless network; and

provide the device generated usage information in a syntax and a communication protocol that can be used by the wireless network to augment or replace network generated usage information for the one or more devices on the wireless network; and

a memory coupled to the processor and configured to provide the processor with instructions.

2. The system recited in claim 1, wherein the syntax is a charging data record (CDR).

3. The system recited in claim 1, wherein the syntax is a charging data record (CDR), and the communication protocol is selected from one or more of the following: 3GPP and 3GPP2.

4. The system recited in claim 1, wherein the network device includes a service usage data store.

5. The system recited in claim 1, wherein the network device includes a service usage data store and a rules engine for aggregating the collected device generated usage information.

6. The system recited in claim 1, wherein the syntax is a charging data record (CDR), and the network device is a CDR feed aggregator, and wherein the processor is further configured to:

aggregate CDRs for the one or more devices on the wireless network; and

apply a set of rules to the aggregated CDRs using a rules engine.

7. The system recited in claim 1, wherein the syntax is a charging data record (CDR), and the network device is a CDR feed aggregator, and wherein the processor is further configured to:

aggregate CDRs for the one or more devices on the wireless network;

apply a set of rules to the aggregated CDRs using a rules engine; and

communicate a new set of CDRs for the one or more devices on the wireless network to a billing interface or a billing system.

8. The system recited in claim 1, wherein the syntax is a charging data record (CDR), and the network device is a CDR feed aggregator, and wherein the processor is further configured to:

aggregate CDRs for the one or more devices on the wireless network;

apply a set of rules to the aggregated CDRs using a rules engine, wherein at least one rule includes a bill by account rule; and

communicate a new set of CDRs for the one or more devices on the wireless network to a billing interface or a billing system.

9. The system recited in claim 1, wherein the syntax is a charging data record (CDR), and the network device is a CDR feed aggregator, and wherein the processor is further configured to:

aggregate CDRs for the one or more devices on the wireless network;

apply a set of rules to the aggregated CDRs using a rules engine, wherein at least one rule includes a bill by account rule; and

communicate a new set of CDRs for the one or more devices on the wireless network to a billing interface or a billing system, wherein at least one CDR includes a billing offset.

10. The system recited in claim 1, wherein the syntax is a charging data record (CDR), and the network device is a CDR feed aggregator, and wherein the processor is further configured to:

communicate a new set of CDRs for the one or more devices on the wireless network to a billing interface or a billing system.

11. The system recited in claim 1, wherein the processor is further configured to:

communicate with a service controller to collect the device generated usage information for the one or more devices on the wireless network.

12. The system recited in claim 1, wherein the processor is further configured to:

communicate with a service controller, wherein the service controller is in communication with a billing interface or a billing system, and wherein the service controller communicates the device generated service usage information to the network device.

13. The system recited in claim 1, wherein the processor is further configured to:

communicate the device generated usage information to a billing interface or a billing system.

14. The system recited in claim 1, wherein a service controller in communication with the network device performs a rules engine for aggregating and mediating the device generated usage information.

15. The system recited in claim 1, wherein a rules engine device in communication with the network device performs a rules engine for aggregating and mediating the device generated usage information.

16. The system recited in claim 1, wherein the processor is further configured to:

communicate with a transport gateway or a Radio Access Network (RAN) gateway to collect the network generated usage information for the one or more devices on the wireless network.

17. The system recited in claim 1, wherein the processor is further configured to:

execute rules for performing a bill by account aggregation and mediation function.

18. A method, comprising:

collecting device generated usage information for one or more devices on a wireless network; and

providing the device generated usage information in a syntax and a communication protocol that can be used by the wireless network to augment or replace network generated usage information for the one or more devices on the wireless network.

19. The method recited in claim 18, wherein the syntax is a charging data record (CDR).

20. The system recited in claim 18, wherein the syntax is a charging data record (CDR), and the communication protocol is selected from one or more of the following: 3GPP and 3GPP2.

DEVICE ASSISTED CDR CREATION, AGGREGATION, MEDIATION AND BILLING

ABSTRACT OF THE DISCLOSURE

[0079] Device assisted CDR creation, aggregation, mediation and billing is provided. In some embodiments, device assisted CDR creation, aggregation, mediation and billing for a wireless network collects device generated usage information for one or more devices on the wireless network; and provides the device generated usage information in a syntax (e.g., charging data record (CDR)), and a communication protocol (e.g., 3GPP, 3GPP2, or other communication protocols) that can be used by the wireless network to augment or replace network generated usage information for the one or more devices on the wireless network.

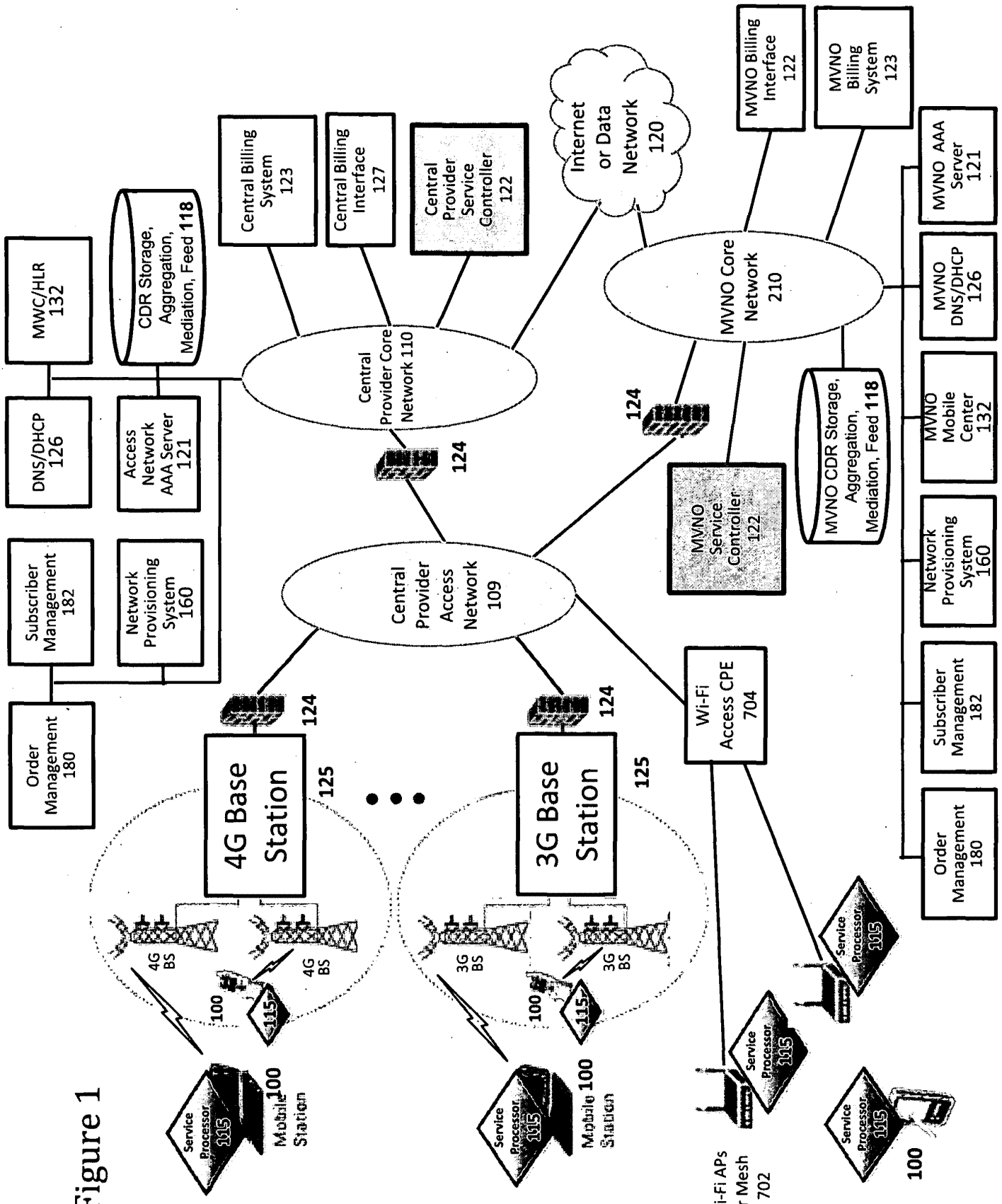

MWC/HLR 132
CDR Storage, Aggregation, Mediation, Feed 118
Central Billing System 123
Central Billing Interface 127
Central Provider Service Controller 122
Internet or Data Network 120
MVNO Billing Interface 122
MVNO Billing System 123
MVNO AAA Server 121
DNS/DHCP 126
Access Network AAA Server 121
Central Provider Core Network 110
MVNO Core Network 210
MVNO DNS/DHCP 126
Subscriber Management 182
Network Provisioning System 160
Central Provider Access Network 109
MVNO Service Controller 122
MVNO CDR Storage, Aggregation, Mediation, Feed 118
MVNO Mobile Center 132
Network Provisioning System 160
Order Management 180
4G Base Station
3G Base Station
Wi-Fi Access CPE 704
Subscriber Management 182
Order Management 180
124
125
4G BS
3G BS
100
115
Service Processor 115
Mobile Station 100
Wi-Fi APs or Mesh 702

Figure 1

Figure 2

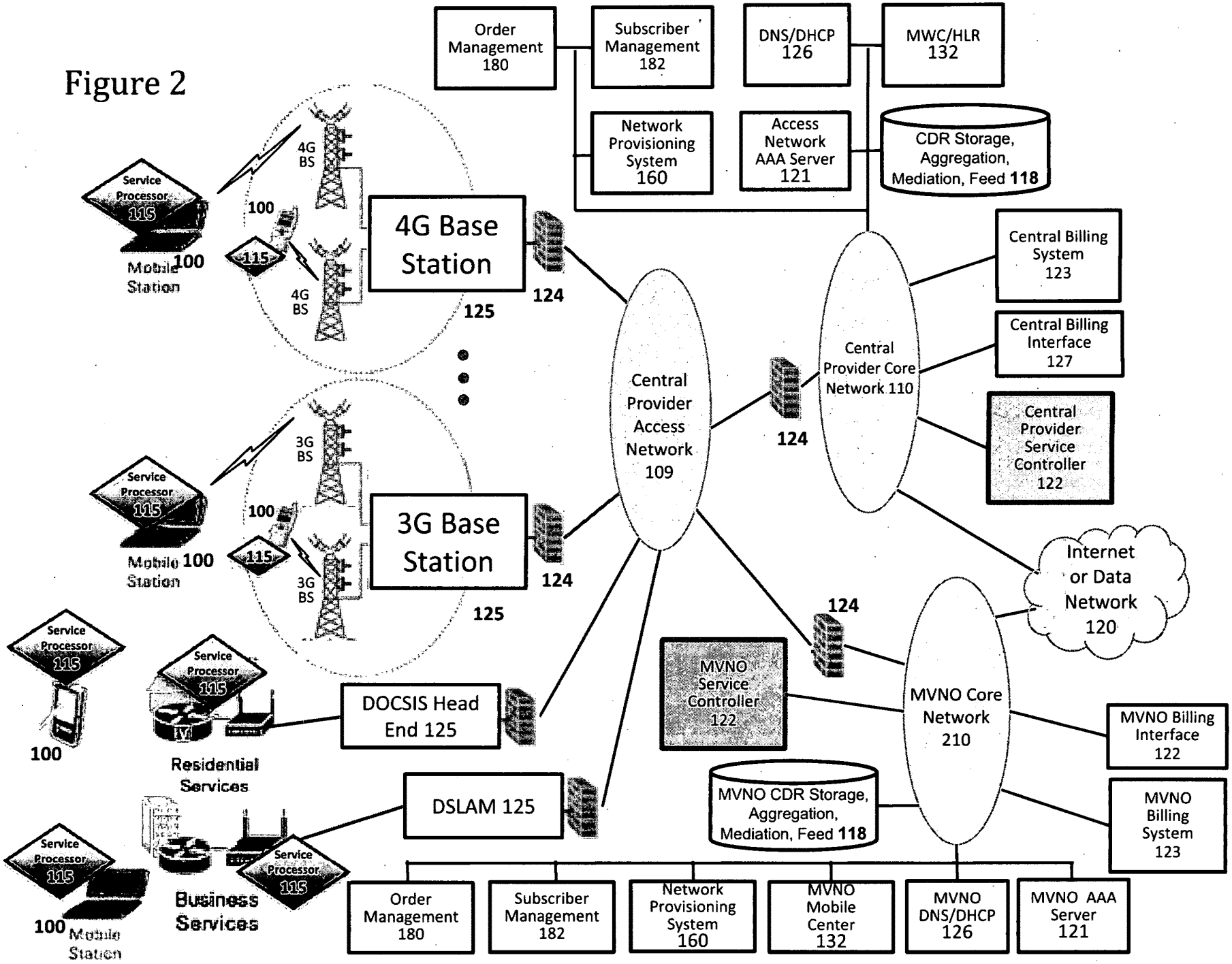

Order Management 180
Subscriber Management 182
DNS/DHCP 126
MWC/HLR 132
Network Provisioning System 160
Access Network AAA Server 121
CDR Storage, Aggregation, Mediation, Feed 118
4G Base Station
125
124
4G BS
Service Processor 115
100
Mobile Station
Central Provider Access Network 109
Central Provider Core Network 110
Central Billing System 123
Central Billing Interface 127
Central Provider Service Controller 122
3G Base Station
3G BS
Internet or Data Network 120
MVNO Service Controller 122
MVNO Core Network 210
MVNO Billing Interface 122
MVNO Billing System 123
DOCSIS Head End 125
DSLAM 125
Residential Services
Business Services
MVNO CDR Storage, Aggregation, Mediation, Feed 118
Order Management 180
Subscriber Management 182
Network Provisioning System 160
MVNO Mobile Center 132
MVNO DNS/DHCP 126
MVNO AAA Server 121

Figure 3

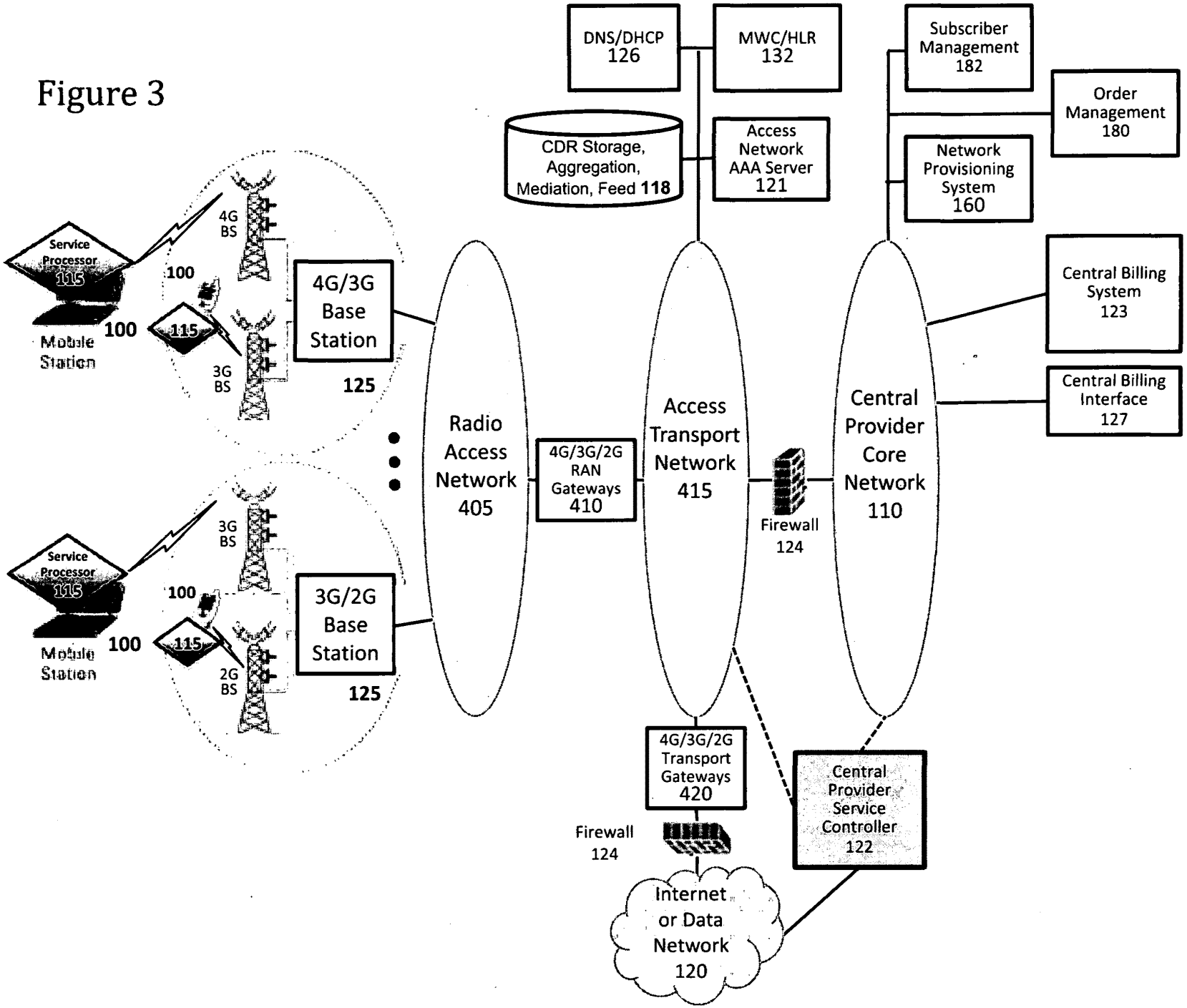

DNS/DHCP
126
MWC/HLR
132
Subscriber Management
182
Order Management
180
CDR Storage, Aggregation, Mediation, Feed 118
Access Network AAA Server
121
Network Provisioning System
160
Central Billing System
123
Central Billing Interface
127
Service Processor
115
100
Module Station
4G BS
3G BS
4G/3G Base Station
125
Radio Access Network
405
4G/3G/2G RAN Gateways
410
Access Transport Network
415
Firewall
124
Central Provider Core Network
110
3G BS
2G BS
3G/2G Base Station
4G/3G/2G Transport Gateways
420
Central Provider Service Controller
122
Internet or Data Network
120

Figure 4

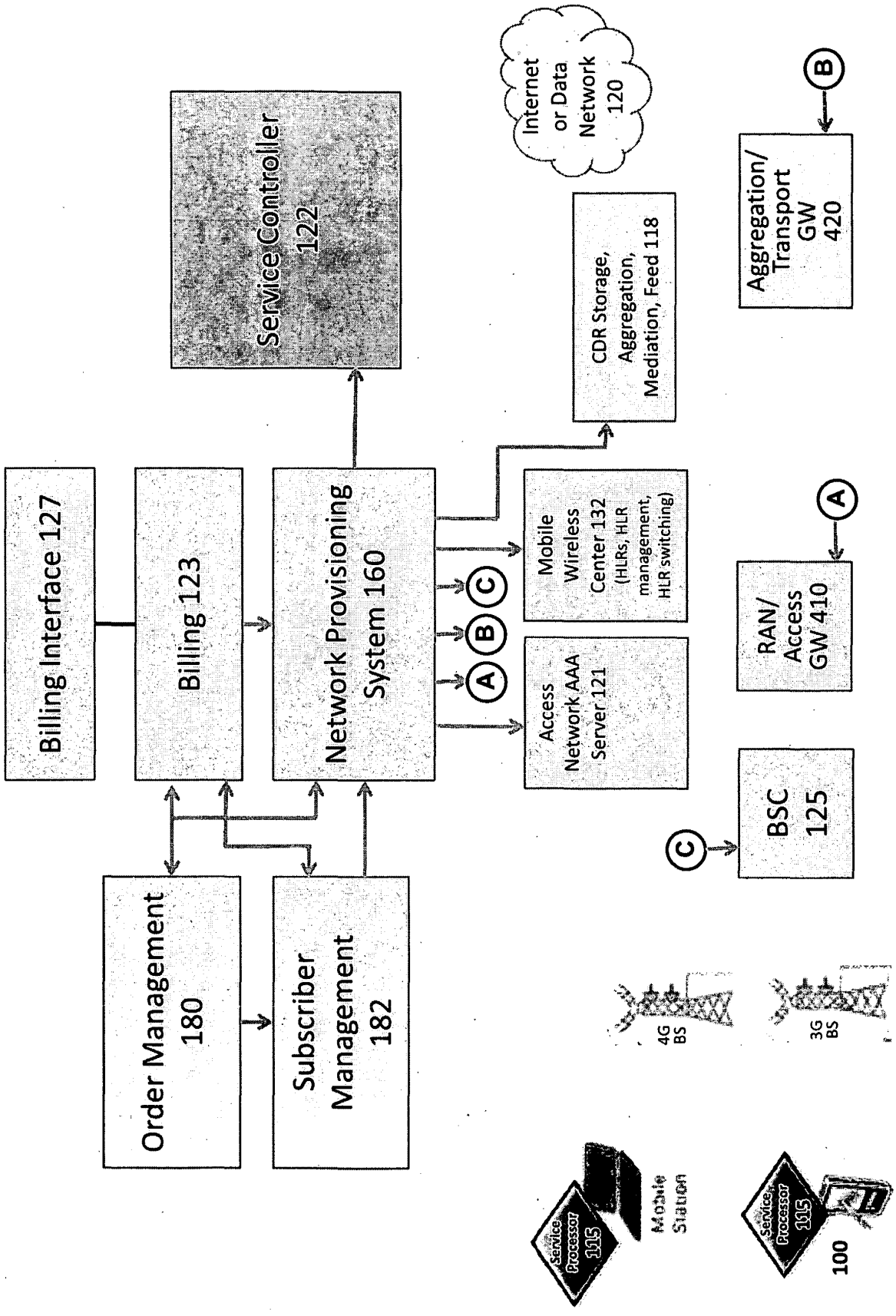

Billing Interface 127
Billing 123
Order Management 180
Subscriber Management 182
Network Provisioning System 160
Service Controller 122
Internet or Data Network 120
CDR Storage, Aggregation, Mediation, Feed 118
Mobile Wireless Center 132 (HLRs, HLR management, HLR switching)
Access Network AAA Server 121
BSC 125
RAN/ Access GW 410
Aggregation/ Transport GW 420
A
B
C
4G BS
3G BS
Service Processor 115
Mobile Station
100

Figure 5

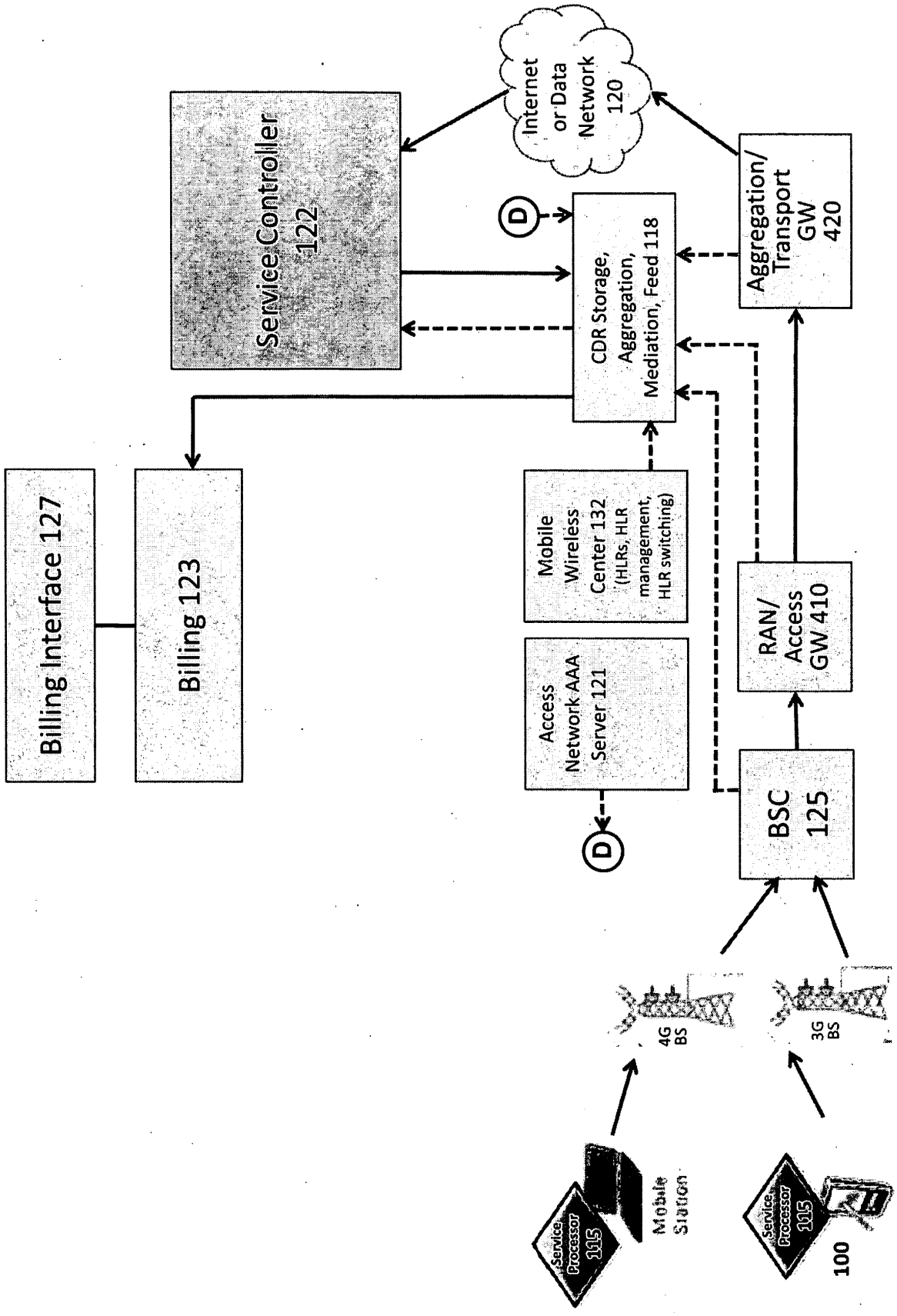

Billing Interface 127
Billing 123
Service Controller 122
Internet or Data Network 120
CDR Storage, Aggregation, Mediation, Feed 118
Aggregation/ Transport GW 420
Mobile Wireless Center 132 (HLRs, HLR management, HLR switching)
Access Network AAA Server 121
RAN/ Access GW 410
BSC 125
4G BS
3G BS
Mobile Station
Service Processor 115
Service Processor 115
100

Figure 6

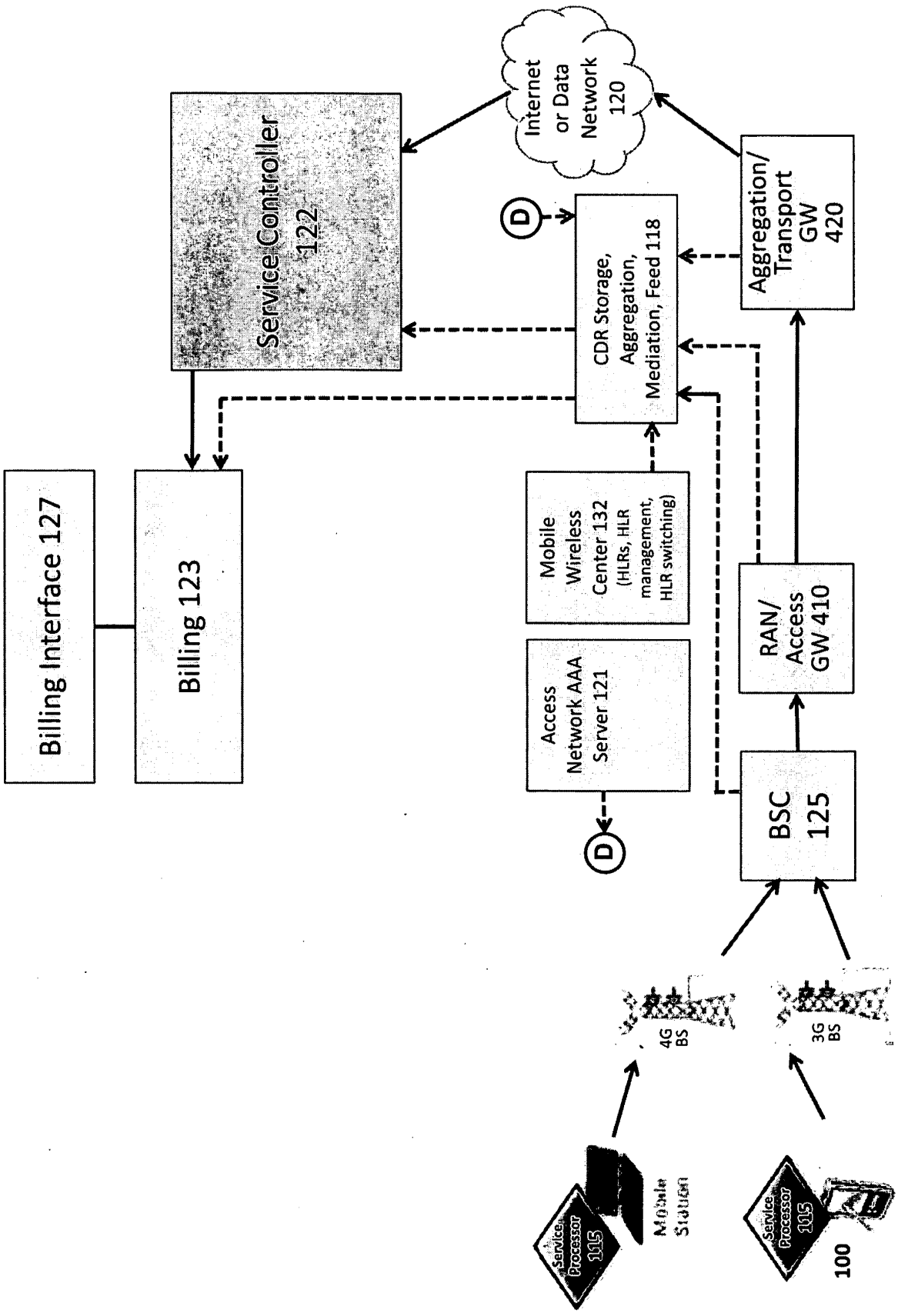

Billing Interface 127
Billing 123
Service Controller 122
Internet or Data Network 120
Aggregation/ Transport GW 420
CDR Storage, Aggregation, Mediation, Feed 118
Mobile Wireless Center 132 (HLRs, HLR management, HLR switching)
Access Network AAA Server 121
RAN/ Access GW 410
BSC 125
4G BS
3G BS
Service Processor 115
Service Processor 115
100

Figure 7

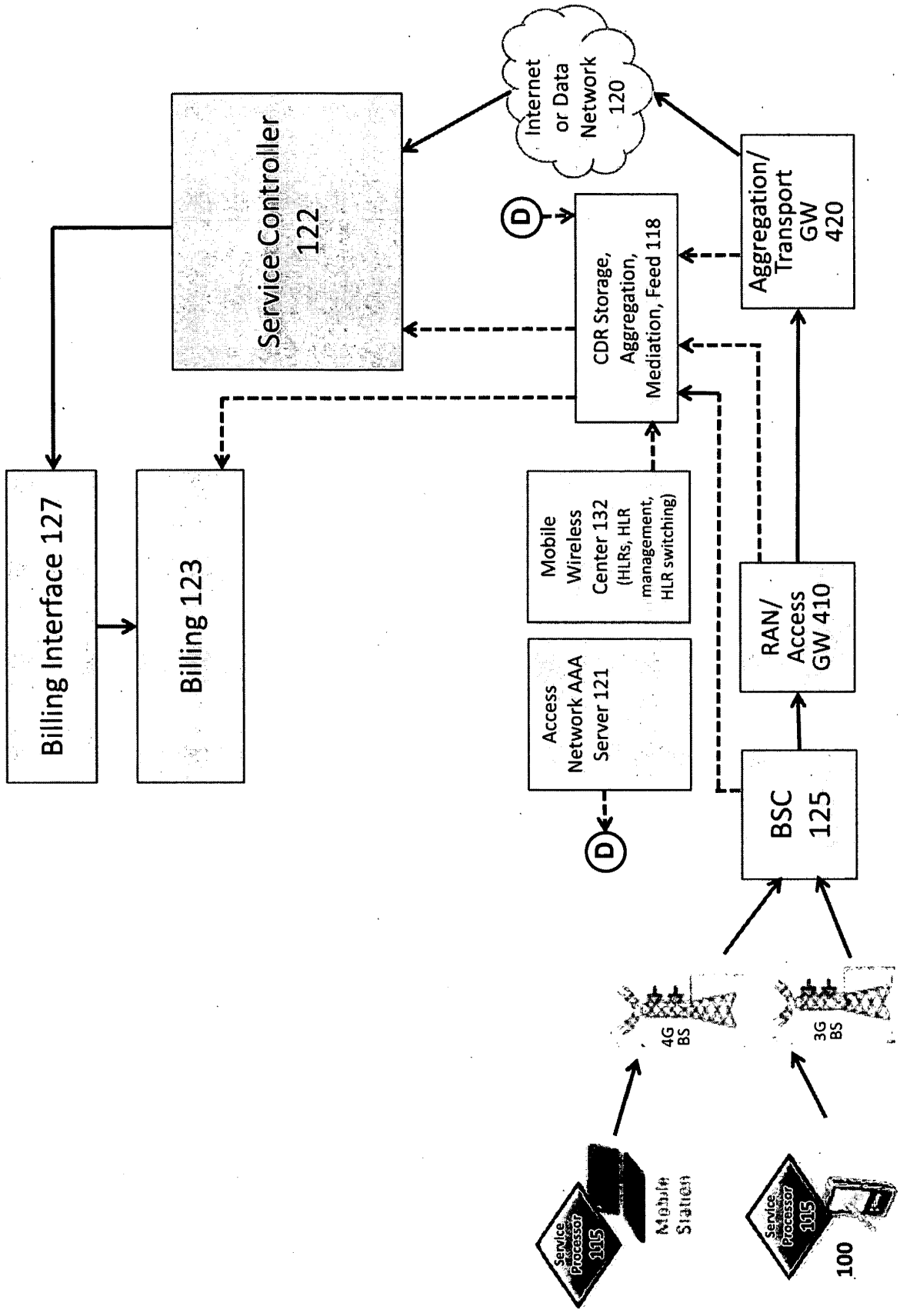
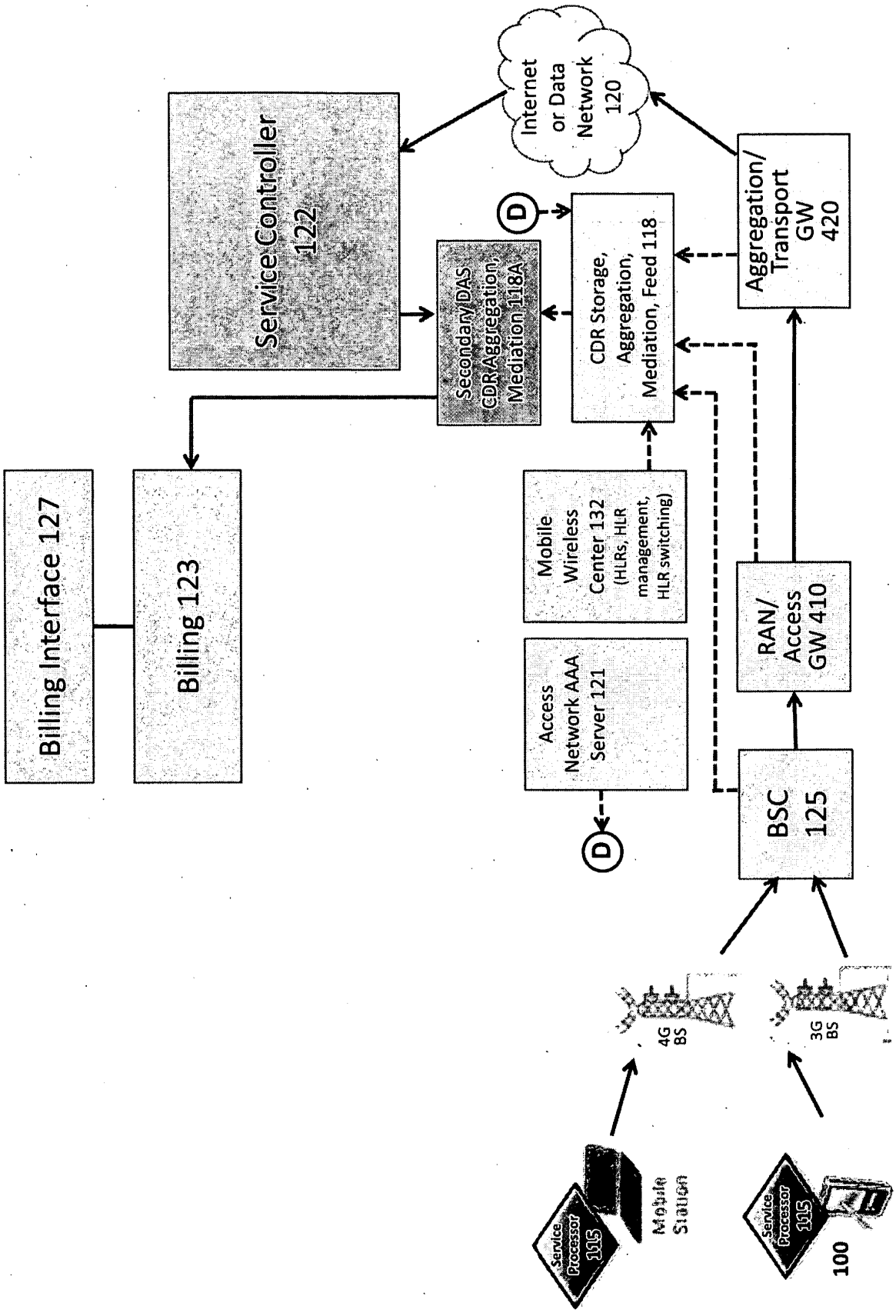

Billing Interface 127
Billing 123
Service Controller 122
Internet or Data Network 120
CDR Storage, Aggregation, Mediation, Feed 118
Aggregation/ Transport GW 420
Mobile Wireless Center 132 (HLRs, HLR management, HLR switching)
Access Network AAA Server 121
RAN/ Access GW 410
BSC 125
4G BS
3G BS
Service Processor 115
Service Processor 115
100

Figure 8


Billing Interface 127
Billing 123
Service Controller 122
Internet or Data Network 120
Secondary DAS CDR Aggregation, Mediation 118A
CDR Storage, Aggregation, Mediation, Feed 118
Aggregation/ Transport GW 420
Mobile Wireless Center 132 (HLRs, HLR management, HLR switching)
Access Network AAA Server 121
RAN/ Access GW 410
BSC 125
4G BS
3G BS
Service Processor 115
Service Processor 115
100

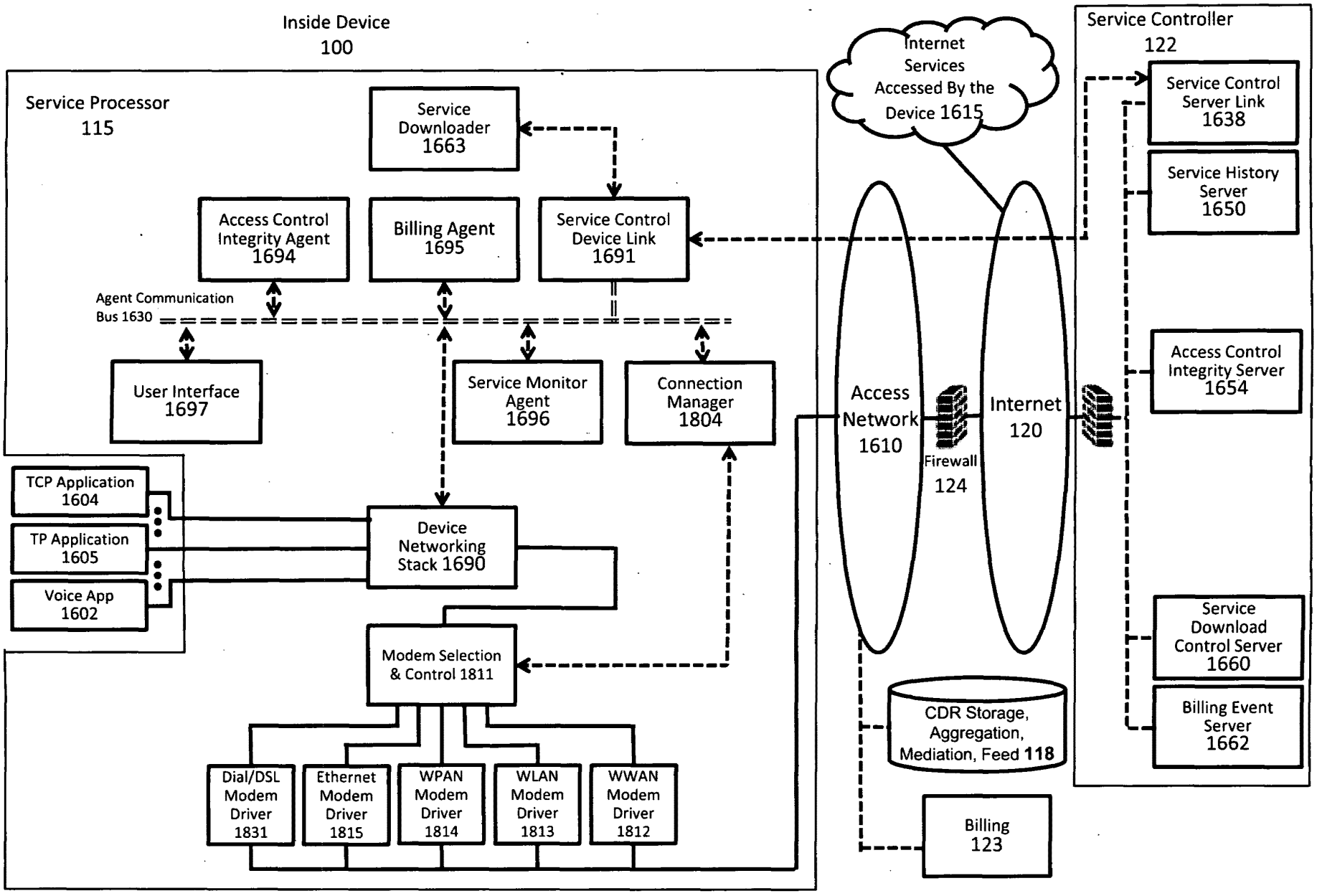

Inside Device
100
Service Processor
115
Service Downloader
1663
Access Control Integrity Agent
1694
Billing Agent
1695
Service Control Device Link
1691
Agent Communication Bus 1630
User Interface
1697
Service Monitor Agent
1696
Connection Manager
1804
TCP Application
1604
TP Application
1605
Voice App
1602
Device Networking Stack 1690
Modem Selection & Control 1811
Dial/DSL Modem Driver
1831
Ethernet Modem Driver
1815
WPAN Modem Driver
1814
WLAN Modem Driver
1813
WWAN Modem Driver
1812
Internet Services Accessed By the Device 1615
Access Network
1610
Firewall
124
Internet
120
Service Controller
122
Service Control Server Link
1638
Service History Server
1650
Access Control Integrity Server
1654
Service Download Control Server
1660
Billing Event Server
1662
CDR Storage, Aggregation, Mediation, Feed 118
Billing
123
= Service Control Plane Communication Path
= Service Traffic Plane Communication Path

Figure 9

Service Processor 115 Embodiment	Partial Summary of Embodiment Functions
Service Control Device Link 1691	Device side control plane link for connecting Service Processor 415 to Service Controller. In some embodiments, also serves as the link for the agent heartbeat function.
Access Control Integrity Agent 1694	Collects device information on service policy, service usage, agent configuration and agent behavior. Cross checks this information to identify integrity breaches in the service policy implementation and control system. Initiates action when a service policy violation or a system integrity breach is suspected. In some embodiments, verifies configuration of other agents or performs challenge-response sequence testing. In some embodiments, monitors software loading activity, protected memory access or communication with Service Processor agents to detect unauthorized changes to Service Processor software or configuration.
Service Monitor Agent 1696	Records and reports device service usage. In some embodiments, assists in communicating application tagging of traffic flows through the networking stack policy implementation. In some embodiments, maintains a history and provides reports or summary reports of which networks in addition to the networks controlled by the Service Controller that the device has connected to. In some embodiments, this network activity summary may include a summary of the networks accessed, activity vs. time per connection, traffic vs. time per connection.
Billing Agent 1695	Detects and reports billing events. In some embodiments interacts with the User Interface Agent 497 to provide the user with service plan options, accept service plan selections, provide notification on service usage levels, provide options on service usage control policy, accept choices on service usage policy, provide transaction options or accept transaction choices. In some embodiments, interacts with Transaction Servers 134 to conduct ecommerce transactions with central billing.
User Interface 1697	Provide service interface to users.
Service Downloader 1663	Provides a download function to install or update service software elements on the device.
Connection Manager 1804	Provides a control and supervision function for one or more modem drivers or modems that connect to an access network.
Modem Selection and Control 1811	Selects the access network connection.
Modem Drivers 1831, 1815, 1814, 1813, 1812	Converts data traffic into modem bus traffic for one or more modems.
Modems 2141, 2125, 2124, 2123, 2122	Connects the device to one or more networks.

Figure 10

Service Controller 122 Element	Partial Summary of Embodiment Functions
Service Control Server Link 1638	Network side control plane link for connecting Service Controller 422 Service Processor 415 device agents. In some embodiments, also serves as the link for the agent heartbeat function.
Access Control Integrity Server 1654	Collects device information on service policy, service usage, agent configuration and agent behavior. Cross checks this information to identify integrity breaches in the service policy implementation and control system. Initiates action when a service policy violation or a system integrity breach is suspected.
Service History Server 118	Collects and records service usage reports from the Access Network AAA Server 421 and the Service Monitor Agent 496. In some embodiments, maintains a history of which networks in addition to the networks controlled by the Service Controller that the device has connected to. In some embodiments, this network activity summary may include a summary of the networks accessed, activity vs. time per connection, traffic vs. time per connection. In some embodiments, this activity summary is further analyzed or reported to estimate the type of service plan associated with the traffic activity for the purpose of bill sharing reconciliation.
Central Provider Billing System 123	Provides mediation function for central provider billing events. Accepts service plan changes. In some embodiments, provides updates on device service usage, service plan limits or service policies.
Billing Event Server 1662	In some embodiments, collects billing events, provides service plan information to the Service Processor 415, provides service usage updates to the Service Processor 415, serves as interface between device and central Provider Billing System 123, or provides trusted third party function for certain ecommerce billing transactions.
Service Download Control Server 1660	Provides a download function to install or update service software elements on the device.

Figure 11

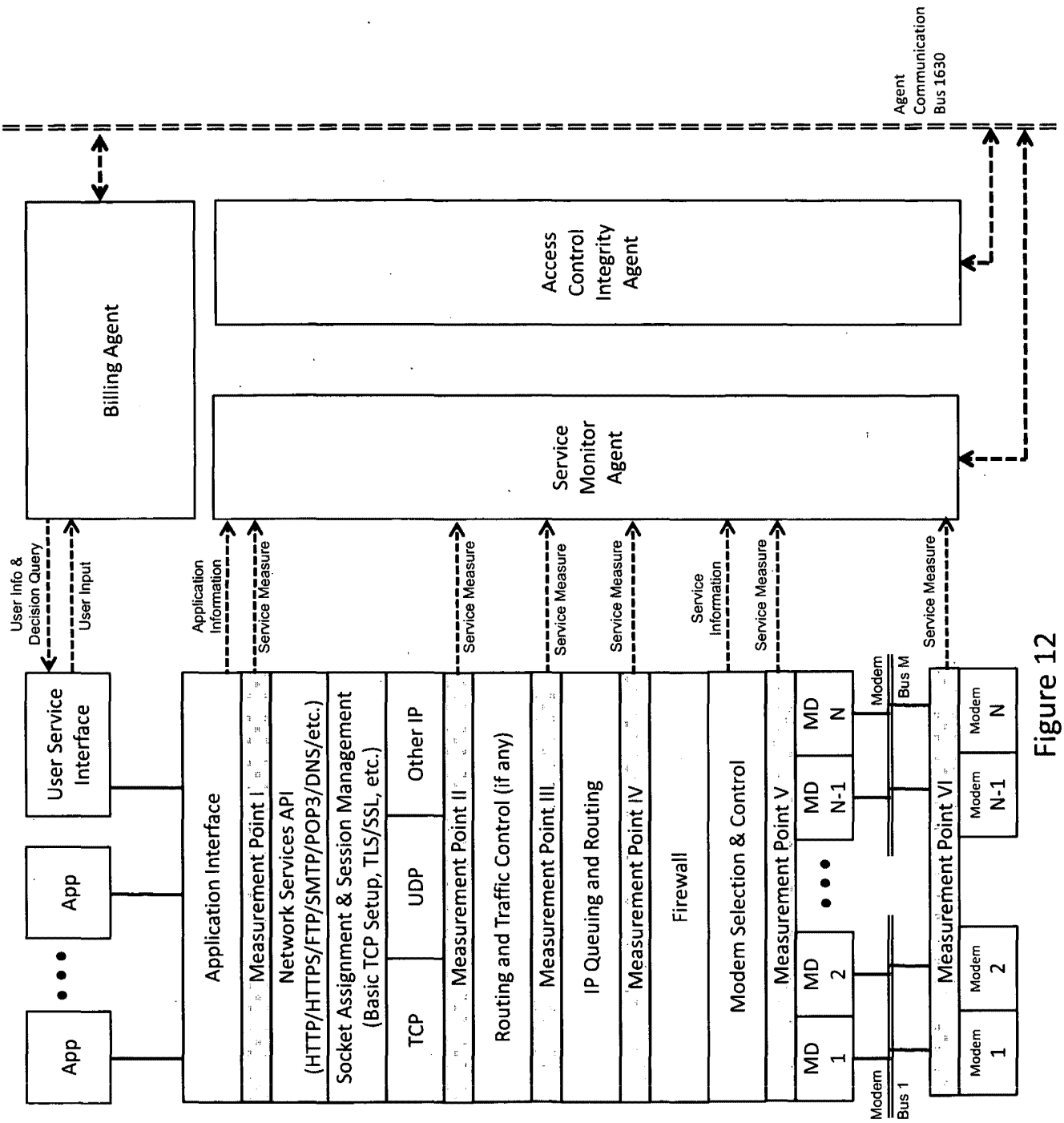

Agent Communication Bus 1630
Billing Agent
Access Control Integrity Agent
Service Monitor Agent
User Info & Decision Query
User Input
Application Information
Service Measure
Service Information
App
User Service Interface
Application Interface
Measurement Point I
Network Services API (HTTP/HTTPS/FTP/SMTP/POP3/DNS/etc.)
Socket Assignment & Session Management (Basic TCP Setup, TLS/SSL, etc.)
TCP
UDP
Other IP
Measurement Point II
Routing and Traffic Control (if any)
Measurement Point III
IP Queuing and Routing
Measurement Point IV
Firewall
Modem Selection & Control
Measurement Point V
MD 1
MD 2
MD N-1
MD N
Modem
Bus 1
Bus M
Measurement Point VI
Modem 1
Modem 2
Modem N-1
Modem N

Figure 12

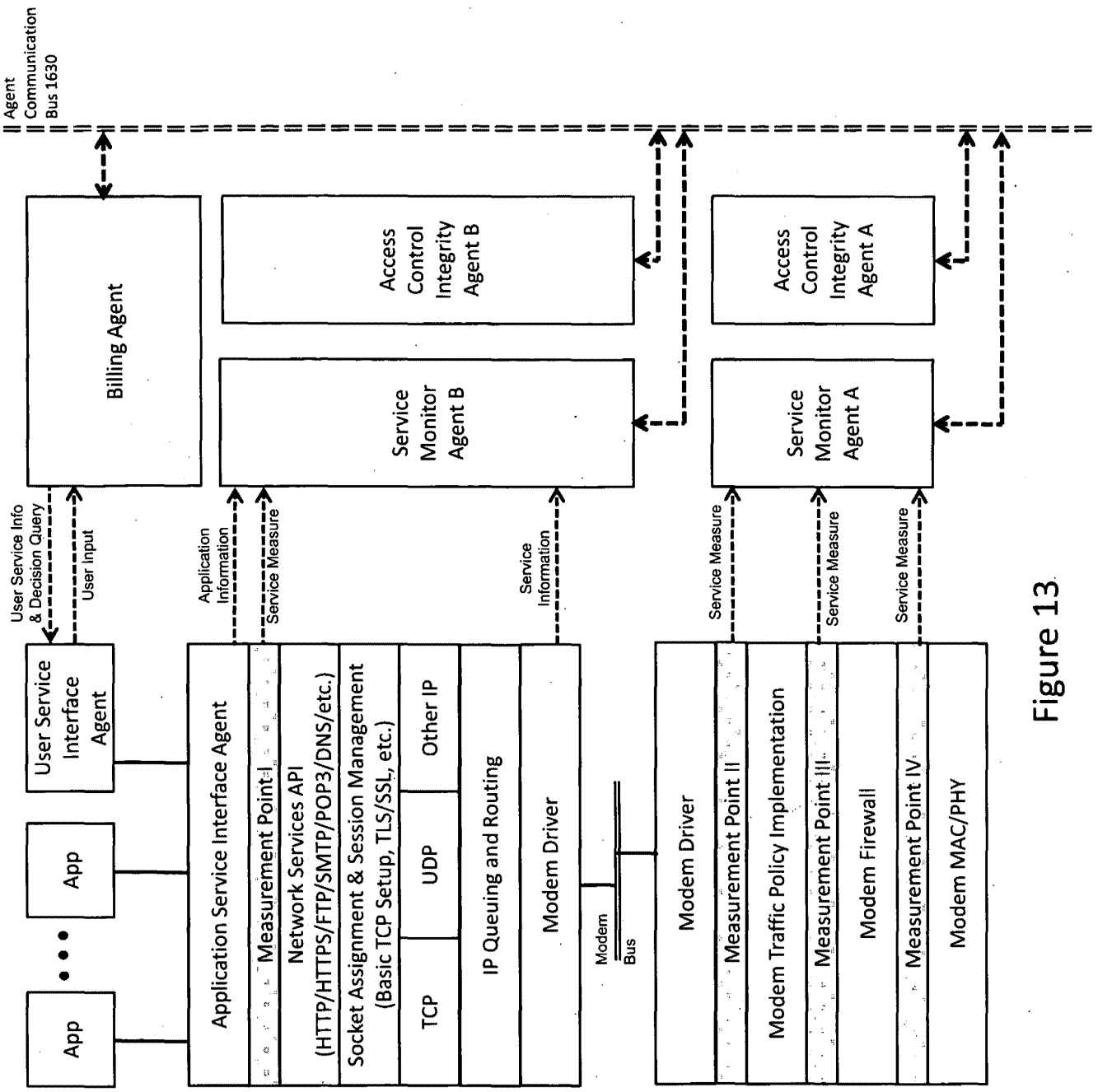

Agent Communication Bus 1630
Billing Agent
Access Control Integrity Agent B
Service Monitor Agent B
Access Control Integrity Agent A
Service Monitor Agent A
User Service Info & Decision Query
User Input
Application Information
Service Measure
Service Information
Service Measure
Service Measure
Service Measure
User Service Interface Agent
App
App
Application Service Interface Agent
Measurement Point I
Network Services API (HTTP/HTTPS/FTP/SMTP/POP3/DNS/etc.)
Socket Assignment & Session Management (Basic TCP Setup, TLS/SSL, etc.)
TCP
UDP
Other IP
IP Queuing and Routing
Modem Driver
Modem Bus
Modem Driver
Measurement Point II
Modem Traffic Policy Implementation
Measurement Point III
Modem Firewall
Measurement Point IV
Modem MAC/PHY

Figure 13

Figure 14(A)

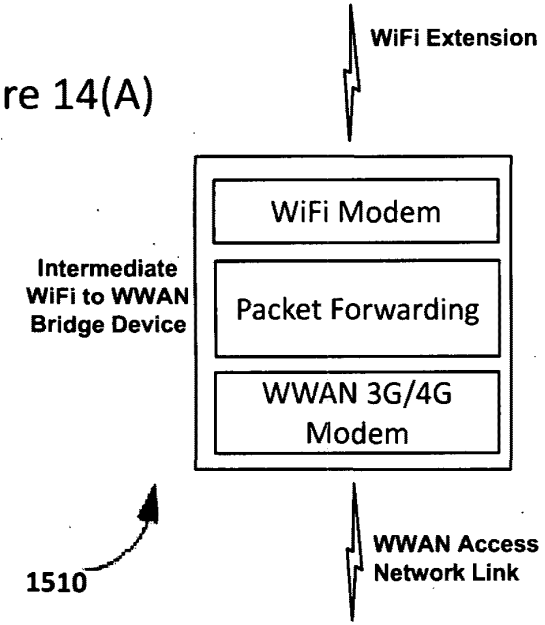
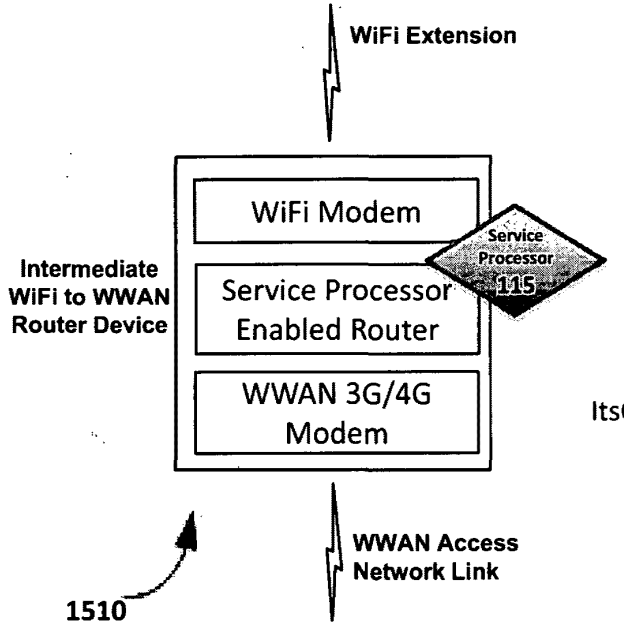


Figure 14(B)



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Figure 14

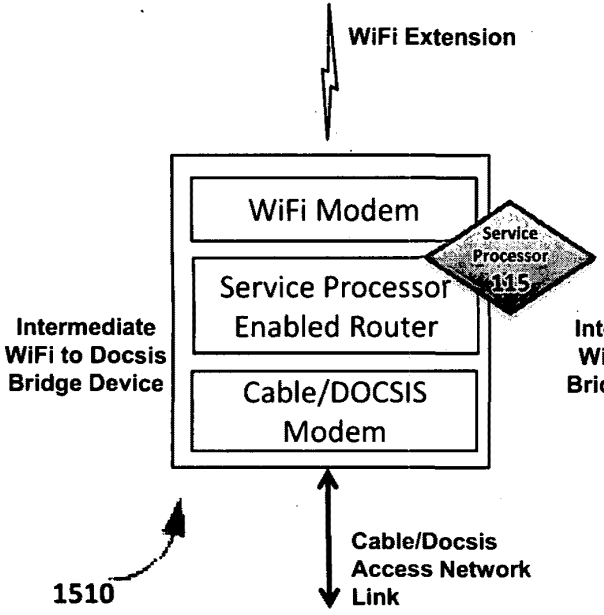


Figure 14(C)

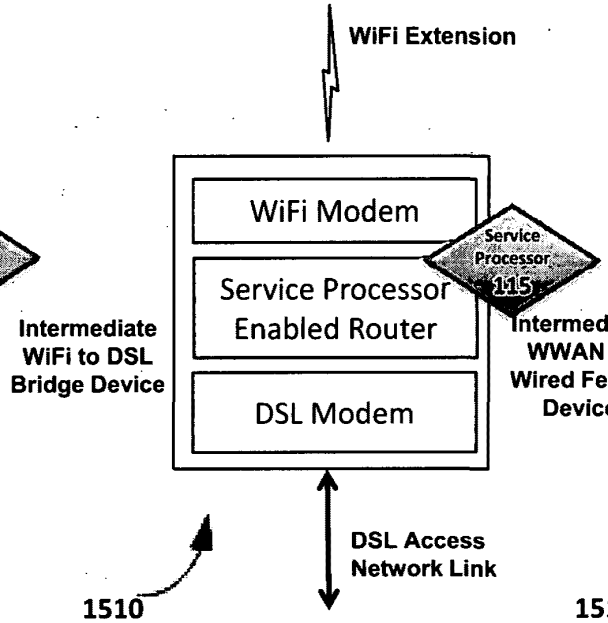


Figure 14 (D)

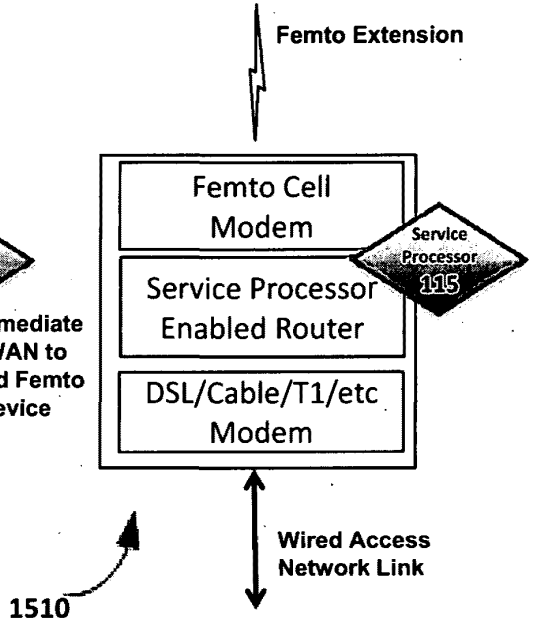


Figure 14 (E)

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