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(54) **ENTERPRISE ACCESS CONTROL AND ACCOUNTING ALLOCATION FOR ACCESS NETWORKS**

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(56) **References Cited**

U.S. PATENT DOCUMENTS

5,131,020 A 7/1992 Liebesny et al.
5,283,904 A 2/1994 Carson et al.
(Continued)

FOREIGN PATENT DOCUMENTS

CA 2688553 A1 12/2008
CN 1310401 A 8/2001
(Continued)

OTHER PUBLICATIONS

A. Freier, et al., The Secure Sockets Layer (SSL) Protocol Version 3.0, Internet Engineering Task Force (IETF), Request for Comments: 6101, ISSN: 2070-1721, Aug. 2011, available at <https://datatracker.ietf.org/doc/html/rfc6101>.

(Continued)

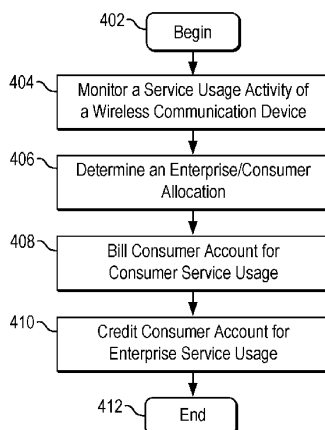
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(57) **ABSTRACT**

Enterprise and consumer billing allocation for wireless communication device service usage activities is provided. In some embodiments, enterprise and consumer billing allocation for wireless communication device service usage activities includes monitoring a service usage activity of a wireless communication device, and determining an enterprise and consumer billing allocation for the monitored service usage activity. In some embodiments, enterprise and consumer billing allocation for wireless communication device service usage activities includes monitoring a service usage activity of a wireless communication device, and reporting the monitored service usage activity to a network element, in which the network element determines an enterprise and consumer billing allocation for the monitored service usage activity. In some embodiments, enterprise and consumer billing allocation for wireless communication device service usage activities includes providing a service design center for configuring an enterprise and consumer

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billing allocation of monitored service usage activities for a plurality of wireless communication devices associated with an enterprise account, and implementing the configured enterprise and consumer billing allocation for monitored service usage activities for the plurality of wireless communication devices associated with the enterprise account.

12 Claims, 28 Drawing Sheets

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(56) References Cited

U.S. PATENT DOCUMENTS

5,325,532 A 6/1994 Crosswy et al.
 5,572,528 A 11/1996 Shuen
 5,577,100 A 11/1996 McGregor et al.
 5,594,777 A 1/1997 Makkonen et al.
 5,617,539 A 4/1997 Ludwig et al.
 5,630,159 A 5/1997 Zanchi
 5,633,484 A 5/1997 Zanchi et al.
 5,633,868 A 5/1997 Baldwin et al.
 5,751,719 A 5/1998 Chen et al.
 5,754,953 A 5/1998 Briancon et al.
 5,774,532 A 6/1998 Gottlieb et al.
 5,794,142 A 8/1998 Vanttila et al.
 5,814,798 A 9/1998 Zanchi
 5,889,477 A 3/1999 Fastenrath
 5,892,900 A 4/1999 Ginter et al.
 5,903,845 A 5/1999 Buhrmann et al.
 5,915,008 A 6/1999 Dulman
 5,915,226 A 6/1999 Martineau
 5,933,778 A 8/1999 Buhrmann et al.
 5,940,472 A 8/1999 Newman et al.
 5,974,439 A 10/1999 Bollella
 5,983,270 A 11/1999 Abraham et al.

5,987,611 A 11/1999 Freund
 6,035,281 A 3/2000 Crosskey et al.
 6,038,452 A 3/2000 Strawczynski et al.
 6,038,540 A 3/2000 Krist et al.
 6,047,268 A 4/2000 Bartoli et al.
 6,047,270 A 4/2000 Joao et al.
 6,058,434 A 5/2000 Wilt et al.
 6,061,571 A 5/2000 Tamura
 6,064,878 A 5/2000 Denker et al.
 6,078,953 A 6/2000 Vaid et al.
 6,081,591 A 6/2000 Skoog
 6,098,878 A 8/2000 Dent et al.
 6,104,700 A 8/2000 Haddock et al.
 6,115,823 A 9/2000 Velasco et al.
 6,119,933 A 9/2000 Wong et al.
 6,125,391 A 9/2000 Meltzer et al.
 6,141,565 A 10/2000 Feuerstein et al.
 6,141,686 A 10/2000 Jackowski et al.
 6,148,336 A 11/2000 Thomas et al.
 6,154,738 A 11/2000 Call
 6,157,636 A 12/2000 Voit et al.
 6,185,576 B1 2/2001 McIntosh
 6,198,915 B1 3/2001 McGregor et al.
 6,219,786 B1 4/2001 Cunningham et al.
 6,223,042 B1 4/2001 Raffel
 6,226,277 B1 5/2001 Chuah
 6,246,870 B1 6/2001 Dent et al.
 6,263,055 B1 7/2001 Garland et al.
 6,292,828 B1 9/2001 Williams
 6,317,584 B1 11/2001 Abu-Amara et al.
 6,370,139 B2 4/2002 Redmond
 6,381,316 B2 4/2002 Joyce et al.
 6,393,014 B1 5/2002 Daly et al.
 6,397,259 B1 5/2002 Lincke et al.
 6,401,113 B2 6/2002 Lazaridis et al.
 6,418,147 B1 7/2002 Wiedeman
 6,438,575 B1 8/2002 Khan et al.
 6,445,777 B1 9/2002 Clark
 6,449,479 B1 9/2002 Sanchez
 6,466,984 B1 10/2002 Naveh et al.
 6,477,670 B1 11/2002 Ahmadvand
 6,502,131 B1 12/2002 Vaid et al.
 6,505,114 B2 1/2003 Luciani
 6,510,152 B1 1/2003 Gerszberg et al.
 6,522,629 B1 2/2003 Anderson, Sr.
 6,526,066 B1 2/2003 Weaver
 6,532,235 B1 3/2003 Benson et al.
 6,532,579 B2 3/2003 Sato et al.
 6,535,855 B1 3/2003 Cahill et al.
 6,535,949 B1 3/2003 Parker
 6,539,082 B1 3/2003 Lowe et al.
 6,542,465 B1 4/2003 Wang
 6,542,500 B1 4/2003 Gerszberg et al.
 6,542,992 B1 4/2003 Peirce et al.
 6,546,016 B1 4/2003 Gerszberg et al.
 6,563,806 B1 5/2003 Yano et al.
 6,570,974 B1 5/2003 Gerszberg et al.
 6,574,321 B1 6/2003 Cox et al.
 6,574,465 B2 6/2003 Marsh et al.
 6,578,076 B1 6/2003 Putzolu
 6,581,092 B1 6/2003 Motoyama
 6,591,098 B1 7/2003 Shieh et al.
 6,598,034 B1 7/2003 Kloth
 6,601,040 B1 7/2003 Kolls
 6,603,969 B1 8/2003 Vuoristo et al.
 6,603,975 B1 8/2003 Inouchi et al.
 6,606,744 B1 8/2003 Mikurak
 6,615,034 B1 9/2003 Alloune et al.
 6,628,934 B2 9/2003 Rosenberg et al.
 6,631,122 B1 10/2003 Arunachalam et al.
 6,636,721 B2 10/2003 Threadgill et al.
 6,639,975 B1 10/2003 O'Neal et al.
 6,640,097 B2 10/2003 Corrigan et al.
 6,640,334 B1 10/2003 Rasmussen
 6,650,887 B2 11/2003 McGregor et al.
 6,651,101 B1 11/2003 Gai et al.
 6,654,786 B1 11/2003 Fox et al.
 6,654,814 B1 11/2003 Britton et al.
 6,658,254 B1 12/2003 Purdy et al.

US 12,200,786 B2

Page 3

(56)

References Cited

U.S. PATENT DOCUMENTS

6,662,014	B1	12/2003	Walsh	7,042,988	B2	5/2006	Juitt et al.
6,678,516	B2	1/2004	Nordman et al.	7,043,225	B1	5/2006	Patel et al.
6,683,853	B1	1/2004	Kannas et al.	7,043,226	B2	5/2006	Yamauchi
6,684,244	B1	1/2004	Goldman et al.	7,043,268	B2	5/2006	Yukie et al.
6,690,918	B2	2/2004	Evans et al.	7,047,276	B2	5/2006	Liu et al.
6,694,362	B1	2/2004	Secor et al.	7,058,022	B1	6/2006	Carolan et al.
6,697,821	B2	2/2004	Ziff et al.	7,058,968	B2	6/2006	Rowland et al.
6,704,873	B1	3/2004	Underwood	7,068,600	B2	6/2006	Cain
6,725,031	B2	4/2004	Watler et al.	7,069,248	B2	6/2006	Huber
6,725,256	B1	4/2004	Albal et al.	7,082,422	B1	7/2006	Zirngibl et al.
6,732,176	B1	5/2004	Stewart et al.	7,084,775	B1	8/2006	Smith
6,735,206	B1	5/2004	Oki et al.	7,092,696	B1	8/2006	Hosain et al.
6,748,195	B1	6/2004	Phillips	7,095,754	B2	8/2006	Benveniste
6,748,437	B1	6/2004	Mankude et al.	7,099,943	B1	8/2006	Tondering
6,751,296	B1	6/2004	Albal et al.	7,102,620	B2	9/2006	Harries et al.
6,754,470	B2	6/2004	Hendrickson et al.	7,110,753	B2	9/2006	Campen
6,757,717	B1	6/2004	Goldstein	7,113,780	B2	9/2006	Mckenna et al.
6,760,417	B1	7/2004	Wallenius	7,113,997	B2	9/2006	Jayapalan et al.
6,763,000	B1	7/2004	Walsh	7,120,133	B1	10/2006	Joo et al.
6,763,226	B1	7/2004	McZeal, Jr.	7,131,578	B2	11/2006	Paschini et al.
6,765,864	B1	7/2004	Natarajan et al.	7,133,386	B2	11/2006	Holur et al.
6,765,925	B1	7/2004	Sawyer et al.	7,133,695	B2	11/2006	Beyda
6,782,412	B2	8/2004	Brophy et al.	7,133,907	B2	11/2006	Carlson et al.
6,785,889	B1	8/2004	Williams	7,136,361	B2	11/2006	Benveniste
6,792,461	B1	9/2004	Hericourt	7,139,569	B2	11/2006	Kato
6,829,596	B1	12/2004	Fraze	7,142,876	B2	11/2006	Trossen et al.
6,829,696	B1	12/2004	Balmer et al.	7,149,229	B1	12/2006	Leung
6,839,340	B1	1/2005	Voit et al.	7,149,521	B2	12/2006	Sundar et al.
6,842,628	B1	1/2005	Arnold et al.	7,151,764	B1	12/2006	Heinonen et al.
6,873,988	B2	3/2005	Herrmann et al.	7,158,792	B1	1/2007	Cook et al.
6,876,653	B2	4/2005	Ambe et al.	7,162,237	B1	1/2007	Silver et al.
6,879,825	B1	4/2005	Daly	7,165,040	B2	1/2007	Ehrman et al.
6,882,718	B1	4/2005	Smith	7,167,078	B2	1/2007	Pourchot
6,885,997	B1	4/2005	Roberts	7,171,199	B1	1/2007	Rahman
6,898,654	B1	5/2005	Senior et al.	7,174,156	B1	2/2007	Mangal
6,901,440	B1	5/2005	Bimm et al.	7,174,174	B2	2/2007	Boris et al.
6,920,455	B1	7/2005	Weschler	7,177,919	B1	2/2007	Truong et al.
6,922,562	B2	7/2005	Ward et al.	7,180,855	B1	2/2007	Lin
6,928,280	B1	8/2005	Xanthos et al.	7,181,017	B1	2/2007	Nagel et al.
6,934,249	B1	8/2005	Bertin et al.	7,191,248	B2	3/2007	Chattopadhyay et al.
6,934,751	B2	8/2005	Jayapalan et al.	7,197,321	B2	3/2007	Erskine et al.
6,947,723	B1	9/2005	Gurnani et al.	7,200,112	B2	4/2007	Sundar et al.
6,947,985	B2	9/2005	Hegli et al.	7,200,551	B1	4/2007	Senez
6,952,428	B1	10/2005	Necka et al.	7,203,169	B1	4/2007	Okholm et al.
6,957,067	B1	10/2005	Iyer et al.	7,203,721	B1	4/2007	Ben-Efraim et al.
6,959,202	B2	10/2005	Heinonen et al.	7,203,752	B2	4/2007	Rice et al.
6,959,393	B2	10/2005	Hollis et al.	7,207,041	B2	4/2007	Elson et al.
6,965,667	B2	11/2005	Trabandt et al.	7,209,664	B1	4/2007	McNicol et al.
6,965,872	B1	11/2005	Grdina	7,212,491	B2	5/2007	Koga
6,967,958	B2	11/2005	Ono et al.	7,219,123	B1	5/2007	Fiechter et al.
6,970,692	B2	11/2005	Tysor	7,222,190	B2	5/2007	Klinker et al.
6,970,927	B1	11/2005	Stewart et al.	7,222,304	B2	5/2007	Beaton et al.
6,982,733	B1	1/2006	McNally et al.	7,224,968	B2	5/2007	Dobson et al.
6,983,370	B2	1/2006	Eaton et al.	7,228,354	B2	6/2007	Chambliss et al.
6,996,062	B1	2/2006	Freed et al.	7,236,780	B2	6/2007	Benco
6,996,076	B1	2/2006	Forbes et al.	7,242,668	B2	7/2007	Kan et al.
6,996,393	B2	2/2006	Pyhalammi et al.	7,242,920	B2	7/2007	Morris
6,998,985	B2	2/2006	Reisman et al.	7,245,901	B2	7/2007	McGregor et al.
7,000,001	B2	2/2006	Lazaridis	7,248,570	B2	7/2007	Bahl et al.
7,002,920	B1	2/2006	Ayyagari et al.	7,248,868	B2	7/2007	Snyder et al.
7,007,295	B1	2/2006	Rose et al.	7,251,218	B2	7/2007	Jorgensen
7,013,469	B2	3/2006	Smith et al.	7,260,382	B1	8/2007	Lamb et al.
7,017,189	B1	3/2006	DeMello et al.	7,266,371	B1	9/2007	Amin et al.
7,020,781	B1	3/2006	Saw et al.	7,269,157	B2	9/2007	Klinker et al.
7,023,909	B1	4/2006	Adams	7,271,765	B2	9/2007	Stilp et al.
7,024,200	B2	4/2006	McKenna et al.	7,272,660	B1	9/2007	Powers et al.
7,024,460	B2	4/2006	Koopmas et al.	7,280,816	B2	10/2007	Fratti et al.
7,027,055	B2	4/2006	Anderson et al.	7,280,818	B2	10/2007	Clayton
7,027,408	B2	4/2006	Nabkel et al.	7,283,561	B1	10/2007	Picher-Dempsey
7,031,733	B2	4/2006	Alminana et al.	7,283,963	B1	10/2007	Fitzpatrick et al.
7,032,072	B1	4/2006	Quinn et al.	7,286,834	B2	10/2007	Walter
7,039,027	B2	5/2006	Bridgelall	7,286,848	B2	10/2007	Vireday et al.
7,039,037	B2	5/2006	Wang et al.	7,289,489	B1	10/2007	Kung et al.
7,039,403	B2	5/2006	Wong	7,290,283	B2	10/2007	Copeland, III
7,039,713	B1	5/2006	Van Gunter et al.	7,310,424	B2	12/2007	Gehring et al.
				7,313,237	B2	12/2007	Bahl et al.
				7,315,892	B2	1/2008	Freimuth et al.
				7,317,699	B2	1/2008	Godfrey et al.
				7,318,111	B2	1/2008	Zhao

US 12,200,786 B2

Page 4

(56)

References Cited

U.S. PATENT DOCUMENTS

7,320,029 B2	1/2008	Rinne et al.	7,539,132 B2	5/2009	Werner et al.
7,320,781 B2	1/2008	Lambert et al.	7,539,862 B2	5/2009	Edgett et al.
7,322,044 B2	1/2008	Hrastar	7,540,408 B2	6/2009	Levine et al.
7,324,447 B1	1/2008	Morford	7,545,782 B2	6/2009	Rayment et al.
7,325,037 B2	1/2008	Lawson	7,546,460 B2	6/2009	Maes
7,336,960 B2	2/2008	Zavalkovsky et al.	7,546,629 B2	6/2009	Albert et al.
7,340,244 B1	3/2008	Osborne et al.	7,548,875 B2	6/2009	Mikkelsen et al.
7,340,772 B2	3/2008	Panasyuk et al.	7,548,976 B2	6/2009	Bahl et al.
7,346,410 B2	3/2008	Uchiyama	7,551,921 B2	6/2009	Petermann
7,349,695 B2	3/2008	Oommen et al.	7,551,922 B2	6/2009	Roskowski et al.
7,349,698 B2	3/2008	Gallagher et al.	7,554,983 B1	6/2009	Muppala
7,353,533 B2	4/2008	Wright et al.	7,555,757 B2	6/2009	Smith et al.
7,356,011 B1	4/2008	Waters et al.	7,561,899 B2	7/2009	Lee
7,356,337 B2	4/2008	Florence	7,562,213 B1	7/2009	Timms
7,366,497 B2	4/2008	Nagata	7,564,799 B2	7/2009	Holland et al.
7,366,654 B2	4/2008	Moore	7,565,141 B2	7/2009	Macaluso
7,366,934 B1	4/2008	Narayan et al.	7,565,328 B1	7/2009	Donner
7,369,848 B2	5/2008	Jiang	7,574,509 B2	8/2009	Nixon et al.
7,369,856 B2	5/2008	Ovadia	7,574,731 B2	8/2009	Fascenda
7,373,136 B2	5/2008	Watler et al.	7,577,431 B2	8/2009	Jiang
7,373,179 B2	5/2008	Stine et al.	7,580,356 B1	8/2009	Mishra et al.
7,379,731 B2	5/2008	Natsuno et al.	7,580,857 B2	8/2009	VanFleet et al.
7,388,950 B2	6/2008	Elsey et al.	7,583,964 B2	9/2009	Wong
7,389,412 B2	6/2008	Sharma et al.	7,584,298 B2	9/2009	Klinker et al.
7,391,724 B2	6/2008	Alakoski et al.	7,585,217 B2	9/2009	Utnick et al.
7,395,056 B2	7/2008	Petermann	7,586,871 B2	9/2009	Hamilton et al.
7,395,244 B1	7/2008	Kingsford	7,593,417 B2	9/2009	Wang et al.
7,401,338 B1	7/2008	Bowen et al.	7,593,730 B2	9/2009	Khandelwal et al.
7,403,763 B2	7/2008	Maes	7,596,373 B2	9/2009	Mcgregor et al.
7,409,447 B1	8/2008	Assadzadeh	7,599,288 B2	10/2009	Cole et al.
7,409,569 B2	8/2008	Illowsky et al.	7,599,714 B2	10/2009	Kuzminskiy
7,411,930 B2	8/2008	Montejo et al.	7,602,746 B2	10/2009	Calhoun et al.
7,418,253 B2	8/2008	Kavanah	7,603,710 B2	10/2009	Harvey et al.
7,418,257 B2	8/2008	Kim	7,606,357 B2	10/2009	Daigle
7,421,004 B2	9/2008	Fehér	7,606,918 B2	10/2009	Holzman et al.
7,423,971 B1	9/2008	Mohaban et al.	7,607,041 B2	10/2009	Kraemer et al.
7,428,750 B1	9/2008	Dunn et al.	7,609,650 B2	10/2009	Roskowski et al.
7,433,362 B2	10/2008	Mallya et al.	7,609,700 B1	10/2009	Ying et al.
7,436,816 B2	10/2008	Mehta et al.	7,610,047 B2	10/2009	Hicks, III et al.
7,440,433 B2	10/2008	Rink et al.	7,610,057 B2	10/2009	Bahl et al.
7,444,669 B1	10/2008	Bahl et al.	7,610,328 B2	10/2009	Haase et al.
7,450,591 B2	11/2008	Korling et al.	7,610,396 B2	10/2009	Taglienti et al.
7,450,927 B1	11/2008	Creswell et al.	7,612,712 B2	11/2009	LaMance et al.
7,454,191 B2	11/2008	Dawson et al.	7,613,444 B2	11/2009	Lindqvist et al.
7,457,265 B2	11/2008	Julka et al.	7,614,051 B2	11/2009	Glaum et al.
7,457,870 B1	11/2008	Lownsbrough et al.	7,616,962 B2	11/2009	Oswal et al.
7,460,837 B2	12/2008	Diener	7,617,516 B2	11/2009	Huslak et al.
7,466,652 B2	12/2008	Lau et al.	7,620,041 B2	11/2009	Dunn et al.
7,467,160 B2	12/2008	McIntyre	7,620,065 B2	11/2009	Falardeau
7,472,189 B2	12/2008	Mallya et al.	7,620,162 B2	11/2009	Aaron et al.
7,478,420 B2	1/2009	Wright et al.	7,620,383 B2	11/2009	Taglienti et al.
7,486,185 B2	2/2009	Culpepper et al.	7,627,314 B2	12/2009	Carlson et al.
7,486,658 B2	2/2009	Kumar	7,627,600 B2	12/2009	Citron et al.
7,489,918 B2	2/2009	Zhou et al.	7,627,767 B2	12/2009	Sherman et al.
7,493,659 B1	2/2009	Wu et al.	7,627,872 B2	12/2009	Hebeler et al.
7,496,652 B2	2/2009	Pezzutti	7,633,438 B2	12/2009	Tysowski
7,499,438 B2	3/2009	Hinman et al.	7,634,253 B2	12/2009	Plestid et al.
7,499,537 B2	3/2009	Elsey et al.	7,634,388 B2	12/2009	Archer et al.
7,502,672 B1	3/2009	Kolls	7,636,574 B2	12/2009	Poosala
7,505,756 B2	3/2009	Bahl	7,636,626 B2	12/2009	Oesterling et al.
7,505,795 B1	3/2009	Lim et al.	7,643,411 B2	1/2010	Andreassen et al.
7,508,794 B2	3/2009	Feather et al.	7,644,151 B2	1/2010	Jerrim et al.
7,508,799 B2	3/2009	Sumner et al.	7,644,267 B2	1/2010	Ylikoski et al.
7,512,128 B2	3/2009	DiMambro et al.	7,644,414 B2	1/2010	Smith et al.
7,512,131 B2	3/2009	Svensson et al.	7,647,047 B2	1/2010	Moghaddam et al.
7,515,608 B2	4/2009	Yuan et al.	7,650,137 B2	1/2010	Jobs et al.
7,515,926 B2	4/2009	Bu et al.	7,653,394 B2	1/2010	McMillin
7,516,219 B2	4/2009	Moghaddam et al.	7,656,271 B2	2/2010	Ehrman et al.
7,522,549 B2	4/2009	Karaoguz et al.	7,657,920 B2	2/2010	Arseneau et al.
7,522,576 B2	4/2009	Du et al.	7,660,419 B1	2/2010	Ho
7,526,541 B2	4/2009	Roesse et al.	7,661,124 B2	2/2010	Ramanathan et al.
7,529,204 B2	5/2009	Bourlas et al.	7,664,494 B2	2/2010	Jiang
7,533,158 B2	5/2009	Grannan et al.	7,668,176 B2	2/2010	Chuah
7,535,880 B1	5/2009	Hinman et al.	7,668,612 B1	2/2010	Okkonen
7,536,695 B2	5/2009	Alam et al.	7,668,903 B2	2/2010	Edwards et al.
			7,668,966 B2	2/2010	Klinker et al.
			7,676,673 B2	3/2010	Weller et al.
			7,680,086 B2	3/2010	Eglin
			7,681,226 B2	3/2010	Kraemer et al.

US 12,200,786 B2

Page 5

(56)

References Cited

U.S. PATENT DOCUMENTS

7,684,370 B2	3/2010	Kezys	7,843,843 B1	11/2010	Papp, III et al.
7,685,131 B2	3/2010	Batra et al.	7,844,034 B1	11/2010	Oh et al.
7,685,254 B2	3/2010	Pandya	7,844,728 B2	11/2010	Anderson et al.
7,685,530 B2	3/2010	Sherrard et al.	7,848,768 B2	12/2010	Omori et al.
7,688,792 B2	3/2010	Babbar et al.	7,849,161 B2	12/2010	Koch et al.
7,693,107 B2	4/2010	De Froment	7,849,170 B1	12/2010	Hargens et al.
7,693,720 B2	4/2010	Kennewick et al.	7,849,477 B2	12/2010	Cristofalo et al.
7,697,540 B2	4/2010	Haddad et al.	7,853,250 B2	12/2010	Harvey et al.
7,707,320 B2	4/2010	Singhai et al.	7,853,255 B2	12/2010	Karaoguz et al.
7,710,932 B2	5/2010	Muthuswamy et al.	7,853,656 B2	12/2010	Yach et al.
7,711,848 B2	5/2010	Maes	7,856,226 B2	12/2010	Wong et al.
7,719,966 B2	5/2010	Luft et al.	7,860,088 B2	12/2010	Lioy
7,720,206 B2	5/2010	Devolites et al.	7,865,182 B2	1/2011	Macaluso
7,720,464 B2	5/2010	Batta	7,865,187 B2	1/2011	Ramer et al.
7,720,505 B2	5/2010	Gopi et al.	7,868,778 B2	1/2011	Kenwright
7,720,960 B2	5/2010	Pruss et al.	7,868,814 B1	1/2011	Bergman
7,721,296 B2	5/2010	Ricagni	7,873,001 B2	1/2011	Silver
7,724,716 B2	5/2010	Fadell	7,873,344 B2	1/2011	Bowser et al.
7,725,570 B1	5/2010	Lewis	7,873,346 B2	1/2011	Petersson et al.
7,729,326 B2	6/2010	Sekhar	7,873,540 B2	1/2011	Arumugam
7,730,123 B1	6/2010	Erickson et al.	7,873,705 B2	1/2011	Kalish
7,734,784 B1	6/2010	Araujo et al.	7,873,985 B2	1/2011	Baum
7,742,406 B1	6/2010	Muppala	7,877,090 B2	1/2011	Maes
7,742,961 B2	6/2010	Aaron et al.	7,881,199 B2	2/2011	Krstulich
7,743,119 B2	6/2010	Friend et al.	7,881,267 B2	2/2011	Crosswy et al.
7,746,854 B2	6/2010	Ambe et al.	7,881,697 B2	2/2011	Baker et al.
7,747,240 B1	6/2010	Briscoe et al.	7,882,029 B2	2/2011	White
7,747,699 B2	6/2010	Prueitt et al.	7,882,247 B2	2/2011	Sturniolo et al.
7,747,730 B1	6/2010	Harlow	7,882,560 B2	2/2011	Kraemer et al.
7,752,330 B2	7/2010	Olsen et al.	7,885,644 B2	2/2011	Gallagher et al.
7,756,056 B2	7/2010	Kim et al.	7,886,047 B1	2/2011	Potluri
7,756,509 B2	7/2010	Rajagopalan et al.	7,889,384 B2	2/2011	Armentrout et al.
7,756,534 B2	7/2010	Anupam et al.	7,890,084 B1	2/2011	Dudziak et al.
7,756,757 B1	7/2010	Oakes, III	7,890,111 B2	2/2011	Bugenhagen
7,757,185 B2	7/2010	Paquette et al.	7,890,581 B2	2/2011	Rao et al.
7,760,137 B2	7/2010	Martucci et al.	7,894,431 B2	2/2011	Goring et al.
7,760,711 B1	7/2010	Kung et al.	7,899,039 B2	3/2011	Andreasen et al.
7,760,861 B1	7/2010	Croak et al.	7,899,438 B2	3/2011	Baker et al.
7,765,294 B2	7/2010	Edwards et al.	7,903,553 B2	3/2011	Liu
7,769,397 B2	8/2010	Funato et al.	7,907,970 B2	3/2011	Park et al.
7,770,785 B2	8/2010	Jha et al.	7,908,358 B1	3/2011	Prasad et al.
7,774,323 B2	8/2010	Helfman	7,911,975 B2	3/2011	Droz et al.
7,774,412 B1	8/2010	Schnepel	7,912,025 B2	3/2011	Pattenden et al.
7,774,456 B1	8/2010	Lownsbrough et al.	7,912,056 B1	3/2011	Brassem
7,778,176 B2	8/2010	Morford	7,916,707 B2	3/2011	Fontaine
7,778,643 B2	8/2010	Laroia et al.	7,917,130 B1	3/2011	Christensen et al.
7,783,754 B2	8/2010	Morford et al.	7,920,529 B1	4/2011	Mahler et al.
7,788,386 B2	8/2010	Svensson	7,921,463 B2	4/2011	Sood et al.
7,788,700 B1	8/2010	Feezel et al.	7,924,730 B1	4/2011	McAllister et al.
7,792,257 B1	9/2010	Vanier et al.	7,925,740 B2	4/2011	Nath et al.
7,792,538 B2	9/2010	Kozisek	7,925,778 B1	4/2011	Wijnands et al.
7,792,708 B2	9/2010	Alva	7,929,446 B2	4/2011	Bozarth et al.
7,797,019 B2	9/2010	Friedmann	7,929,959 B2	4/2011	DeAtley et al.
7,797,060 B2	9/2010	Grgic et al.	7,929,960 B2	4/2011	Martin et al.
7,797,204 B2	9/2010	Balent	7,929,973 B2	4/2011	Zavalkovsky et al.
7,797,401 B2	9/2010	Stewart et al.	7,930,327 B2	4/2011	Craft et al.
7,801,523 B1	9/2010	Kenderov	7,930,446 B2	4/2011	Kesselman et al.
7,801,783 B2	9/2010	Kende et al.	7,930,553 B2	4/2011	Satarasinghe et al.
7,801,985 B1	9/2010	Pitkow et al.	7,933,274 B2	4/2011	Verma et al.
7,802,724 B1	9/2010	Nohr	7,936,736 B2	5/2011	Proctor, Jr. et al.
7,805,140 B2	9/2010	Friday et al.	7,937,069 B2	5/2011	Rassam
7,805,522 B2	9/2010	Schlüter et al.	7,937,450 B2	5/2011	Janik
7,805,606 B2	9/2010	Birger et al.	7,937,470 B2	5/2011	Curley et al.
7,809,351 B1	10/2010	Panda et al.	7,940,685 B1	5/2011	Breslau et al.
7,809,372 B2	10/2010	Rajaniemi	7,940,751 B2	5/2011	Hansen
7,813,746 B2	10/2010	Rajkotia	7,941,184 B2	5/2011	Prendergast et al.
7,817,615 B1	10/2010	Breau et al.	7,944,948 B2	5/2011	Chow et al.
7,817,983 B2	10/2010	Cassett et al.	7,945,238 B2	5/2011	Baker et al.
7,821,985 B2	10/2010	Van Megen et al.	7,945,240 B1	5/2011	Klock et al.
7,822,837 B1	10/2010	Urban et al.	7,945,470 B1	5/2011	Cohen et al.
7,822,849 B2	10/2010	Titus	7,945,945 B2	5/2011	Graham et al.
7,826,427 B2	11/2010	Sood et al.	7,948,952 B2	5/2011	Hurtta et al.
7,826,607 B1	11/2010	De Carvalho Resende et al.	7,948,953 B2	5/2011	Melkote et al.
7,835,275 B1	11/2010	Swan et al.	7,948,968 B2	5/2011	Voit et al.
7,843,831 B2	11/2010	Morrill et al.	7,949,529 B2	5/2011	Weider et al.
			7,953,808 B2	5/2011	Sharp et al.
			7,953,877 B2	5/2011	Vemula et al.
			7,957,020 B2	6/2011	Mine et al.
			7,957,381 B2	6/2011	Clermidy et al.

US 12,200,786 B2

Page 6

(56)

References Cited

U.S. PATENT DOCUMENTS

7,957,511 B2	6/2011	Drudis et al.	8,073,721 B1	12/2011	Lewis
7,958,029 B1	6/2011	Bobich et al.	8,078,140 B2	12/2011	Baker et al.
7,962,622 B2	6/2011	Friend et al.	8,078,163 B2	12/2011	Lemond et al.
7,965,983 B1	6/2011	Swan et al.	8,081,612 B2	12/2011	Want et al.
7,966,405 B2	6/2011	Sundaresan et al.	8,085,808 B2	12/2011	Brusca et al.
7,967,682 B2	6/2011	Huizinga	8,086,398 B2	12/2011	Sanchez et al.
7,969,950 B2	6/2011	Iyer et al.	8,086,497 B1	12/2011	Oakes, III
7,970,350 B2	6/2011	Sheynman	8,086,791 B2	12/2011	Caulkins
7,970,426 B2	6/2011	Poe et al.	8,090,359 B2	1/2012	Proctor, Jr. et al.
7,974,624 B2	7/2011	Gallagher et al.	8,090,361 B2	1/2012	Hagan
7,975,184 B2	7/2011	Goff et al.	8,090,616 B2	1/2012	Proctor, Jr. et al.
7,978,627 B2	7/2011	Taylor et al.	8,091,087 B2	1/2012	Ali et al.
7,978,686 B2	7/2011	Goyal et al.	8,094,551 B2	1/2012	Huber et al.
7,979,069 B2	7/2011	Hupp et al.	8,095,112 B2	1/2012	Chow et al.
7,979,889 B2	7/2011	Gladstone et al.	8,095,124 B2	1/2012	Balia
7,979,896 B2	7/2011	McMurtry et al.	8,095,175 B2	1/2012	Todd et al.
7,984,130 B2	7/2011	Bogineni et al.	8,095,640 B2	1/2012	Guingo et al.
7,984,511 B2	7/2011	Kocher et al.	8,095,666 B2	1/2012	Schmidt et al.
7,986,935 B1	7/2011	D'Souza et al.	8,098,579 B2	1/2012	Ray et al.
7,987,449 B1	7/2011	Marolia et al.	8,099,077 B2	1/2012	Chowdhury et al.
7,987,496 B2	7/2011	Bryce et al.	8,099,517 B2	1/2012	Jia et al.
7,987,510 B2	7/2011	Kocher et al.	8,102,814 B2	1/2012	Rahman et al.
7,990,049 B2	8/2011	Shioya	8,103,285 B2	1/2012	Kalhan
8,000,276 B2	8/2011	Scherzer et al.	8,104,080 B2	1/2012	Burns et al.
8,000,318 B2	8/2011	Wiley et al.	8,107,953 B2	1/2012	Zimmerman et al.
8,000,715 B2	8/2011	Melpignano et al.	8,108,520 B2	1/2012	Ruutu et al.
8,005,009 B2	8/2011	McKee et al.	8,108,680 B2	1/2012	Murray
8,005,459 B2	8/2011	Balsillie	8,112,435 B2	2/2012	Epstein et al.
8,005,726 B1	8/2011	Bao	8,116,223 B2	2/2012	Tian et al.
8,005,913 B1	8/2011	Carlander	8,116,749 B2	2/2012	Proctor, Jr. et al.
8,005,988 B2	8/2011	Maes	8,116,781 B2	2/2012	Chen et al.
8,010,080 B1	8/2011	Thenthiruperai et al.	8,121,117 B1	2/2012	Amdahl et al.
8,010,081 B1	8/2011	Roskowski	8,122,128 B2	2/2012	Burke, II et al.
8,010,082 B2	8/2011	Sutaria et al.	8,122,249 B2	2/2012	Falk et al.
8,010,623 B1	8/2011	Fitch et al.	8,125,897 B2	2/2012	Ray et al.
8,010,990 B2	8/2011	Ferguson et al.	8,126,123 B2	2/2012	Cai et al.
8,015,133 B1	9/2011	Wu et al.	8,126,396 B2	2/2012	Bennett
8,015,234 B2	9/2011	Lum et al.	8,126,476 B2	2/2012	Vardi et al.
8,015,249 B2	9/2011	Nayak et al.	8,126,722 B2	2/2012	Robb et al.
8,019,687 B2	9/2011	Wang et al.	8,130,793 B2	3/2012	Edwards et al.
8,019,820 B2	9/2011	Son et al.	8,131,256 B2	3/2012	Martti et al.
8,019,846 B2	9/2011	Roelens et al.	8,131,281 B1	3/2012	Hildner et al.
8,019,868 B2	9/2011	Rao et al.	8,131,301 B1	3/2012	Ahmed et al.
8,019,886 B2	9/2011	Harrang et al.	8,131,840 B1	3/2012	Denker
8,020,192 B2 *	9/2011	Wright	8,131,858 B2	3/2012	Agulnik et al.
			8,132,256 B2	3/2012	Bari
			8,134,954 B2	3/2012	Godfrey et al.
			8,135,388 B1	3/2012	Gailloux et al.
			8,135,392 B2	3/2012	Marcellino et al.
			8,135,657 B2	3/2012	Kapoor et al.
			8,140,690 B2	3/2012	Ly et al.
			8,144,591 B2	3/2012	Ghai et al.
			8,144,853 B1	3/2012	Aboujaoude et al.
			8,145,194 B2	3/2012	Yoshikawa et al.
			8,146,142 B2	3/2012	Ortiz et al.
			8,149,748 B2	4/2012	Bata et al.
			8,149,771 B2	4/2012	Khivesara et al.
			8,149,823 B2	4/2012	Turcan et al.
			8,150,394 B2	4/2012	Bianconi et al.
			8,150,431 B2	4/2012	Wolovitz et al.
			8,151,205 B2	4/2012	Follmann et al.
			8,152,246 B2	4/2012	Miller et al.
			8,155,155 B1	4/2012	Chow et al.
			8,155,620 B2	4/2012	Wang et al.
			8,155,666 B2	4/2012	Alizadeh-Shabdiz
			8,155,670 B2	4/2012	Fullam et al.
			8,156,206 B2	4/2012	Kiley et al.
			8,159,520 B1	4/2012	Dhanoa et al.
			8,160,015 B2	4/2012	Rashid et al.
			8,160,056 B2	4/2012	Van der Merwe et al.
			8,160,554 B2	4/2012	Gosselin et al.
			8,160,555 B2	4/2012	Gosselin et al.
			8,160,556 B2	4/2012	Gosselin et al.
			8,160,598 B2	4/2012	Savoor
			8,165,576 B2	4/2012	Raju et al.
			8,166,040 B2	4/2012	Brindisi et al.
			8,166,554 B2	4/2012	John
			8,170,553 B2	5/2012	Bennett
			8,174,378 B2	5/2012	Richman et al.

US 12,200,786 B2

Page 7

(56)

References Cited

U.S. PATENT DOCUMENTS

8,174,970 B2	5/2012	Adamczyk et al.	8,266,269 B2	9/2012	Short et al.
8,175,574 B1	5/2012	Panda et al.	8,266,681 B2	9/2012	Deshpande et al.
8,175,966 B2	5/2012	Steinberg et al.	8,270,955 B2	9/2012	Ramer et al.
8,180,333 B1	5/2012	Wells et al.	8,270,972 B2	9/2012	Otting et al.
8,180,375 B2	5/2012	Awad	8,271,025 B2	9/2012	Brisebois et al.
8,180,881 B2	5/2012	Seo et al.	8,271,045 B2	9/2012	Parolkar et al.
8,180,886 B2	5/2012	Overcash et al.	8,271,049 B2	9/2012	Silver et al.
8,184,530 B1	5/2012	Swan et al.	8,271,992 B2	9/2012	Chatley et al.
8,184,590 B2	5/2012	Rosenblatt	8,275,415 B2	9/2012	Huslak
8,185,088 B2	5/2012	Klein et al.	8,275,830 B2	9/2012	Raleigh
8,185,093 B2	5/2012	Jheng et al.	8,279,067 B2	10/2012	Berger et al.
8,185,127 B1	5/2012	Cai et al.	8,279,864 B2	10/2012	Wood
8,185,152 B1	5/2012	Goldner	8,280,351 B1	10/2012	Ahmed et al.
8,185,158 B2	5/2012	Tamura et al.	8,280,354 B2	10/2012	Smith et al.
8,190,087 B2	5/2012	Fisher et al.	8,284,740 B2	10/2012	O'Connor
8,190,122 B1	5/2012	Alexander et al.	8,285,249 B2	10/2012	Baker et al.
8,190,675 B2	5/2012	Tribbett	8,285,992 B2	10/2012	Mathur et al.
8,191,106 B2	5/2012	Choyi et al.	8,290,820 B2	10/2012	Plastina et al.
8,191,116 B1	5/2012	Gazzard	8,291,238 B2	10/2012	Ginter et al.
8,191,124 B2	5/2012	Wynn et al.	8,291,439 B2	10/2012	Jethi et al.
8,194,549 B2	6/2012	Huber et al.	8,296,404 B2	10/2012	McDysan et al.
8,194,553 B2	6/2012	Liang et al.	8,300,575 B2	10/2012	Willars
8,194,572 B2	6/2012	Horvath et al.	8,301,513 B1	10/2012	Peng et al.
8,194,581 B1	6/2012	Schroeder et al.	8,306,505 B2	11/2012	Bennett
8,195,093 B2	6/2012	Garrett et al.	8,306,518 B1	11/2012	Gailloux
8,195,153 B1	6/2012	Frencel et al.	8,306,741 B2	11/2012	Tu
8,195,163 B2	6/2012	Gisby et al.	8,307,067 B2	11/2012	Ryan
8,195,661 B2	6/2012	Kalavade	8,307,095 B2	11/2012	Clark et al.
8,196,182 B2	6/2012	Sussland et al.	8,310,943 B2	11/2012	Mehta et al.
8,196,199 B2	6/2012	Hrastar et al.	8,315,198 B2	11/2012	Corneille et al.
8,200,163 B2	6/2012	Hoffman	8,315,593 B2	11/2012	Gallant et al.
8,200,200 B1	6/2012	Belser et al.	8,315,594 B1	11/2012	Mausser et al.
8,200,509 B2	6/2012	Kenedy et al.	8,315,718 B2	11/2012	Caffrey et al.
8,200,775 B2	6/2012	Moore	8,315,999 B2	11/2012	Chatley et al.
8,200,818 B2	6/2012	Freund et al.	8,320,244 B2	11/2012	Muqattash et al.
8,204,190 B2	6/2012	Bang et al.	8,320,902 B2	11/2012	Moring et al.
8,204,505 B2	6/2012	Jin et al.	8,320,949 B2	11/2012	Matta
8,204,794 B1	6/2012	Peng et al.	8,325,638 B2	12/2012	Jin et al.
8,208,788 B2	6/2012	Ando et al.	8,325,906 B2	12/2012	Fullarton et al.
8,208,919 B2	6/2012	Kotecha	8,326,319 B2	12/2012	Davis
8,213,296 B2	7/2012	Shannon et al.	8,326,359 B2	12/2012	Kauffman
8,213,363 B2	7/2012	Ying et al.	8,326,828 B2	12/2012	Zhou et al.
8,214,536 B2	7/2012	Zhao	8,331,223 B2	12/2012	Hill et al.
8,214,890 B2	7/2012	Kirovski et al.	8,331,293 B2	12/2012	Sood
8,219,134 B2	7/2012	Maharajh et al.	8,332,375 B2	12/2012	Chatley et al.
8,219,821 B2	7/2012	Zimmels et al.	8,332,517 B2	12/2012	Russell
8,223,655 B2	7/2012	Heinz et al.	8,335,161 B2	12/2012	Footitt et al.
8,223,741 B1	7/2012	Bartlett et al.	8,339,991 B2	12/2012	Biswas et al.
8,224,382 B2	7/2012	Bultman	8,340,625 B1	12/2012	Johnson et al.
8,224,773 B2	7/2012	Spiegel	8,340,628 B2	12/2012	Taylor et al.
8,228,818 B2	7/2012	Chase et al.	8,340,644 B2	12/2012	Sigmund et al.
8,229,394 B2	7/2012	Karlberg	8,340,678 B1	12/2012	Pandey
8,229,914 B2	7/2012	Ramer et al.	8,340,718 B2	12/2012	Colonna et al.
8,230,061 B2	7/2012	Hassan et al.	8,346,023 B2	1/2013	Lin
8,233,433 B2	7/2012	Kalhan	8,346,210 B2	1/2013	Balsan et al.
8,233,878 B2	7/2012	Gosnell et al.	8,346,225 B2	1/2013	Raleigh
8,233,883 B2	7/2012	De Froment	8,346,923 B2	1/2013	Rowles et al.
8,233,895 B2	7/2012	Tysowski	8,347,104 B2	1/2013	Pathiyal
8,234,583 B2	7/2012	Sloo et al.	8,347,362 B2	1/2013	Cai et al.
8,238,287 B1	8/2012	Gopi et al.	8,347,378 B2	1/2013	Merkin et al.
8,238,913 B1	8/2012	Bhattacharyya et al.	8,350,700 B2	1/2013	Fast et al.
8,239,520 B2	8/2012	Grah	8,351,592 B2	1/2013	Freeny, Jr. et al.
8,242,959 B2	8/2012	Mia et al.	8,351,898 B2	1/2013	Raleigh
8,244,241 B2	8/2012	Montemurro	8,352,360 B2	1/2013	De Judicibus et al.
8,249,601 B2	8/2012	Embersson et al.	8,352,630 B2	1/2013	Hart
8,254,880 B2	8/2012	Aaltonen et al.	8,352,980 B2	1/2013	Howcroft
8,254,915 B2	8/2012	Kozisek	8,353,001 B2	1/2013	Herrod
8,255,515 B1	8/2012	Melman et al.	8,355,570 B2	1/2013	Karsanbhai et al.
8,255,534 B2	8/2012	Assadzadeh	8,355,696 B1	1/2013	Olding et al.
8,255,689 B2	8/2012	Kim et al.	8,356,336 B2	1/2013	Johnston et al.
8,259,692 B2	9/2012	Bajko	8,358,638 B2	1/2013	Scherzer et al.
8,260,252 B2	9/2012	Agarwal	8,358,975 B2	1/2013	Bahl et al.
8,264,965 B2	9/2012	Dolganow et al.	8,363,658 B1	1/2013	Delker et al.
8,265,004 B2	9/2012	Toutonghi	8,363,799 B2	1/2013	Gruchala et al.
8,266,249 B2	9/2012	Hu	8,364,089 B2	1/2013	Phillips
			8,364,806 B2	1/2013	Short et al.
			8,369,274 B2	2/2013	Sawai
			8,370,477 B2	2/2013	Short et al.
			8,370,483 B2	2/2013	Choong et al.

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Page 8

(56)

References Cited

U.S. PATENT DOCUMENTS

8,374,090 B2	2/2013	Morrill et al.	8,500,533 B2	8/2013	Lutnick et al.
8,374,102 B2	2/2013	Luft et al.	8,503,358 B2	8/2013	Hanson et al.
8,374,592 B2	2/2013	Proctor, Jr. et al.	8,503,455 B2	8/2013	Heikens
8,375,128 B2	2/2013	Tofighbakhsh et al.	8,504,032 B2	8/2013	Lott et al.
8,375,136 B2	2/2013	Roman et al.	8,504,574 B2	8/2013	Dvorak et al.
8,379,847 B2	2/2013	Bell et al.	8,504,687 B2	8/2013	Maffione et al.
8,380,247 B2	2/2013	Engstrom	8,504,690 B2	8/2013	Shah et al.
8,380,804 B2	2/2013	Jain et al.	8,504,729 B2	8/2013	Pezzutti
8,381,127 B2	2/2013	Singh et al.	8,505,073 B2	8/2013	Taglienti et al.
8,385,199 B1	2/2013	Coward et al.	8,509,082 B2	8/2013	Heinz et al.
8,385,896 B2	2/2013	Proctor, Jr. et al.	8,510,743 B2	8/2013	Hackborn et al.
8,385,964 B2	2/2013	Haney	8,510,804 B1	8/2013	Bonn et al.
8,385,975 B2	2/2013	Forutanpour et al.	8,514,927 B2	8/2013	Sundararajan et al.
8,386,386 B1	2/2013	Zhu	8,516,552 B2	8/2013	Raleigh
8,391,262 B2	3/2013	Maki et al.	8,520,589 B2	8/2013	Bhatt et al.
8,391,834 B2	3/2013	Raleigh	8,520,595 B2	8/2013	Yadav et al.
8,392,982 B2	3/2013	Harris et al.	8,521,110 B2	8/2013	Rofougaran
8,396,458 B2	3/2013	Raleigh	8,521,775 B1	8/2013	Poh et al.
8,396,929 B2	3/2013	Helfman et al.	8,522,039 B2	8/2013	Hyndman et al.
8,397,083 B1	3/2013	Sussland et al.	8,522,249 B2	8/2013	Beaule
8,401,906 B2	3/2013	Ruckart	8,522,337 B2	8/2013	Adusumilli et al.
8,401,968 B1	3/2013	Schattauer et al.	8,523,547 B2	9/2013	Pekrul
8,402,165 B2	3/2013	Deu-Ngoc et al.	8,526,329 B2	9/2013	Mahany et al.
8,402,540 B2	3/2013	Kapoor et al.	8,526,350 B2	9/2013	Xue et al.
8,406,427 B2	3/2013	Chand et al.	8,527,013 B2	9/2013	Guba et al.
8,406,736 B2	3/2013	Das et al.	8,527,410 B2	9/2013	Markki et al.
8,406,756 B1	3/2013	Reeves et al.	8,527,662 B2	9/2013	Biswas et al.
8,407,345 B2	3/2013	Lim	8,528,068 B1	9/2013	Weglein et al.
8,407,472 B2	3/2013	Hao et al.	8,531,954 B2	9/2013	McNaughton et al.
8,407,763 B2	3/2013	Weller et al.	8,531,995 B2	9/2013	Khan et al.
8,411,587 B2	4/2013	Curtis et al.	8,532,610 B2	9/2013	Manning Cassett et al.
8,411,691 B2	4/2013	Aggarwal	8,533,341 B2	9/2013	Aguirre et al.
8,412,798 B1	4/2013	Wang	8,533,775 B2	9/2013	Alcorn et al.
8,413,172 B2	4/2013	Sng	8,535,160 B2	9/2013	Lutnick et al.
8,413,245 B2	4/2013	Kraemer et al.	8,538,394 B2	9/2013	Zimmerman et al.
8,418,168 B2	4/2013	Tyhurst et al.	8,538,421 B2	9/2013	Brisebois et al.
8,422,988 B1	4/2013	Keshav	8,538,458 B2	9/2013	Haney
8,423,016 B2	4/2013	Buckley et al.	8,539,544 B2	9/2013	Garimella et al.
8,429,403 B2	4/2013	Moret et al.	8,539,561 B2	9/2013	Gupta et al.
8,437,734 B2	5/2013	Ray et al.	8,543,265 B2	9/2013	Ekhaguere et al.
8,441,955 B2	5/2013	Wilkinson et al.	8,543,814 B2	9/2013	Laitinen et al.
8,442,015 B2	5/2013	Behzad et al.	8,544,105 B2	9/2013	Mclean et al.
8,442,507 B2	5/2013	Duggal et al.	8,548,427 B2	10/2013	Chow et al.
8,443,390 B2	5/2013	Lo et al.	8,548,428 B2	10/2013	Raleigh
8,446,831 B2	5/2013	Kwan et al.	8,549,173 B1	10/2013	Wu et al.
8,447,324 B2	5/2013	Shuman et al.	8,554,876 B2	10/2013	Winsor
8,447,607 B2	5/2013	Weider et al.	8,559,369 B2	10/2013	Barkan
8,447,980 B2	5/2013	Godfrey et al.	8,561,138 B2	10/2013	Rothman et al.
8,448,015 B2	5/2013	Gerhart	8,565,746 B2	10/2013	Hoffman
8,452,858 B2	5/2013	Wu et al.	8,565,766 B2	10/2013	Scherzer et al.
8,457,603 B2	6/2013	El-Kadri et al.	8,566,236 B2	10/2013	Busch
8,461,958 B2	6/2013	Saenz et al.	8,571,474 B2	10/2013	Chavez et al.
8,463,194 B2	6/2013	Erlenback et al.	8,571,501 B2	10/2013	Miller et al.
8,463,232 B2	6/2013	Tuli et al.	8,571,598 B2	10/2013	Valavi
8,468,337 B2	6/2013	Gaur et al.	8,571,993 B2	10/2013	Kocher et al.
8,472,371 B1	6/2013	Bari et al.	8,572,117 B2	10/2013	Rappaport
8,477,778 B2	7/2013	Lehmann, Jr. et al.	8,572,256 B2	10/2013	Babbar
8,478,840 B2	7/2013	Skutela et al.	8,583,499 B2	11/2013	De Judicibus et al.
8,483,057 B2	7/2013	Cuervo	8,584,226 B2	11/2013	Kudla et al.
8,483,135 B2	7/2013	Cai et al.	8,588,240 B2	11/2013	Ramankutty et al.
8,483,694 B2	7/2013	Lewis et al.	8,589,541 B2	11/2013	Raleigh et al.
8,484,327 B2	7/2013	Werner et al.	8,589,955 B2	11/2013	Roundtree et al.
8,484,568 B2	7/2013	Rados et al.	8,594,626 B1	11/2013	Woodson et al.
8,488,597 B2	7/2013	Nie et al.	8,594,665 B2	11/2013	Anschutz
8,489,110 B2	7/2013	Frank et al.	8,595,186 B1	11/2013	Mandyam et al.
8,489,720 B1	7/2013	Morford et al.	8,600,850 B2	12/2013	Zabawskyj et al.
8,494,559 B1	7/2013	Malmi	8,600,895 B2	12/2013	Felscher
8,495,181 B2	7/2013	Venkatraman et al.	8,601,125 B2	12/2013	Huang et al.
8,495,207 B2	7/2013	Lee	8,605,691 B2	12/2013	Soomro et al.
8,495,227 B2	7/2013	Kaminsky et al.	8,609,911 B1	12/2013	Nicholas et al.
8,495,360 B2	7/2013	Falk et al.	8,611,919 B2	12/2013	Barnes, Jr.
8,495,700 B2	7/2013	Shahbazi	8,615,507 B2	12/2013	Varadarajulu et al.
8,495,743 B2	7/2013	Kraemer et al.	8,619,735 B2	12/2013	Montemurro et al.
8,499,087 B2	7/2013	Hu	8,620,257 B2	12/2013	Qiu et al.
RE44,412 E	8/2013	Naqvi et al.	8,620,281 B2	12/2013	Gosselin et al.
			8,621,056 B2	12/2013	Coussemaeker et al.
			8,630,314 B2	1/2014	York
			8,630,630 B2	1/2014	Raleigh
			8,630,925 B2	1/2014	Bystrom et al.

US 12,200,786 B2

Page 9

(56)

References Cited

U.S. PATENT DOCUMENTS

8,631,428 B2	1/2014	Scott et al.	8,862,751 B2	10/2014	Faccin et al.
8,634,425 B2	1/2014	Gorti et al.	8,863,111 B2	10/2014	Selitsner et al.
8,635,164 B2	1/2014	Rosenhaft et al.	8,868,725 B2	10/2014	Samba
8,635,335 B2	1/2014	Raleigh et al.	8,868,727 B2	10/2014	Yumerefendi et al.
8,639,215 B2	1/2014	McGregor et al.	8,875,042 B2	10/2014	LeJeune et al.
8,644,702 B1	2/2014	Kalajan	8,880,047 B2	11/2014	Konicek et al.
8,644,813 B1	2/2014	Gailloux et al.	8,886,261 B2	11/2014	Aerrabotu
8,645,518 B2	2/2014	David	8,891,483 B2	11/2014	Connelly et al.
8,654,952 B2	2/2014	Wang et al.	8,898,748 B2	11/2014	Burks et al.
8,655,357 B1	2/2014	Gazzard et al.	8,908,516 B2	12/2014	Tzamaloukas et al.
8,656,472 B2	2/2014	McMurtry et al.	8,909,211 B2	12/2014	Huq et al.
8,660,853 B2	2/2014	Robb et al.	8,914,783 B2	12/2014	Van Camp
8,666,395 B2	3/2014	Silver	8,924,469 B2	12/2014	Raleigh et al.
8,667,542 B1	3/2014	Bertz et al.	8,929,374 B2	1/2015	Tönsing et al.
8,670,334 B2	3/2014	Keohane et al.	8,930,238 B2	1/2015	Coffman et al.
8,670,752 B2	3/2014	Fan et al.	8,930,551 B2	1/2015	Pandya et al.
8,675,507 B2	3/2014	Raleigh	8,943,551 B2	1/2015	Ganapathy et al.
8,675,852 B2	3/2014	Maes	8,948,198 B2	2/2015	Nee et al.
8,676,682 B2	3/2014	Kalliola	8,948,726 B2	2/2015	Smith et al.
8,676,925 B1	3/2014	Liu et al.	8,949,382 B2	2/2015	Cornett et al.
8,688,671 B2	4/2014	Ramer et al.	8,949,597 B1	2/2015	Reeves et al.
8,688,784 B2	4/2014	Zabawskyj et al.	8,955,038 B2	2/2015	Nicodemus et al.
8,693,323 B1	4/2014	McDysan	8,966,018 B2	2/2015	Bugwadia et al.
8,694,772 B2	4/2014	Kao et al.	8,971,841 B2	3/2015	Menezes et al.
8,699,355 B2	4/2014	Macias	8,971,912 B2	3/2015	Chou et al.
8,700,729 B2	4/2014	Dua	8,977,284 B2	3/2015	Reed
8,701,015 B2	4/2014	Bonnat	8,995,952 B1	3/2015	Baker et al.
8,701,080 B2	4/2014	Tripathi	9,002,342 B2	4/2015	Tenhunen et al.
8,705,361 B2	4/2014	Venkataraman et al.	9,008,653 B2	4/2015	Sparks et al.
8,706,863 B2	4/2014	Fadell	9,009,309 B2	4/2015	Krzanowski et al.
8,713,535 B2	4/2014	Malhotra et al.	9,014,059 B2	4/2015	Richardson et al.
8,713,641 B1	4/2014	Pagan et al.	9,014,973 B2	4/2015	Ruckart
8,713,667 B2	4/2014	Kalibjian et al.	9,015,331 B2	4/2015	Lai et al.
8,719,397 B2	5/2014	Levi et al.	9,026,100 B2	5/2015	Castro et al.
8,719,423 B2	5/2014	Wylde	9,030,934 B2	5/2015	Shah et al.
8,724,486 B2	5/2014	Seto et al.	9,032,427 B2	5/2015	Gallant et al.
8,725,700 B2	5/2014	Rappaport	9,049,010 B2	6/2015	Jueneman et al.
8,725,899 B2	5/2014	Short et al.	9,064,275 B1	6/2015	Lu et al.
8,730,842 B2	5/2014	Collins et al.	9,105,031 B2	8/2015	Shen et al.
8,731,519 B2	5/2014	Flynn et al.	9,106,414 B2	8/2015	Laves
8,732,808 B2	5/2014	Sewall et al.	9,107,053 B2	8/2015	Davis et al.
8,738,860 B1	5/2014	Griffin et al.	9,111,088 B2	8/2015	Ghai et al.
8,739,035 B2	5/2014	Trethewey	9,135,037 B1	9/2015	Petrescu-Prahova et al.
8,742,694 B2	6/2014	Bora et al.	9,137,286 B1	9/2015	Yuan
8,744,339 B2	6/2014	Halfmann et al.	9,137,744 B2	9/2015	Scherzer et al.
8,761,711 B2	6/2014	Grignani et al.	9,143,933 B2	9/2015	Keda et al.
8,761,809 B2	6/2014	Faith et al.	9,158,579 B1	10/2015	Robles
8,775,233 B1	7/2014	Ybrook et al.	9,172,553 B2	10/2015	Dawes et al.
8,780,857 B2	7/2014	Balasubramanian et al.	9,173,090 B2	10/2015	Tuchman et al.
8,787,249 B2	7/2014	Giaretta et al.	9,177,455 B2	11/2015	Remer
8,792,857 B2	7/2014	Cai et al.	9,183,524 B2	11/2015	Carter
8,793,304 B2	7/2014	Lu et al.	9,204,282 B2	12/2015	Raleigh
8,793,758 B2	7/2014	Raleigh et al.	9,225,847 B2	12/2015	Daymond et al.
8,798,610 B2	8/2014	Prakash et al.	9,252,977 B2	2/2016	Levi et al.
8,799,440 B2	8/2014	Zhou et al.	9,262,370 B2	2/2016	Hofstaedter et al.
8,804,517 B2	8/2014	Oerton	9,265,003 B2	2/2016	Zhao et al.
8,804,695 B2	8/2014	Branam	9,277,433 B2	3/2016	Raleigh et al.
8,811,338 B2	8/2014	Jin et al.	9,277,445 B2	3/2016	Raleigh et al.
8,811,991 B2	8/2014	Jain et al.	9,282,460 B2	3/2016	Souissi
8,812,525 B1	8/2014	Taylor, III	9,286,469 B2	3/2016	Kraemer et al.
8,818,394 B2	8/2014	Bienas et al.	9,286,604 B2	3/2016	Aabye et al.
8,819,253 B2	8/2014	Simeloff et al.	9,288,276 B2 *	3/2016	Adamczyk H04L 67/54
8,825,109 B2	9/2014	Montemurro et al.	9,313,708 B2	4/2016	Nam et al.
8,826,411 B2	9/2014	Moen et al.	9,325,737 B2	4/2016	Gutowski et al.
8,831,561 B2	9/2014	Sutaria et al.	9,326,173 B2	4/2016	Luft
8,837,322 B2	9/2014	Venkataramanan et al.	9,344,557 B2	5/2016	Gruchala et al.
8,838,686 B2	9/2014	Getchius	9,350,842 B2	5/2016	Swanburg et al.
8,838,752 B2	9/2014	Lor et al.	9,363,285 B2	6/2016	Kitamura
8,839,388 B2	9/2014	Raleigh	9,367,680 B2	6/2016	Mahaffey et al.
8,843,849 B2	9/2014	Neil et al.	9,402,254 B2	7/2016	Kneckt et al.
8,845,415 B2	9/2014	Lutnick et al.	9,408,070 B2	8/2016	Altbaum
8,849,262 B2	9/2014	Desai et al.	9,413,546 B2	8/2016	Meier et al.
8,849,297 B2	9/2014	Balasubramanian	9,418,381 B2	8/2016	Ahuja et al.
8,855,620 B2	10/2014	Sievers et al.	9,419,867 B2	8/2016	Okholm et al.
8,856,015 B2	10/2014	Mesaros	9,436,805 B1	9/2016	Kravets
			9,438,642 B2	9/2016	Alberth, Jr. et al.
			9,479,917 B1	10/2016	Gota et al.
			9,491,199 B2	11/2016	Raleigh et al.
			9,501,803 B2	11/2016	Bilac et al.

(56)

References Cited

U.S. PATENT DOCUMENTS

9,516,456 B2	12/2016	Stephens et al.	2002/0161601 A1	10/2002	Nauer et al.
9,525,992 B2	12/2016	Rao et al.	2002/0164983 A1	11/2002	Raviv et al.
9,534,861 B1	1/2017	Kellgren	2002/0176377 A1	11/2002	Hamilton
9,544,397 B2	1/2017	Raleigh et al.	2002/0188732 A1	12/2002	Buckman et al.
9,557,889 B2	1/2017	Raleigh et al.	2002/0191573 A1	12/2002	Whitehill et al.
9,560,108 B2	1/2017	Salkintzis	2002/0199001 A1	12/2002	Wenocur et al.
9,589,117 B2	3/2017	Ali et al.	2003/0004937 A1	1/2003	Salmenkaita et al.
9,609,459 B2	3/2017	Raleigh	2003/0005112 A1	1/2003	Krautkremer
9,609,510 B2	3/2017	Raleigh et al.	2003/0013434 A1	1/2003	Rosenberg et al.
9,609,544 B2	3/2017	Raleigh et al.	2003/0018524 A1	1/2003	Fishman et al.
9,615,192 B2	4/2017	Raleigh	2003/0028623 A1	2/2003	Hennessey et al.
9,634,850 B2	4/2017	Taft et al.	2003/0046396 A1	3/2003	Richter et al.
9,642,004 B2	5/2017	Wang et al.	2003/0050070 A1	3/2003	Mashinsky et al.
9,648,022 B2	5/2017	Peterka et al.	2003/0050837 A1	3/2003	Kim
9,673,996 B1	6/2017	Upadhyay et al.	2003/0060189 A1	3/2003	Minear et al.
9,680,658 B2	6/2017	Goel et al.	2003/0084321 A1	5/2003	Tarquini et al.
9,681,003 B1	6/2017	Kim et al.	2003/0088671 A1	5/2003	Klinker et al.
9,691,082 B1	6/2017	Burnett et al.	2003/0133408 A1	7/2003	Cheng et al.
9,712,331 B1	7/2017	Poh et al.	2003/0134650 A1	7/2003	Sundar et al.
9,712,443 B1	7/2017	Phaal	2003/0159030 A1	8/2003	Evans
9,712,476 B2	7/2017	Boynton et al.	2003/0161265 A1	8/2003	Cao et al.
9,749,899 B2	8/2017	Raleigh et al.	2003/0171112 A1	9/2003	Lupper et al.
9,755,842 B2	9/2017	Raleigh et al.	2003/0182420 A1	9/2003	Jones et al.
9,766,873 B2	9/2017	Steigleder	2003/0182435 A1	9/2003	Redlich et al.
9,852,426 B2	12/2017	Bacastow	2003/0184793 A1	10/2003	Pineau
9,923,790 B2	3/2018	Patel et al.	2003/0188006 A1	10/2003	Bard
9,942,796 B2	4/2018	Raleigh	2003/0188117 A1	10/2003	Yoshino et al.
9,954,975 B2	4/2018	Raleigh et al.	2003/0191646 A1	10/2003	D'Avello et al.
9,986,413 B2	5/2018	Raleigh	2003/0220984 A1	11/2003	Jones et al.
10,002,332 B2	6/2018	Spong	2003/0224781 A1	12/2003	Millford et al.
10,021,251 B2	7/2018	Aaron et al.	2003/0229900 A1	12/2003	Reisman
10,021,463 B2	7/2018	Qiu et al.	2003/0233332 A1	12/2003	Keeler et al.
10,024,948 B2	7/2018	Ganick et al.	2003/0236745 A1	12/2003	Hartsell et al.
10,027,819 B2	7/2018	Lu et al.	2004/0019539 A1	1/2004	Raman et al.
10,034,220 B2	7/2018	Silver	2004/0019564 A1	1/2004	Goldthwaite et al.
10,057,775 B2	8/2018	Raleigh et al.	2004/0021697 A1	2/2004	Beaton et al.
10,064,033 B2	8/2018	Raleigh	2004/0024756 A1	2/2004	Rickard
10,171,681 B2	1/2019	Raleigh et al.	2004/0030705 A1	2/2004	Bowman-Amuah
10,171,988 B2	1/2019	Raleigh et al.	2004/0039792 A1	2/2004	Nakanishi
10,171,990 B2	1/2019	Raleigh et al.	2004/0044623 A1	3/2004	Wake et al.
10,178,554 B2	1/2019	Pawar et al.	2004/0047358 A1	3/2004	Chen et al.
10,237,773 B2	3/2019	Raleigh et al.	2004/0054779 A1	3/2004	Takeshima et al.
10,248,996 B2	4/2019	Raleigh	2004/0073672 A1	4/2004	Fascenda
10,264,138 B2	4/2019	Raleigh et al.	2004/0082346 A1	4/2004	Skytt et al.
10,285,025 B1	5/2019	Baker et al.	2004/0098610 A1	5/2004	Hrastar
10,321,515 B2	6/2019	Shen et al.	2004/0098715 A1	5/2004	Aghera et al.
10,326,800 B2	6/2019	Raleigh et al.	2004/0102182 A1	5/2004	Reith et al.
10,395,216 B2	8/2019	Coffing	2004/0103193 A1	5/2004	Pandya et al.
10,410,184 B2	9/2019	Green et al.	2004/0107360 A1	6/2004	Herrmann et al.
10,462,627 B2	10/2019	Raleigh et al.	2004/0114553 A1	6/2004	Jiang et al.
10,492,102 B2	11/2019	Raleigh et al.	2004/0116140 A1	6/2004	Babbar et al.
10,521,781 B1	12/2019	Singfield	2004/0123153 A1	6/2004	Wright et al.
10,523,726 B2	12/2019	Pantos et al.	2004/0127200 A1	7/2004	Shaw et al.
10,536,983 B2	1/2020	Raleigh et al.	2004/0127208 A1	7/2004	Nair et al.
10,567,930 B2	2/2020	Silver	2004/0127256 A1	7/2004	Goldthwaite et al.
10,582,375 B2	3/2020	Raleigh	2004/0132427 A1	7/2004	Lee et al.
10,616,818 B2	4/2020	Silver	2004/0133668 A1	7/2004	Nicholas, III
10,779,177 B2	9/2020	Raleigh	2004/0137890 A1	7/2004	Kalke
2001/0048738 A1	12/2001	Baniak et al.	2004/0165596 A1	8/2004	Garcia et al.
2001/0053694 A1	12/2001	Igarashi et al.	2004/0167958 A1	8/2004	Stewart et al.
2002/0013844 A1	1/2002	Garrett et al.	2004/0168052 A1	8/2004	Clisham et al.
2002/0022472 A1	2/2002	Watler et al.	2004/0170191 A1	9/2004	Guo et al.
2002/0022483 A1	2/2002	Thompson et al.	2004/0176104 A1	9/2004	Arcens
2002/0049074 A1	4/2002	Eisinger et al.	2004/0198331 A1	10/2004	Coward et al.
2002/0085516 A1	7/2002	Bridgelall	2004/0203755 A1	10/2004	Brunet et al.
2002/0099848 A1	7/2002	Lee	2004/0203833 A1	10/2004	Rathunde et al.
2002/0116338 A1	8/2002	Gonthier et al.	2004/0224668 A1	11/2004	Shell et al.
2002/0120370 A1	8/2002	Parupudi et al.	2004/0225561 A1	11/2004	Hertzberg et al.
2002/0120540 A1	8/2002	Kende et al.	2004/0225898 A1	11/2004	Frost et al.
2002/0131397 A1	9/2002	Patel et al.	2004/0236547 A1	11/2004	Rappaport et al.
2002/0131404 A1	9/2002	Mehta et al.	2004/0243680 A1	12/2004	Mayer
2002/0138599 A1	9/2002	Dilman et al.	2004/0243992 A1	12/2004	Gustafson et al.
2002/0138601 A1	9/2002	Piponius et al.	2004/0249918 A1	12/2004	Sunshine
2002/0152319 A1	10/2002	Amin et al.	2004/0255145 A1	12/2004	Chow
2002/0154751 A1	10/2002	Thompson et al.	2004/0259534 A1	12/2004	Chaudhari et al.
			2004/0260766 A1	12/2004	Barros et al.
			2004/0267872 A1	12/2004	Serdy et al.
			2004/0268351 A1	12/2004	Mogensen et al.
			2005/0007993 A1	1/2005	Chambers et al.

US 12,200,786 B2

Page 11

(56)

References Cited

U.S. PATENT DOCUMENTS

2005/0009499 A1	1/2005	Koster	2006/0174035 A1	8/2006	Tufail
2005/0021995 A1	1/2005	Lal et al.	2006/0178917 A1	8/2006	Merriam et al.
2005/0037740 A1	2/2005	Smith et al.	2006/0178918 A1	8/2006	Mikurak
2005/0041617 A1	2/2005	Huotari et al.	2006/0178943 A1	8/2006	Rollinson et al.
2005/0048950 A1	3/2005	Morper	2006/0182137 A1	8/2006	Zhou et al.
2005/0055291 A1	3/2005	Bevente et al.	2006/0183461 A1	8/2006	Pearce
2005/0055309 A1	3/2005	Williams et al.	2006/0183462 A1	8/2006	Kolehmainen
2005/0055595 A1	3/2005	Frazer et al.	2006/0190314 A1	8/2006	Hernandez
2005/0060266 A1	3/2005	Demello et al.	2006/0190987 A1	8/2006	Ohta et al.
2005/0060525 A1	3/2005	Schwartz et al.	2006/0193280 A1	8/2006	Lee et al.
2005/0075115 A1	4/2005	Corneille et al.	2006/0199608 A1	9/2006	Dunn et al.
2005/0079863 A1	4/2005	Macaluso	2006/0200663 A1	9/2006	Thornton
2005/0091505 A1	4/2005	Riley et al.	2006/0206709 A1	9/2006	Labrou et al.
2005/0096024 A1	5/2005	Bicker et al.	2006/0206904 A1	9/2006	Watkins et al.
2005/0097516 A1	5/2005	Donnelly et al.	2006/0218395 A1	9/2006	Maes
2005/0107091 A1	5/2005	Vannithamby et al.	2006/0221829 A1	10/2006	Holmstrom et al.
2005/0108075 A1	5/2005	Douglas et al.	2006/0233108 A1	10/2006	Krishnan
2005/0111463 A1	5/2005	Leung et al.	2006/0233166 A1	10/2006	Bou-Diab et al.
2005/0128967 A1	6/2005	Scobbie	2006/0236095 A1	10/2006	Smith et al.
2005/0135264 A1	6/2005	Popoff et al.	2006/0242685 A1	10/2006	Heard et al.
2005/0163320 A1	7/2005	Brown et al.	2006/0258341 A1	11/2006	Miller et al.
2005/0166043 A1	7/2005	Zhang et al.	2006/0274706 A1	12/2006	Chen et al.
2005/0183143 A1	8/2005	Anderholm et al.	2006/0277590 A1	12/2006	Limont et al.
2005/0186948 A1	8/2005	Gallagher et al.	2006/0291419 A1	12/2006	McConnell et al.
2005/0198377 A1	9/2005	Ferguson et al.	2006/0291477 A1	12/2006	Croak et al.
2005/0216421 A1	9/2005	Barry et al.	2007/0005795 A1	1/2007	Gonzalez
2005/0226178 A1	10/2005	Forand et al.	2007/0010248 A1	1/2007	Dravida et al.
2005/0228985 A1	10/2005	Ylikoski et al.	2007/0019670 A1	1/2007	Falardeau
2005/0238046 A1	10/2005	Hassan et al.	2007/0022289 A1	1/2007	Alt et al.
2005/0239447 A1	10/2005	Holzman et al.	2007/0025301 A1	2/2007	Petersson et al.
2005/0245241 A1	11/2005	Durand et al.	2007/0033194 A1	2/2007	Srinivas et al.
2005/0246282 A1	11/2005	Naslund et al.	2007/0033197 A1	2/2007	Scherzer et al.
2005/0250508 A1	11/2005	Guo et al.	2007/0035390 A1	2/2007	Thomas et al.
2005/0250536 A1	11/2005	Deng et al.	2007/0036312 A1	2/2007	Cai et al.
2005/0254435 A1	11/2005	Moakley et al.	2007/0038763 A1	2/2007	Oestvall
2005/0266825 A1	12/2005	Clayton	2007/0055694 A1	3/2007	Ruge et al.
2005/0266880 A1	12/2005	Gupta	2007/0060200 A1	3/2007	Boris et al.
2005/0286476 A1	12/2005	Crosswy et al.	2007/0061243 A1	3/2007	Ramer et al.
2006/0014519 A1	1/2006	Marsh et al.	2007/0061800 A1	3/2007	Cheng et al.
2006/0019632 A1	1/2006	Cunningham et al.	2007/0061878 A1	3/2007	Hagiu et al.
2006/0020787 A1	1/2006	Choyi et al.	2007/0073899 A1	3/2007	Judge et al.
2006/0026679 A1	2/2006	Zakas	2007/0076616 A1	4/2007	Ngo et al.
2006/0030306 A1	2/2006	Kuhn	2007/0083610 A1 *	4/2007	Treder H04L 67/34 709/217
2006/0034256 A1	2/2006	Addagatla et al.	2007/0083655 A1 *	4/2007	Pedersen H04L 63/102 709/226
2006/0035631 A1	2/2006	White et al.	2007/0093243 A1	4/2007	Kapadekar et al.
2006/0039354 A1	2/2006	Rao et al.	2007/0100981 A1	5/2007	Adamczyk et al.
2006/0039364 A1	2/2006	Wright	2007/0101426 A1	5/2007	Lee et al.
2006/0040642 A1	2/2006	Boris et al.	2007/0104126 A1	5/2007	Calhoun et al.
2006/0045245 A1	3/2006	Aaron et al.	2007/0104169 A1	5/2007	Polson
2006/0048223 A1	3/2006	Lee et al.	2007/0109983 A1	5/2007	Shankar et al.
2006/0068796 A1	3/2006	Millen et al.	2007/0111740 A1	5/2007	Wandel
2006/0072451 A1	4/2006	Ross	2007/0124077 A1	5/2007	Hedlund
2006/0072550 A1	4/2006	Davis et al.	2007/0130283 A1	6/2007	Klein et al.
2006/0072646 A1	4/2006	Fehér	2007/0130315 A1	6/2007	Friend et al.
2006/0075506 A1	4/2006	Sanda et al.	2007/0140113 A1	6/2007	Gemelos
2006/0085543 A1	4/2006	Hrastar et al.	2007/0140145 A1	6/2007	Kumar et al.
2006/0093107 A1	5/2006	Chien	2007/0140275 A1	6/2007	Bowman et al.
2006/0095517 A1	5/2006	O'Connor et al.	2007/0143824 A1	6/2007	Shahbazi
2006/0098627 A1	5/2006	Karaoguz et al.	2007/0147317 A1	6/2007	Smith et al.
2006/0099970 A1	5/2006	Morgan et al.	2007/0147324 A1	6/2007	McGary
2006/0101507 A1	5/2006	Camenisch	2007/0149252 A1	6/2007	Jobs et al.
2006/0112016 A1	5/2006	Ishibashi	2007/0155365 A1	7/2007	Kim et al.
2006/0114821 A1	6/2006	Willey et al.	2007/0165630 A1	7/2007	Rasanen et al.
2006/0114832 A1	6/2006	Hamilton et al.	2007/0168499 A1	7/2007	Chu
2006/0126562 A1	6/2006	Liu	2007/0171856 A1	7/2007	Bruce et al.
2006/0135144 A1	6/2006	Jothipragasam	2007/0173283 A1	7/2007	Livet et al.
2006/0136882 A1	6/2006	Noonan et al.	2007/0174490 A1	7/2007	Choi et al.
2006/0143066 A1	6/2006	Calabria	2007/0191006 A1	8/2007	Carpenter
2006/0143098 A1	6/2006	Lazaridis	2007/0192460 A1	8/2007	Choi et al.
2006/0153122 A1	7/2006	Hinman et al.	2007/0198656 A1	8/2007	Mazzaferri et al.
2006/0156398 A1	7/2006	Ross et al.	2007/0201502 A1	8/2007	Abramson
2006/0160536 A1	7/2006	Chou	2007/0213054 A1	9/2007	Han
2006/0165060 A1	7/2006	Dua	2007/0220251 A1	9/2007	Rosenberg et al.
2006/0168128 A1	7/2006	Sistla et al.	2007/0226225 A1	9/2007	Yiu et al.
2006/0173959 A1	8/2006	Mckelvie et al.	2007/0226775 A1	9/2007	Andreasen et al.
			2007/0234402 A1	10/2007	Khosravi et al.
			2007/0242619 A1	10/2007	Murakami et al.

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Page 12

(56)

References Cited

U.S. PATENT DOCUMENTS

2007/0242659	A1	10/2007	Cantu et al.	2008/0126287	A1	5/2008	Cox et al.
2007/0243862	A1	10/2007	Coskun et al.	2008/0127304	A1	5/2008	Ginter et al.
2007/0244965	A1	10/2007	Dowling	2008/0130534	A1	6/2008	Tomioka
2007/0245409	A1 *	10/2007	Harris H04L 67/06 726/5	2008/0130656	A1	6/2008	Kim et al.
2007/0248100	A1	10/2007	Zuberi et al.	2008/0132201	A1	6/2008	Karlberg
2007/0254646	A1	11/2007	Sokondar	2008/0132268	A1	6/2008	Choi-Grogan et al.
2007/0254675	A1	11/2007	Zorlu Ozer et al.	2008/0134330	A1	6/2008	Kapoor et al.
2007/0255769	A1	11/2007	Agrawal et al.	2008/0139210	A1	6/2008	Gisby et al.
2007/0255797	A1	11/2007	Dunn et al.	2008/0146268	A1	6/2008	Gandhi et al.
2007/0255848	A1	11/2007	Sewall et al.	2008/0147454	A1	6/2008	Walker et al.
2007/0256128	A1	11/2007	Jung et al.	2008/0148402	A1	6/2008	Bogineni et al.
2007/0257767	A1	11/2007	Beeson	2008/0160958	A1	7/2008	Abichandani et al.
2007/0259656	A1	11/2007	Jeong	2008/0161041	A1	7/2008	Pernu
2007/0259673	A1	11/2007	Willars et al.	2008/0162637	A1	7/2008	Adamczyk et al.
2007/0263558	A1	11/2007	Salomone	2008/0162704	A1	7/2008	Poplett et al.
2007/0265003	A1	11/2007	Kezys et al.	2008/0164304	A1	7/2008	Narasimhan et al.
2007/0266422	A1	11/2007	Germano et al.	2008/0166993	A1	7/2008	Gautier et al.
2007/0271598	A1	11/2007	Chen et al.	2008/0167027	A1	7/2008	Gautier et al.
2007/0274327	A1	11/2007	Kaarela et al.	2008/0167033	A1	7/2008	Beckers
2007/0280453	A1	12/2007	Kelley	2008/0168275	A1	7/2008	DeAtley et al.
2007/0282896	A1	12/2007	Wydrong et al.	2008/0168523	A1	7/2008	Ansari et al.
2007/0293191	A1	12/2007	Mir et al.	2008/0177998	A1	7/2008	Apsangi et al.
2007/0294395	A1	12/2007	Strub et al.	2008/0178300	A1	7/2008	Brown et al.
2007/0294410	A1	12/2007	Pandya et al.	2008/0181117	A1	7/2008	Acke et al.
2007/0297378	A1	12/2007	Poyhonen et al.	2008/0181208	A1	7/2008	Maes
2007/0298764	A1	12/2007	Clayton	2008/0183811	A1	7/2008	Kotras et al.
2007/0299965	A1	12/2007	Nieh et al.	2008/0183812	A1	7/2008	Paul et al.
2007/0300252	A1	12/2007	Acharya et al.	2008/0184127	A1	7/2008	Rafey et al.
2008/0005285	A1	1/2008	Robinson et al.	2008/0189760	A1	8/2008	Rosenberg et al.
2008/0005561	A1	1/2008	Brown et al.	2008/0201266	A1	8/2008	Chua et al.
2008/0010379	A1	1/2008	Zhao	2008/0207167	A1	8/2008	Bugenhagen
2008/0010452	A1	1/2008	Holtzman et al.	2008/0212470	A1	9/2008	Castaneda et al.
2008/0018494	A1	1/2008	Waite et al.	2008/0212751	A1	9/2008	Chung
2008/0022354	A1	1/2008	Grewal et al.	2008/0219268	A1	9/2008	Dennison
2008/0025230	A1	1/2008	Patel et al.	2008/0221951	A1	9/2008	Stanforth et al.
2008/0032715	A1	2/2008	Jia et al.	2008/0222692	A1	9/2008	Andersson et al.
2008/0034063	A1	2/2008	Yee	2008/0225748	A1	9/2008	Khemani et al.
2008/0034419	A1	2/2008	Mullick et al.	2008/0229385	A1	9/2008	Feder et al.
2008/0039102	A1	2/2008	Sewall et al.	2008/0229388	A1	9/2008	Maes
2008/0049630	A1	2/2008	Kozisek et al.	2008/0235511	A1	9/2008	O'Brien et al.
2008/0050715	A1	2/2008	Golczewski et al.	2008/0240373	A1	10/2008	Wilhelm
2008/0051076	A1	2/2008	O'Shaughnessy et al.	2008/0242290	A1	10/2008	Bhatia et al.
2008/0052387	A1	2/2008	Heinz et al.	2008/0250053	A1	10/2008	Aaltonen et al.
2008/0056273	A1	3/2008	Pelletier et al.	2008/0256593	A1	10/2008	Vinberg et al.
2008/0057894	A1	3/2008	Aleksic et al.	2008/0259924	A1	10/2008	Gooch et al.
2008/0059474	A1	3/2008	Lim	2008/0262798	A1	10/2008	Kim et al.
2008/0059743	A1	3/2008	Bychkov et al.	2008/0263348	A1	10/2008	Zaltsman et al.
2008/0060066	A1	3/2008	Wynn et al.	2008/0268813	A1	10/2008	Maes
2008/0062900	A1	3/2008	Rao	2008/0270212	A1	10/2008	Blight et al.
2008/0064367	A1	3/2008	Nath et al.	2008/0279216	A1	11/2008	Sharif-Ahmadi et al.
2008/0066149	A1	3/2008	Lim	2008/0280656	A1	11/2008	Gonikberg et al.
2008/0066150	A1	3/2008	Lim	2008/0282319	A1	11/2008	Fontijn et al.
2008/0066181	A1	3/2008	Haveson et al.	2008/0291872	A1	11/2008	Henriksson
2008/0070550	A1	3/2008	Hose	2008/0293395	A1	11/2008	Mathews et al.
2008/0077705	A1	3/2008	Li et al.	2008/0298230	A1	12/2008	Luft et al.
2008/0080457	A1	4/2008	Cole	2008/0305793	A1	12/2008	Gallagher et al.
2008/0080458	A1	4/2008	Cole	2008/0311885	A1	12/2008	Dawson et al.
2008/0081606	A1	4/2008	Cole	2008/0311897	A1	12/2008	Segal
2008/0082643	A1	4/2008	Storrie et al.	2008/0313315	A1	12/2008	Karaoguz et al.
2008/0083013	A1	4/2008	Soliman et al.	2008/0313730	A1	12/2008	Iftimie et al.
2008/0085707	A1	4/2008	Fadell	2008/0316923	A1	12/2008	Fedders et al.
2008/0089295	A1	4/2008	Keeler et al.	2008/0316983	A1	12/2008	Daigle
2008/0089303	A1	4/2008	Wirtanen et al.	2008/0318547	A1	12/2008	Ballou, Jr. et al.
2008/0095339	A1	4/2008	Elliott et al.	2008/0318550	A1	12/2008	DeAtley
2008/0096559	A1	4/2008	Phillips et al.	2008/0319879	A1	12/2008	Carroll et al.
2008/0098062	A1	4/2008	Balia	2008/0320497	A1	12/2008	Tarkoma et al.
2008/0101291	A1	5/2008	Jiang et al.	2009/0005000	A1	1/2009	Baker et al.
2008/0101293	A1	5/2008	Woo	2009/0005005	A1	1/2009	Forstall et al.
2008/0109679	A1	5/2008	Wright et al.	2009/0006116	A1	1/2009	Baker et al.
2008/0120129	A1	5/2008	Seubert et al.	2009/0006200	A1	1/2009	Baker et al.
2008/0120174	A1	5/2008	Li	2009/0006229	A1	1/2009	Sweeney et al.
2008/0120668	A1	5/2008	Yau	2009/0013157	A1	1/2009	Beaule
2008/0120688	A1	5/2008	Qiu et al.	2009/0016310	A1	1/2009	Rasal
2008/0125079	A1	5/2008	O'Neil et al.	2009/0017809	A1	1/2009	Jethi et al.
				2009/0019022	A1	1/2009	Schallert et al.
				2009/0036111	A1	2/2009	Danford et al.
				2009/0042536	A1	2/2009	Bernard et al.
				2009/0044185	A1	2/2009	Krivopaltsev
				2009/0046707	A1	2/2009	Smires et al.

US 12,200,786 B2

Page 13

(56)

References Cited

U.S. PATENT DOCUMENTS

2009/0046723 A1	2/2009	Rahman et al.	2010/0103820 A1	4/2010	Fuller et al.
2009/0047989 A1	2/2009	Harmon et al.	2010/0105378 A1	4/2010	Shi et al.
2009/0048913 A1	2/2009	Shenfield et al.	2010/0113020 A1	5/2010	Subramanian et al.
2009/0049156 A1	2/2009	Aronsson et al.	2010/0115048 A1	5/2010	Scahill
2009/0049518 A1	2/2009	Roman et al.	2010/0121744 A1	5/2010	Belz et al.
2009/0054030 A1	2/2009	Golds	2010/0131584 A1	5/2010	Johnson
2009/0054061 A1	2/2009	Dawson et al.	2010/0142478 A1	6/2010	Forssell et al.
2009/0065571 A1	3/2009	Jain	2010/0144310 A1	6/2010	Bedingfield
2009/0066999 A1	3/2009	Ito	2010/0151866 A1	6/2010	Karpov et al.
2009/0067372 A1	3/2009	Shah et al.	2010/0153781 A1	6/2010	Hanna
2009/0068984 A1	3/2009	Burnett	2010/0167696 A1	7/2010	Smith et al.
2009/0070379 A1	3/2009	Rappaport	2010/0188975 A1	7/2010	Raleigh
2009/0077622 A1	3/2009	Baum et al.	2010/0188990 A1	7/2010	Raleigh
2009/0079699 A1	3/2009	Sun	2010/0188992 A1	7/2010	Raleigh
2009/0093247 A1	4/2009	Srinivasan	2010/0188994 A1	7/2010	Raleigh
2009/0109898 A1	4/2009	Adams et al.	2010/0190469 A1	7/2010	Vanderveen et al.
2009/0113514 A1	4/2009	Hu	2010/0191576 A1	7/2010	Raleigh
2009/0119773 A1	5/2009	D'Amore et al.	2010/0191612 A1	7/2010	Raleigh
2009/0125619 A1	5/2009	Antani	2010/0191846 A1	7/2010	Raleigh
2009/0132860 A1	5/2009	Liu et al.	2010/0192170 A1	7/2010	Raleigh
2009/0149154 A1	6/2009	Bhasin et al.	2010/0192212 A1	7/2010	Raleigh
2009/0154348 A1	6/2009	Newman	2010/0195503 A1	8/2010	Raleigh
2009/0157792 A1	6/2009	Fiatel	2010/0197268 A1	8/2010	Raleigh
2009/0163173 A1	6/2009	Williams	2010/0198698 A1	8/2010	Raleigh et al.
2009/0170554 A1	7/2009	Want et al.	2010/0198939 A1	8/2010	Raleigh
2009/0172077 A1	7/2009	Roxburgh et al.	2010/0199325 A1	8/2010	Raleigh
2009/0180391 A1	7/2009	Petersen et al.	2010/0227632 A1	9/2010	Bell et al.
2009/0181662 A1	7/2009	Fleischman et al.	2010/0235329 A1	9/2010	Koren et al.
2009/0197585 A1	8/2009	Aaron	2010/0241544 A1	9/2010	Benson et al.
2009/0197612 A1	8/2009	Kiiskinen	2010/0248719 A1	9/2010	Scholaert
2009/0203352 A1	8/2009	Fordon et al.	2010/0254387 A1	10/2010	Trinh et al.
2009/0207817 A1	8/2009	Montemurro et al.	2010/0284327 A1	11/2010	Miklos
2009/0210537 A1	8/2009	Irwin et al.	2010/0284388 A1	11/2010	Fantini et al.
2009/0217065 A1	8/2009	Araujo, Jr.	2010/0287599 A1	11/2010	He et al.
2009/0217364 A1	8/2009	Salmela et al.	2010/0311402 A1	12/2010	Srinivasan et al.
2009/0219170 A1	9/2009	Clark et al.	2010/0318652 A1	12/2010	Samba
2009/0248883 A1	10/2009	Suryanarayana et al.	2010/0322071 A1	12/2010	Avdanin et al.
2009/0254857 A1	10/2009	Romine et al.	2010/0325420 A1	12/2010	Kanekar
2009/0257379 A1	10/2009	Robinson et al.	2011/0004917 A1	1/2011	Saisa et al.
2009/0261783 A1	10/2009	Gonzales et al.	2011/0013569 A1	1/2011	Scherzer et al.
2009/0262715 A1	10/2009	Juang	2011/0019574 A1	1/2011	Malomsoky et al.
2009/0271514 A1	10/2009	Thomas et al.	2011/0071854 A1	3/2011	Medeiros et al.
2009/0282127 A1	11/2009	Leblanc et al.	2011/0081881 A1	4/2011	Baker et al.
2009/0286507 A1	11/2009	O'Neil et al.	2011/0082790 A1	4/2011	Baker et al.
2009/0287921 A1	11/2009	Zhu et al.	2011/0110309 A1	5/2011	Bennett
2009/0288140 A1	11/2009	Huber et al.	2011/0126141 A1	5/2011	King et al.
2009/0291665 A1	11/2009	Gaskarth et al.	2011/0145920 A1	6/2011	Mahaffey et al.
2009/0292815 A1	11/2009	Gao et al.	2011/0159818 A1	6/2011	Scherzer et al.
2009/0293378 A1	12/2009	Benson	2011/0173678 A1	7/2011	Kaippallimalil et al.
2009/0299857 A1	12/2009	Brubaker	2011/0177811 A1	7/2011	Heckman et al.
2009/0307696 A1	12/2009	Vals et al.	2011/0182220 A1	7/2011	Black et al.
2009/0307746 A1	12/2009	Di et al.	2011/0185202 A1	7/2011	Black et al.
2009/0315735 A1	12/2009	Bhavani et al.	2011/0195700 A1	8/2011	Kukuchka et al.
2009/0318124 A1	12/2009	Haughn	2011/0238545 A1	9/2011	Fanaian et al.
2009/0320110 A1	12/2009	Nicolson et al.	2011/0241624 A1	10/2011	Park et al.
2010/0010873 A1	1/2010	Moreau	2011/0244837 A1	10/2011	Murata et al.
2010/0017506 A1	1/2010	Fadell	2011/0249668 A1	10/2011	Milligan et al.
2010/0020822 A1	1/2010	Zerillo et al.	2011/0252430 A1	10/2011	Chapman et al.
2010/0027469 A1	2/2010	Gurajala et al.	2011/0264923 A1	10/2011	Kocher et al.
2010/0027525 A1	2/2010	Zhu	2011/0277019 A1	11/2011	Pritchard, Jr.
2010/0027559 A1	2/2010	Lin et al.	2011/0294502 A1	12/2011	Oerton
2010/0030890 A1	2/2010	Dutta et al.	2012/0011017 A1	1/2012	Wolcott et al.
2010/0041364 A1	2/2010	Lott et al.	2012/0020296 A1	1/2012	Scherzer et al.
2010/0041365 A1	2/2010	Lott et al.	2012/0029718 A1	2/2012	Davis
2010/0041391 A1	2/2010	Spivey et al.	2012/0108225 A1	5/2012	Luna et al.
2010/0042675 A1	2/2010	Fujii	2012/0122514 A1	5/2012	Cheng et al.
2010/0043068 A1	2/2010	Varadhan et al.	2012/0144025 A1	6/2012	Melander et al.
2010/0046373 A1	2/2010	Smith et al.	2012/0155296 A1	6/2012	Kashanian
2010/0069074 A1	3/2010	Kodialam et al.	2012/0166364 A1	6/2012	Ahmad et al.
2010/0071053 A1	3/2010	Ansari et al.	2012/0166604 A1	6/2012	Fortier et al.
2010/0075666 A1	3/2010	Garner	2012/0195200 A1	8/2012	Regan
2010/0077035 A1	3/2010	Li et al.	2012/0196644 A1	8/2012	Scherzer et al.
2010/0080202 A1	4/2010	Hanson	2012/0238287 A1	9/2012	Scherzer
2010/0082431 A1	4/2010	Ramer et al.	2012/0330792 A1	12/2012	Kashanian
2010/0088387 A1	4/2010	Calamera	2013/0024914 A1	1/2013	Ahmed et al.
			2013/0029653 A1	1/2013	Baker et al.
			2013/0030960 A1	1/2013	Kashanian
			2013/0058274 A1	3/2013	Scherzer et al.
			2013/0065555 A1	3/2013	Baker et al.

(56)

References Cited

U.S. PATENT DOCUMENTS

2013/0072177 A1 3/2013 Ross et al.
 2013/0084835 A1 4/2013 Scherzer et al.
 2013/0095787 A1 4/2013 Kashanian
 2013/0117140 A1 5/2013 Kashanian
 2013/0144789 A1 6/2013 Aaltonen et al.
 2013/0176908 A1 7/2013 Baniel et al.
 2013/0196685 A1 8/2013 Griff et al.
 2013/0225151 A1 8/2013 King et al.
 2013/0286942 A1 10/2013 Bonar et al.
 2013/0326356 A9 12/2013 Zheng et al.
 2014/0071895 A1 3/2014 Bane et al.
 2014/0073291 A1 3/2014 Hildner et al.
 2014/0080539 A1 3/2014 Scherzer et al.
 2014/0198687 A1 7/2014 Raleigh
 2014/0226624 A1 8/2014 Woo et al.
 2014/0241342 A1 8/2014 Constantinof
 2015/0039763 A1 2/2015 Chaudhary et al.
 2015/0181628 A1 6/2015 Haverinen et al.
 2015/0341226 A1 11/2015 Griff et al.
 2017/0063695 A1 3/2017 Ferrell
 2018/0262947 A1 9/2018 Raleigh et al.
 2020/0077892 A1 3/2020 Tran
 2020/0092707 A1 3/2020 Raleigh

FOREIGN PATENT DOCUMENTS

CN 1345154 A 4/2002
 CN 1508734 A 6/2004
 CN 1538730 A 10/2004
 CN 1567818 A 1/2005
 CN 101035308 A 3/2006
 CN 1801829 A 7/2006
 CN 1802839 A 7/2006
 CN 1889777 A 7/2006
 CN 101155343 B 9/2006
 CN 1867024 A 11/2006
 CN 1878160 A 12/2006
 CN 1937511 A 3/2007
 CN 101123553 A 9/2007
 CN 101080055 A 11/2007
 CN 101114878 A 1/2008
 CN 101115248 A 1/2008
 CN 101127988 A 2/2008
 CN 101183958 A 5/2008
 CN 101335666 A 12/2008
 CN 101341764 A 1/2009
 CN 101437224 A 5/2009
 CN 101815275 A 8/2010
 CN 101911772 A 12/2010
 EP 1098490 A2 5/2001
 EP 1289326 A1 3/2003
 EP 1484871 8/2004
 EP 1463238 9/2004
 EP 1484871 A1 12/2004
 EP 1503548 A1 2/2005
 EP 1545114 A1 6/2005
 EP 1739518 1/2007
 EP 1772988 4/2007
 EP 1850575 A1 10/2007
 EP 1887732 A1 2/2008
 EP 1942698 A1 7/2008
 EP 1978772 10/2008
 EP 2007065 A1 12/2008
 EP 2026514 A1 2/2009
 EP 2381711 A1 10/2011
 EP 2466831 A1 6/2012
 EP 2154602 B1 6/2017
 JP 3148713 B2 3/2001
 JP 2005339247 A 12/2005
 JP 2006041989 2/2006
 JP 2006155263 A 6/2006
 JP 2006197137 7/2006
 JP 2006344007 A 12/2006
 JP 2007318354 A 12/2007
 JP 2008301121 A 12/2008

JP 2009111919 5/2009
 JP 2009212707 A 9/2009
 JP 2009218773 9/2009
 JP 2009232107 A 10/2009
 KR 20040053858 A 6/2004
 WO 1998058505 12/1998
 WO 1999027723 6/1999
 WO 1999065185 A3 5/2001
 WO 0208863 1/2002
 WO 2002045315 A2 6/2002
 WO 2002067616 A1 8/2002
 WO 2002093877 A1 11/2002
 WO 2003014891 2/2003
 WO 2003017063 A2 2/2003
 WO 2003017065 A2 2/2003
 WO 2003058880 A1 7/2003
 WO 03/100581 12/2003
 WO 03/100581 A2 12/2003
 WO 2004028070 A1 4/2004
 WO 2004064306 A2 7/2004
 WO 2004095753 A3 1/2005
 WO 2005008995 1/2005
 WO 2005053335 A1 6/2005
 WO 2005083934 A1 9/2005
 WO 2006004467 A1 1/2006
 WO 2006004784 A1 1/2006
 WO 2006012018 2/2006
 WO 2006012610 A2 2/2006
 WO 2006050758 A1 5/2006
 WO 2006077481 A1 7/2006
 WO 2006093961 A1 9/2006
 WO 2006120558 11/2006
 WO 2006130960 A1 12/2006
 WO 2007001833 A2 1/2007
 WO 2007014630 A1 2/2007
 WO 2007018363 A1 2/2007
 WO 2007053848 A1 5/2007
 WO 2007068288 6/2007
 WO 2007097786 A 8/2007
 WO 2007107701 A2 9/2007
 WO 2007120310 10/2007
 WO 2007124279 11/2007
 WO 2007126352 11/2007
 WO 2007129180 A2 11/2007
 WO 2007133844 A 11/2007
 WO 2004077797 A3 2/2008
 WO 2008017837 A1 2/2008
 WO 2008051379 A2 5/2008
 WO 2008066419 A1 6/2008
 WO 2008080139 A1 7/2008
 WO 2008080430 A1 7/2008
 WO 2008099802 A1 8/2008
 WO 2008/113986 9/2008
 WO 2009008817 A1 1/2009
 WO 2006073837 A3 4/2009
 WO 2007069245 A3 4/2009
 WO 2009091295 A1 7/2009
 WO 2010088413 A1 8/2010
 WO 2010128391 A2 11/2010
 WO 2010128391 A3 1/2011
 WO 2011002450 A1 1/2011
 WO 2011149532 A1 12/2011

OTHER PUBLICATIONS

M. V. Pedersen, F. H. P. Fitzek, and T. Larsen, "Implementation and Performance Evaluation of Network Coding for Cooperative Mobile Devices," ICC Workshops—2008 IEEE International Conference on Communications Workshops, Beijing, China: IEEE, May 2008, pp. 91-96. doi: 10.1109/ICCW.2008.22.
 W. R. Stevens, "TCP/IP Illustrated, vol. 1," 2003, ISBN: 0-13-141155-1 ("Stevens").
 Bajaj, et al., IETF RFC 3198, Web Services Policy 1.2—Framework (WS-Policy), Apr. 25, 2006, downloaded from the internet at <https://www.w3.org/Submission/WS-Policy/> on Aug. 29, 2023.
 Sloman, et. al., "Security and management policy specification." IEEE Network, Mar./Apr. 2002 pp. 10-19.

(56)

References Cited

OTHER PUBLICATIONS

- Lu, et al., "Comparing system level power management policies." IEEE Design & Test of Computers, Mar./Apr. 2001 pp. 10-19.
- Davie, et al., IETF RFC 3246, An Expedited Forwarding PHB (Per-Hop Behavior), Mar. 2002, downloaded from the internet at <https://datatracker.ietf.org/doc/html/rfc3246> on Sep. 5, 2023.
- Excerpts, The New Penguin Dictionary of Computing, by Dick Pountain, 2001.
- Westerinen, et al., IETF RFC 3198, Terminology for Policy-Based Management, Nov. 2001, downloaded from the internet at <https://www.ietf.org/rfc/rfc3198.txt> on Aug. 15, 2023.
- Yavatkar, IETF RFC 2753, A Framework for Policy-Based Admission Control, Jan. 2000, downloaded from the internet at <https://datatracker.ietf.org/doc/html/rfc2753> on Sep. 5, 2023.
- IPR2023-01360; Petition for Inter Partes Review of U.S. Pat. No. 9,609,544, filed on Sep. 11, 2023.
- IPR2023-01361; Petition for Inter Partes Review of U.S. Pat. No. 9,271,184, filed on Sep. 8, 2023.
- IPR2023-01362; Petition for Inter Partes Review of U.S. Pat. No. 9,271,184, filed on Sep. 8, 2023.
- IPR2023-01336; Petition for Inter Partes Review of U.S. Pat. No. 9,137,701, filed on Aug. 25, 2023.
- IPR2023-01337; Petition for Inter Partes Review of U.S. Pat. No. 9,521,578, filed on Aug. 25, 2023.
- IPR2023-01462; Petition for Inter Partes Review of U.S. Pat. No. 9,277,445, filed on Sep. 28, 2023.
- "Ads and movies on the run," the Gold Coast Bulletin, Southport, Qld, Jan. 29, 2008.
- "ASA/PIX: Allow Split Tunneling for VPN Clients on the ASA Configuration Example," Document ID 70917, Jan. 10, 2008.
- "Communication Concepts for Mobile Agent Systems," by Joachim Baumann et al.; Inst. of Parallel and Distributed High-Performance Systems, Univ. of Stuttgart, Germany, pp. 123-135, 1997.
- "End to End QoS Solution for Real-time Multimedia Application;" Computer Engineering and Applications, 2007, 43 (4): 155-159, by Tan Zu-guo, Wang Wen-juan; Information and Science School, Zhanjian Normal College, Zhan jiang, Guangdong 524048, China.
- "Jentro Technologies launches Zenlet platform to accelerate location-based content delivery to mobile devices," The Mobile Internet, Boston, MA, Feb. 2008.
- "The Construction of Intelligent Residential District in Use of Cable Television Network," Shandong Science, vol. 13, No. 2, Jun. 2000.
- 3rd Generation Partnership Project, "Technical Specification Group Core Network and Terminals; Access Network Discovery and Selection Function (ANDSF) Management Object (MO)," Release 9, Document No. 3GPP TS 24.312, V9.1.0, Mar. 2010.
- 3rd Generation Partnership Project, "Technical Specification Group Services and System Aspects; General Packet Radio Service (GPRS) Enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) Access," Release 8, Document No. 3GPP TS 23.401, V8.4.0, Dec. 2008.
- 3rd Generation Partnership Project, "Technical Specification Group Services and System Aspects; Policy and Charging Control Architecture," Release 8, Document No. 3GPP TS 23.203, V8.4.0, Dec. 2008.
- 3rd Generation Partnership Project; "Technical Specification Group Services and System Aspects; IP Flow Mobility and seamless WLAN offload; Stage 2," Release 10, Document No. 3GPP TS 23.261, V1.0.0, Mar. 2010.
- Accuris Networks, "The Business Value of Mobile Data Offload—a White Paper", 2010.
- Ahmed et al., "A Context-Aware Vertical Handover Decision Algorithm for Multimode Mobile Terminals and Its Performance," BenQ Mobile, Munich Germany; University of Klagenfurt, Klagenfurt, Austria; 2006.
- Ahmed et al., "Multi Access Data Network Connectivity and IP Flow Mobility in Evolved Packet System (EPS)," 2010 IEEE.
- Alonistioti et al., "Intelligent Architectures Enabling Flexible Service Provision and Adaptability," 2002.
- Amazon Technologies, Inc., "Kindle™ User's Guide," 3rd Edition, Copyright 2004-2009.
- Android Cupcake excerpts, The Android Open Source Project, Feb. 10, 2009.
- Anton, B. et al., "Best Current Practices for Wireless Internet Service Provider (WISP) Roaming"; Release Date Feb. 2003, Version 1.0; Wi-Fi Alliance—Wireless ISP Roaming (WISPr).
- Blackberry Mobile Data System, version 4.1, Technical Overview, 2006.
- Byrd, Open Secure Wireless, May 5, 2010.
- Chandrasekhar et al., "Femtocell Networks: A Survey," Jun. 28, 2008.
- Chaouchi et al., "Policy Based Networking in the Integration Effort of 4G Networks and Services," 2004 IEEE.
- Cisco Systems, Inc., "Cisco Mobile Exchange (CMX) Solution Guide: Chapter 2—Overview of GSM, GPRS, and UMTS," Nov. 4, 2008.
- Client Guide for Symantec Endpoint Protection and Symantec Network Access Control, 2007.
- Dikaiakos et al., "A Distributed Middleware Infrastructure for Personalized Services," Nov. 24, 2003.
- Dixon et al., Triple Play Digital Services: Comcast and Verizon (Digital Phone, Television, and Internet), Aug. 2007.
- Droid Wall 1.3.7 description 20100428 obtained from <https://www.freewarelovers.com/android/apps/droid-wall>.
- Ehnert, "Small application to monitor IP traffic on a Blackberry—1.01.03", Mar. 27, 2008; <http://www.ehnert.net/MiniMoni/>.
- European Commission, "Data Roaming Tariffs—Transparency Measures," obtained from EUROPA—Europe's Information Society Thematic Portal website, Jun. 24, 2011: "http://ec.europa.eu/information_society/activities/roaming/data/measures/index_en.htm."
- Farooq et al., "An IEEE 802.16 WiMax Module for the NS-3 Simulator," Mar. 2-6, 2009.
- Fujitsu, "Server Push Technology Survey and Bidirectional Communication in HTTP Browser," Jan. 9, 2008 (JP).
- Han et al., "Information Collection Services for Qos-Aware Mobile Applications," 2005.
- Hartmann et al., "Agent-Based Banking Transactions & Information Retrieval—What About Performance Issues?" 1999.
- Hewlett-Packard Development Company, LP, "IP Multimedia Services Charging," white paper, Jan. 2006.
- Hossain et al., "Gain-Based Selection of Ambient Media Services in Pervasive Environments," Mobile Networks and Applications. Oct. 3, 2008.
- Jing et al., "Client-Server Computing in Mobile Environments," GTE Labs. Inc., Purdue University, ACM Computing Surveys, vol. 31, No. 2, Jun. 1999.
- Kasper et al., "Subscriber Authentication in mobile cellular Networks with virtual software SIM Credentials using Trusted Computing," Fraunhofer-Institute for Secure Information Technology SIT, Darmstadt, Germany; ICACT 2008.
- Kassar et al., "An overview of vertical handover decision strategies in heterogeneous wireless networks," ScienceDirect, University Pierre & Marie Curie, Paris, France, Jun. 5, 2007.
- Kim, "Free wireless a high-wire act; MetroFi needs to draw enough ads to make service add profits," San Francisco Chronicle, Aug. 21, 2006.
- Knight et al., "Layer 2 and 3 Virtual Private Networks: Taxonomy, Technology, and Standardization Efforts," IEEE Communications Magazine, Jun. 2004.
- Koutsopoulou et al., "Charging, Accounting and Billing Management Schemes In Mobile Telecommunication Networks and the Internet," IEEE Communications Surveys & Tutorials, First Quarter 2004, vol. 6, No. 1.
- Koutsopoulou et al., "Middleware Platform for the Support of Charging Reconfiguration Actions," 2005.
- Kuntze et al., "Trustworthy content push," Fraunhofer-Institute for Secure Information Technology SIT; Germany; WCNC 2007 proceedings, IEEE.
- Kyriakakos et al., "Ubiquitous Service Provision in Next Generation Mobile Networks," Proceedings of the 13th IST Mobile and Wireless Communications Summit, Lyon, France, Jun. 2004.

(56)

References Cited

OTHER PUBLICATIONS

- Li, Yu, "Dedicated E-Reading Device: The State of the Art and The Challenges," Scroll, vol. 1, No. 1, 2008.
- Loopt User Guide, metroPCS, Jul. 17, 2008.
- Muntermann et al., "Potentiale und Sicherheitsanforderungen mobiler Finanzinformationsdienste und deren Systeminfrastrukturen," Chair of Mobile Commerce & Multilateral Security, Goethe Univ. Frankfurt, 2004.
- NetLimiter Lite 4.0.19.0; <http://www.heise.de/download/netlimiter-lite-3617703.html> from vol. 14/2007.
- Nilsson et al., "A Novel MAC Scheme for Solving the QoS Parameter Adjustment Problem in IEEE802.11e EDCA," Feb. 2006.
- Aral, Masato, et al.; "A Proposal for an Effective Information Flow Control Model for Sharing and Protecting Sensitive Information", Proc. 7th Australasian Information Security Conference (AISC 2009), Wellington, New Zealand.
- Nuzman et al., "A compound model for TCP connection arrivals for LAN and WAN applications," Oct. 22, 2002.
- Open Mobile Alliance (OMA), Push Architecture, Candidate Version 2.2; Oct. 2, 2007; OMA-AD-Push-V2_2-20071002-C.
- Oppliger, Rolf, "Internet Security: Firewalls and Beyond," Communications of the ACM, May 1997, vol. 40, No. 5.
- Quintana, David, "Mobile Multitasking," Apr. 14, 2010.
- Rao et al., "Evolution of Mobile Location-Based Services," Communication of the ACM, Dec. 2003.
- Richtel, "Cellphone consumerism: If even a debit card is too slow, now you have a new way to act on impulse: [National Edition]," National Post, Canada, Oct. 2, 2007.
- Rivadeneira et al., "A communication architecture to access data services through GSM," San Sebastian, Spain, 1998.
- Roy et al., "Energy Management in Mobile Devices with the Cinder Operating System", Stanford University, MIT CSAIL, Jun. 3, 2010.
- Ruckus Wireless—White Paper; "Smarter Wi-Fi for Mobile Operator Infrastructures" 2010.
- Sabat, "The evolving mobile wireless value chain and market structure," Nov. 2002.
- Sadeh et al., "Understanding and Capturing People's Privacy Policies in a Mobile Social Networking Application," ISR School of Computer Science, Carnegie Mellon University, 2007.
- Schiller et al., "Location-Based Services," The Morgan Kaufmann Series in Data Management Systems, 2004.
- Sharkey, "Coding for Life—Battery Life, That Is," May 27, 2009.
- Sharkey, Jeff, "Coding for Life—Battery Life, That Is," May 27, 2009.
- Steglich, Stephan, "I-Centric User Interaction," Nov. 21, 2003.
- Sun et al., "Towards Connectivity Management Adaptability: Context Awareness in Policy Representation and End-to-end Evaluation Algorithm," Dept. of Electrical and Information Engineering, Univ. of Oulu, Finland, 2004.
- Thurston, Richard, "WISPr 2.0 Boosts Roaming Between 3G and Wi-Fi"; Jun. 23, 2010; Web page from zdnet.com; zdnet.com/wispr-2-0-boosts-roaming-between-3g-and-wi-fi-3040089325/.
- Van Eijk, et al., "GigaMobile, Agent Technology for Designing Personalized Mobile Service Brokerage," Jul. 1, 2002.
- VerizonWireless.com news, "Verizon Wireless Adds to Portfolio of Consumer-Friendly Tools With Introduction of Usage Controls, Usage Controls and Chaperone 2.0 Offer Parents Full Family Security Solution," Aug. 18, 2008.
- Windows7 Power Management, published Apr. 2009.
- Wireless Broadband Alliance, "WISPr 2.0, Apr. 8, 2010"; Doc. Ref. No. WBA/RM/WISPr, Version 01.00.
- Zhu et al., "A Survey of Quality of Service in IEEE 802.11 Networks," IEEE Wireless Communications, Aug. 2004.
- IPR2023-01157: Petition for Inter Partes Review of U.S. Pat. No. 11,405,224, filed Jul. 20, 2023.
- IPR2023-01226: Petition for Inter Partes Review of U.S. Pat. No. 10,237,773, filed Jul. 21, 2023.
- Complaint filed in *Headwater Research LLC v. Samsung Electronics Co., Ltd., Samsung Electronics America, Inc.*, dated Oct. 26, 2022, Case No. 2:22-cv-00422, E.D. Texas.
- First Amended Complaint filed in *Headwater Research LLC v. Samsung Electronics Co., Ltd., Samsung Electronics America, Inc.*, dated Nov. 30, 2022, Case No. 2:22-cv-00422, E.D. Texas.
- Complaint filed in *Headwater Research LLC v. Samsung Electronics Co., Ltd et al.*, dated Dec. 6, 2022, Case No. 2:22-cv-00467, E.D. Texas.
- File History of U.S. Pat. No. 9,277,445 (Raleigh et al.), issued Mar. 1, 2016.
- File History of IPR2023-01157, filed Jul. 20, 2023.
- File History of IPR2023-01226, filed Jul. 21, 2023.
- Samsung Stipulation letter, dated Jul. 21, 2023 in *Headwater Research LLC v. Samsung Electronics Co., Ltd., et al.* Case No. 2:22-cv-00467, E.D. Texas.
- Samsung Stipulation letter, dated Jul. 20, 2023 in *Headwater Research LLC v. Samsung Electronics Co., Ltd., et al.* Case No. 2:22-cv-00422, E.D. Texas.
- Banchs, et. al., Distributed weighted fair queuing in 802.11 wireless LAN, 2002 IEEE International Conference on Communications, Conference Proceedings. ICC 2002 pp. 3121-3127), 2002.
- File History of U.S. Pat. No. 9,277,433 (Raleigh, et al.), issued Mar. 1, 2016.
- Burt, "Competition in Mobile Chips to Grow in 2009: In-Stat," eWEEK, Aug. 18, 2009, downloaded from the internet at <https://www.eweek.com/pc-hardware/competition-inmobile-chips-to-grow-in-2009-in-stat/> on Jul. 29, 2023.
- Enck, et. al., Understanding Android Security, IEEE Security & Privacy Magazine, vol. 7, No. 1, 78 pages, Jan./Feb. 2009.
- Excerpts, Rosen, et al. "UNIX: The Complete Reference", Second Edition, McGraw-Hill 2007.
- Bray, et. al., Extensible Markup Language (XML) 1.1 (Second Edition), W3C, 2006, Aug. 16, 2006, 41 pages, downloaded from the internet at <https://www.w3.org/TR/2006/REC-xml11-20060816/> on Jul. 29, 2023.
- File History of IPR2023-01250; filed on Aug. 14, 2023.
- File History of IPR2023-01253, filed on Aug. 11, 2023.
- File History of U.S. Pat. No. 9,143,976 (Raleigh, et al.), issued Sep. 22, 2015.
- Nichols, et al., IETF RFC 2474, "Definition of the Differentiated Services Field (DS Field) in the IPV4 and IPV6 Headers," Dec. 1998, downloaded from the internet at <https://datatracker.ietf.org/doc/html/rfc2474> on Jul. 29, 2023.
- Blake, et al., IETF RFC 2475, "An Architecture for Differentiated Services," Dec. 1998, downloaded from the internet at <https://datatracker.ietf.org/doc/html/rfc2475> on Jul. 29, 2023.
- Durham, et al., IETF RFC 2748, "The COPS (Common Open Policy Service) Protocol," Jan. 2000, downloaded from the internet at <https://www.rfc-editor.org/rfc/rfc2748.html> on Aug. 1, 2023.
- Westerinen, et al., IETF RFC 3198, Terminology for Policy-Based Management, Nov. 2001, available at <https://www.ietf.org/rfc/rfc3198.txt>.
- Babiarz, et al., IETF RFC 4594, Configuration Guidelines for DiffServ Service Classes, Aug. 2006, downloaded from the internet at <https://datatracker.ietf.org/doc/html/rfc4594> on Jul. 29, 2023.
- Schulzrinne, et. al., IETF RFC 4745, "Common Policy: A Document Format for Expressing Privacy Preferences," Feb. 2007, downloaded from the internet at <https://datatracker.ietf.org/doc/html/rfc4745> on Jul. 29, 2023.
- IETF RFC 791, Internet Protocol, Sep. 1981, downloaded from the internet at <https://www.ietf.org/rfc/rfc791.txt> on Jul. 28, 2023.
- IPR2023-01250: Petition for Inter Partes Review of U.S. Pat. No. 9,277,433, filed Aug. 14, 2023.
- IPR2023-01253: Petition for Inter Partes Review of U.S. Pat. No. 9,143,976, filed Aug. 11, 2023.
- Model-View-Controller, Microsoft Patterns & Practices, Mar. 17, 2014, 9 pages, downloaded from the internet at <http://msdn2.microsoft.com/en-US/library/ms978748.aspx> on Jul. 29, 2023.
- Overview of the IEEE 802.11 Standard, Dec. 6, 2001, downloaded from the internet at <https://www.informit.com/articles/article.aspx?p=24411&seqNum=5> on Jul. 29, 2023.
- Samsung Stipulation letter, dated Aug. 11, 2023 in *Headwater Research LLC v. Samsung Electronics Co., Ltd et al.*, Case No. 2:22-cv-00422, E.D. Texas.

(56)

References Cited

OTHER PUBLICATIONS

- Samsung Stipulation letter, dated Aug. 14, 2023 in *Headwater Research LLC v. Samsung Electronics Co., Ltd., et al.*, Case No. 2:22-cv-00422, E.D. Texas.
- Shuler, "How Does the Internet Work?", downloaded from the internet at <https://web.stanford.edu/class/msande91si/www-spr04/readings/week1/InternetWhitepaper.htm> on Jul. 29, 2023.
- Excerpts, Computer Networks, Fourth Edition, by Andrew Tanenbaum, Prentice Hall, 2003.
- Excerpts, Stevens "TCP/IP Illustrated", vol. 1, Addison-Wesley Publishing Company, 1994.
- USB720 Modem Hardware User Manual, 2006, downloaded from the internet at <http://s7.vzw.com/is/content/Verizon-Wireless/Devices/Verizon/Userguides/vzw-usb720-modemum.pdf> on Jul. 31, 2023.
- Want, "When Cell Phones Become Computers", IEEE Pervasive Computing, vol. 8, Apr.-Jun. 2009, pp. 2-5.
- Jon Inouye et al., "Dynamic Network Reconfiguration Support for Mobile Computers, Proceedings of the 3rd annual ACM/IEEE International Conference on Mobile Computing and Networking (MobiCom '97), published Sep. 1997.
- Boutaba and Polyrakis, "Toward Extensible Policy Enforcement Points", in M. Sloman, J. Lobo, and E. Lupu (Eds.): Policy 2001, LNCS 1995, pp. 247-261 (© Springer-Verlag Berlin Heidelberg 2001).
- Beigi et al., "Policy Transformation Techniques in Policy-based Systems Management", Proceedings Fifth IEEE International Workshop on Policies for Distributed Systems and Networks (2004).
- Chaouchi et al., "Policy Based Networking in Integration Effort of 4G Networks and Services", 2004 IEEE 59th Vehicular Technology Conference, VTC 2004-Spring, pp. 2977-2981 vol. 5.
- Verma et al., "Simplifying Network Administration Using Policy-Based Management", IEEE Network, pp. 20-26 (Mar./Apr. 2020).
- 3GPP TS 23.203 (v8.4.0 (Dec. 2008) (3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Policy and charging control architecture (Release 8)).
- Plaintiff Headwater Research LLC's Disclosure of Asserted Claims and Infringement Contentions, case No. 2:23-cv-00398, -397.
- IPR2024-01041, filed Jun. 20, 2024.
- IPR2024-01041 Petition for Inter Partes Review of U.S. Pat. No. 8,924,543, filed Jun. 20, 2024.
- File History of IPR2024-01042, filed Jun. 20, 2024.
- IPR2024-01042 Petition for Inter Partes Review of U.S. Pat. No. 8,924,543, filed Jun. 20, 2024.
- IPR2023-01157 Patent Owner's Preliminary Response, dated Oct. 24, 2023.
- IPR2023-01157 Petitioner's Reply to Patent Owner's Preliminary Response, dated Dec. 6, 2023.
- IPR2023-01157 Patent Owner's Preliminary Sur-Reply, dated Dec. 20, 2023.
- IPR2023-01157 Decision Granting Institution of Inter Partes Review, dated Jan. 22, 2024.
- IPR2023-01157 Patent Owner's Response to the Petition, dated May 8, 2024.
- IPR2023-01226 Patent Owner's Preliminary Response, dated Nov. 15, 2023.
- IPR2023-01226 Petitioner's Pre-Institution Reply, dated Dec. 14, 2023.
- IPR2023-01226 Patent Owner's Preliminary Sur-Reply, dated Dec. 21, 2023.
- IPR2023-01226 Decision Granting Institution of Inter Partes Review, dated Feb. 8, 2024.
- IPR2023-01226 Patent Owner's Response to the Petition, dated May 16, 2024.
- IPR2023-01250 Patent Owner's Preliminary Response, dated Dec. 22, 2023.
- IPR2023-01250 Petitioner's Pre-Institution Reply, Jan. 22, 2024.
- IPR2023-01250 Patent Owner's Preliminary Sur-Reply, Feb. 1, 2024.
- IPR2023-01250 Decision Granting Institution of Inter Partes Review, dated Mar. 12, 2024.
- IPR2023-01253 Patent Owner's Preliminary Response, dated Dec. 22, 2023.
- IPR2023-01253 Petitioner's Pre-Institution Reply, dated Jan. 22, 2024.
- IPR2023-01253 Patent Owner's Preliminary Sur-Reply, dated Feb. 1, 2024.
- IPR2023-01253 Decision Denying Institution of Inter Partes Review, dated Mar. 21, 2024.
- IPR2023-01336 Patent Owner's Preliminary Response, dated Dec. 29, 2023.
- IPR2023-01336 Petitioner's Reply, dated Feb. 5, 2024.
- IPR2023-01336 Patent Owner's Preliminary Sur-Reply, dated Feb. 20, 2024.
- IPR2023-01336 Decision Granting Institution of Inter Partes Review, dated Mar. 25, 2024.
- IPR2023-01337 Patent Owner's Preliminary Response, dated Dec. 29, 2023.
- IPR2023-01337 Petitioner's Reply, dated Feb. 5, 2024.
- IPR2023-01337 Patent Owner's Preliminary Sur-Reply, dated Feb. 20, 2024.
- IPR2023-01337 Decision Granting Institution of Inter Partes Review, dated Mar. 12, 2024.
- IPR2023-01360 Patent Owner's Preliminary Response, dated Jan. 4, 2024.
- IPR2023-01360 Decision Granting Institution of Inter Partes Review, dated Apr. 1, 2024.
- IPR2023-01361 Patent Owner's Preliminary Response, dated Jan. 4, 2024.
- IPR2023-01361 Decision Denying Institution of Inter Partes Review, dated Mar. 29, 2024.
- IPR2023-01361 Petitioner's Request for Rehearing, dated Apr. 26, 2024.
- IPR2023-01362 Patent Owner's Preliminary Response, dated Jan. 4, 2024.
- IPR2023-01362 Decision Denying Institution of Inter Partes Review, dated Mar. 29, 2024.
- IPR2023-01362 Petitioner's Request for Rehearing, dated Apr. 26, 2024.
- IPR2023-01462 Patent Owner's Preliminary Response, dated Jan. 4, 2024.
- IPR2023-01462 Decision Denying Institution of Inter Partes Review, dated Mar. 29, 2024.
- IPR2023-01462 Petitioner's Request for Rehearing, dated Apr. 26, 2024.
- Enable-ExchangeCertificate, Microsoft, <https://learn.microsoft.com/en-us/powershell/module/exchange/enable-exchangecertificate?view=exchange-ps> (last visited May 15, 2024).
- Larry L. Peterson & Bruce S. Davie, Computer Networks: A Systems Approach (3d ed. 2003).
- Elizabeth Woyke, World's Most Wired Airports, NBC News (Mar. 11, 2008, 10:02 AM), <https://www.nbcnews.com/id/wbna23391922> (last visited May 15, 2024).
- Madison Avenue Calling, Gainesville Sun (Jan. 19, 2007, 11:00 PM), <https://www.gainesville.com/story/news/2007/01/20/madison-avenue-calling/31509806007/> (last visited May 15, 2024).
- Spyros Sakellariadis, Using Exchange Server with SMTP and POP3, ITPro Today (May 31, 1998), <https://www.itprotoday.com/email-and-calandaring/using-exchange-server-smtp-and-pop3#close-modal> (last visited May 16, 2024).
- Defendants' Motion to Focus Patent Claims, *Headwater Research LLC v. AT&T Services, Inc.*, No. 2:23-cv-00397, ECF No. 53 (E.D. Tex. Apr. 11, 2024).
- Defendants' Motion for Entry of an Order Focusing Asserted Patent Claim and Prior Art, *Headwater Research LLC v. T-Mobile USA, Inc.*, No. 2:23-cv-00379, ECF No. 58 (E.D. Tex. Apr. 30, 2024).
- Defendants' Motion for Entry of an Order Focusing Asserted Patent Claim and Prior Art, *Headwater Research LLC v. Verizon Communications Inc.*, No. 2:23-cv-00352, ECF No. 63 (E.D. Tex. May 1, 2024).
- IPR2024-00942 Petition for Inter Partes Review of U.S. Pat. No. 8,589,541, dated Jun. 7, 2024.
- IPR2024-00942 File History of Petition for Inter Partes Review of U.S. Pat. No. 8,589,541, dated Jun. 7, 2024.

(56)

References Cited

OTHER PUBLICATIONS

- IPR2024-00943 Petition for Inter Partes Review of U.S. Pat. No. 8,589,541, dated Jun. 7, 2024.
- IPR2024-00943 File History of Petition for Inter Partes Review of U.S. Pat. No. 8,589,541, dated.
- IPR2024-00944 Petition for Inter Partes Review of U.S. Pat. No. 8,589,541, dated Jun. 7, 2024.
- IPR2024-00944 File History of Petition for Inter Partes Review of U.S. Pat. No. 8,589,541, dated.
- Mobile Network Evolution: GSM to UMTS, Conningtech (May 8, 2008, 12:26 pm), <https://conningtech.wordpress.com/2008/05/08/mobile-network-evolution-gsm-to-umts/> (last visited May 23, 2024).
- Patent Owner's Preliminary Response, *Samsung Electronics Co., Ltd. v. Headwater Research LLC*, No. IPR2023-01462, Paper 6 (PTAB Jan. 4, 2024).
- File History of IPR2024-00945; filed on Jun. 7, 2024.
- IPR2024-00945: Petition for Inter Partes Review of U.S. Pat. No. 9,215,613, filed Jun. 7, 2024.
- Joint Claim Construction and Prehearing Statement, *Headwater Research LLC v. Motorola Mobility LLC, et al.*, No. 4:23-cv-04496-JST (N.D. Cal. Jun. 11, 2024) (ECF No. 64).
- IPR2024-01181 Petition for Inter Partes Review, filed Aug. 12, 2024.
- Flinn, Jason, et al. "The case for intentional networking," Proceedings of the 10th Workshop on Mobile Computing Systems and Applications, 2009.
- David Flanagan, O'Reilly & Associates, Inc., "Java in a Nutshell," 1996, ISBN: 1-56592-183-6.
- Buxton, B., "Integrating the Periphery and Context: A New Model of Telematics," in Proceedings of Graphics Interface '95, in GI'95, 1995.
- D. C. Verma, "Simplifying network administration using policy-based management." IEEE Network, vol. 16, No. 2, Mar. 20-26, 2002.
- Petition for Inter Partes Review of U.S. Pat. No. 9,143,976 Pursuant to 35 U.S.C. §§ 311-319, 37 C.F.R. § 42 in *Samsung Electronics Co Ltd v. Headwater Research LLC*, IPR2023-01253, Paper 2 (PTAB Aug. 11, 2023).
- Decision Denying Institution of Inter Partes Review in *Samsung Electronics Co Ltd v. Headwater Research LLC*, IPR2023-01253, Paper 9 (PTAB Mar. 21, 2024).
- File History of U.S. Pat. No. 9,143,976.
- Request for Ex Parte Reexamination of U.S. Pat. No. 9,143,976, filed Aug. 5, 2024.
- D. P. Bovet, "Understanding the Linux Kernel," 2000, ISBN: 0-596-00002-2.
- Provisional U.S. Appl. No. 61/082,160.
- Hinckley et al., "Foreground and background interaction with sensor-enhanced mobile devices," ACM Trans. Comput. Hum. Interact., vol. 12, No. 1, pp. 31-52, Mar. 2005.
- Petition for Inter Partes Review of U.S. Pat. No. 9,277,445 Pursuant to 35 U.S.C. §§ 311-319, 37 C.F.R. § 42 in *Samsung Electronics Co Ltd v. Headwater Research LLC*, IPR2023-01462, Paper 2 (PTAB Sep. 28, 2023).
- Decision Denying Institution of Inter Partes Review in *Samsung Electronics Co Ltd v. Headwater Research LLC*, IPR2023-01462, Paper 9 (PTAB Mar. 29, 2024).
- File History of U.S. Pat. No. 9,277,445.
- Request for Ex Parte Reexamination of U.S. Pat. No. 9,277,445.
- Feldmeier, C.C. "Multiplexing issues in communication system design." In Proceedings of the ACM symposium on Communications architectures & protocols (SIGCOMM '90). Association for Computing Machinery, New York, NY, USA, 209-219, 1990.
- Petition for Inter Partes Review of U.S. Pat. No. 9,271,184 Pursuant to 35 U.S.C. §§ 311-319, 37 C.F.R. § 42 in *Samsung Electronics Co Ltd v. Headwater Research LLC*, IPR2023-01361, Paper 3 (PTAB Sep. 8, 2023).
- Decision Denying Institution of Inter Partes Review in *Samsung Electronics Co Ltd v. Headwater Research LLC*, IPR2023-01361, Paper 10 (PTAB Mar. 29, 2024).
- Petition for Inter Partes Review of U.S. Pat. No. 9,271,184 Pursuant to 35 U.S.C. §§ 311-319, 37 C.F.R. § 42 in *Samsung Electronics Co Ltd v. Headwater Research LLC*, IPR2023-01362, Paper 3 (PTAB Sep. 8, 2023).
- Decision Denying Institution of Inter Partes Review in *Samsung Electronics Co Ltd v. Headwater Research LLC*, IPR2023-01362, Paper 10 (PTAB Mar. 29, 2024).
- File History of U.S. Pat. No. 9,271,184.
- Request for Ex Parte Reexamination of U.S. Pat. No. 9,271,184.
- Complaint for Patent Infringement in *Headwater Research LLC v. Samsung Electronics Co., Ltd et al.*, 2-23-cv-00641 (EDTX), Dec. 29, 2023).
- David Flanagan, O'Reilly & Associates, Inc., "Java in a Nutshell," 1996, ISBN: 1-56592-183-6.
- Korhonen, "Host Identity Protocol (HIP) Implementation in the Symbian Environment," Master of Science Thesis, Tampere University of Technology (Dec. 10, 2007).
- Welsh, "Incorporating Memory Management into User-Level Network Interfaces." IEEE Micro, 18(2), 1998, 10 pages.
- Carter, Casey et al., "Contact networking: a localized mobility system," Proceedings of the 1st International Conference on Mobile systems, Applications and Services, 2003.
- S. Lee & N. Golmie, "Power-Efficient Interface Selection Scheme using Paging of WWAN for WLAN in Heterogeneous Wireless Networks," 2006 IEEE International Conference on Communications (Istanbul, 2006), 1742-1747.
- M. Stemm et al., "A network measurement architecture for adaptive applications," Proceedings of the 2000 IEEE INFOCOM Conference on Computer Communications. Nineteenth Annual Joint Conference of the IEEE Computer and Communications Societies (Cat. No. 00CH37064), Tel Aviv, Israel, 2000, 285-294.
- K. Ravindran & V. Bansal, "Delay compensation protocols for synchronization of multimedia data streams," IEEE Transactions on Knowledge and Data Engineering, vol. 5, No. 4, 574-589, Aug. 1993.
- D. C. Verma, "Simplifying network administration using policy-based management." IEEE Network, vol. 16, No. 2, 20-26, Mar. 2002.
- G. Nychis & D. R. Licata, "The impact of background network traffic on foreground network traffic." Proceedings of the IEEE Global Telecommunications Conference (GLOBECOM), 2001.
- I. Pronchev. "Packet Capturing Using the Linux Netfilter Framework." Technical Report, Technische Universität München, 1-31, Jul. 2006.
- A.-J. Moerdijk and L. Klostermann, "Opening the networks with Parlay/OSA: standards and aspects behind the APIs." IEEE Network, vol. 17, No. 3, pp. 58-64, May-Jun. 2003.
- J. B. D. Joshi, E. Bertino, U. Latif and A. Ghafoor, "A generalized temporal role-based access control model." IEEE Transactions on Knowledge and Data Engineering, vol. 17, No. 1, pp. 4-23, Jan. 2005.
- Lymberopoulos et al., "An Adaptive Policy-Based Framework for Network Services Management," Journal of Network and Systems Management, vol. 11, No. 3, Sep. 2003.
- Richard Stevens et al., "UNIX Network Programming vol. 1, Third Edition: The Sockets Networking API," 2004, ISBN: 0-13-141155-1.
- IPR2024-01407 Petition for Inter Partes Review of U.S. Pat. No. 9,179,359.
- Reexamination U.S. Appl. No. 90/119,610—Order Granting Request for Ex Parte Reexamination of U.S. Pat. No. 9,143,976, dated Oct. 23, 2024.
- Reexamination U.S. Appl. No. 90/019,644—Order Granting Request for Ex Parte Reexamination of U.S. Pat. No. 9,277,445, dated Nov. 8, 2024.
- Reexamination U.S. Appl. No. 90/019,643—Order Granting Request for Ex Parte Reexamination of U.S. Pat. No. 9,271,184, dated Nov. 8, 2024.

* cited by examiner

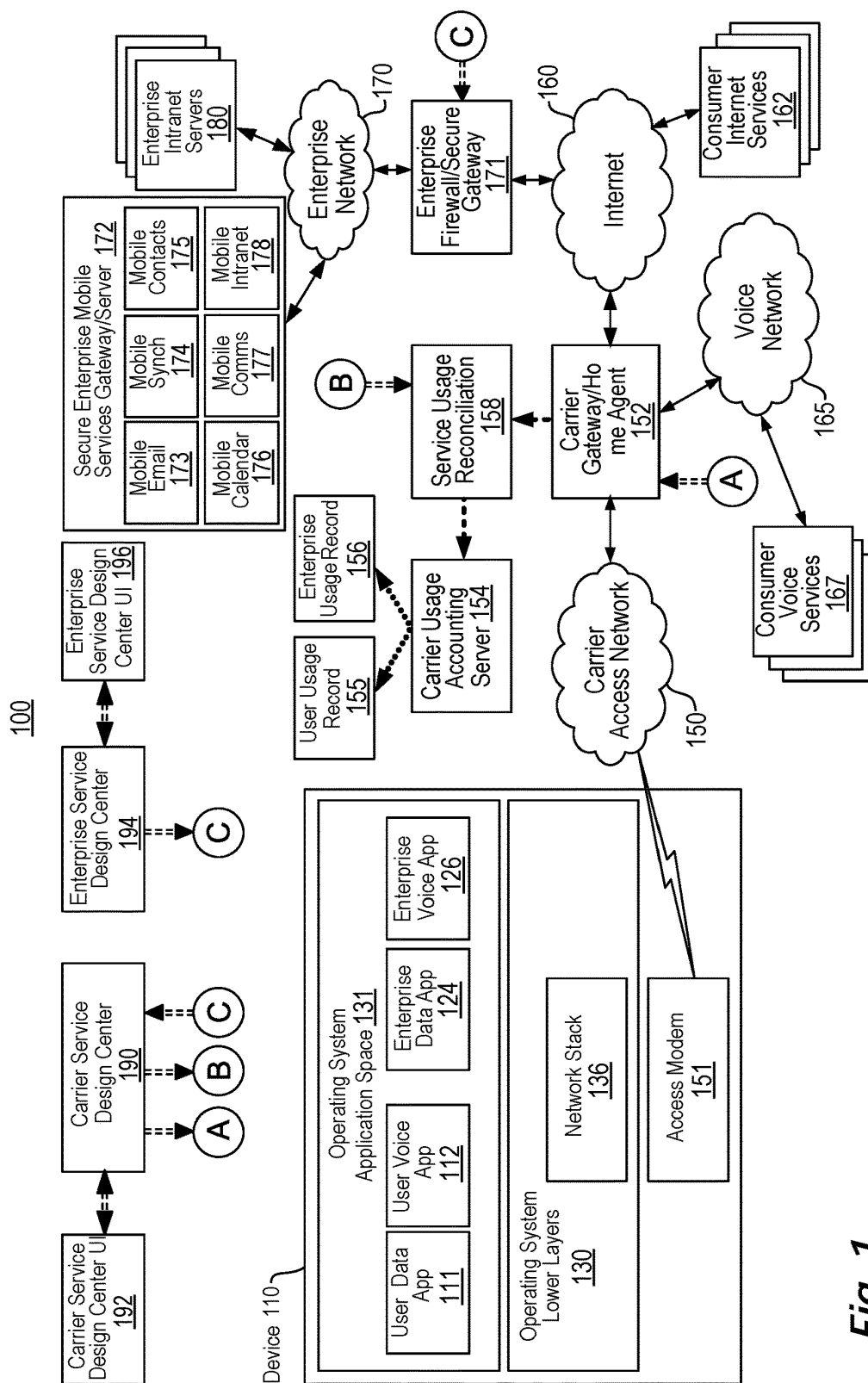


Fig. 1

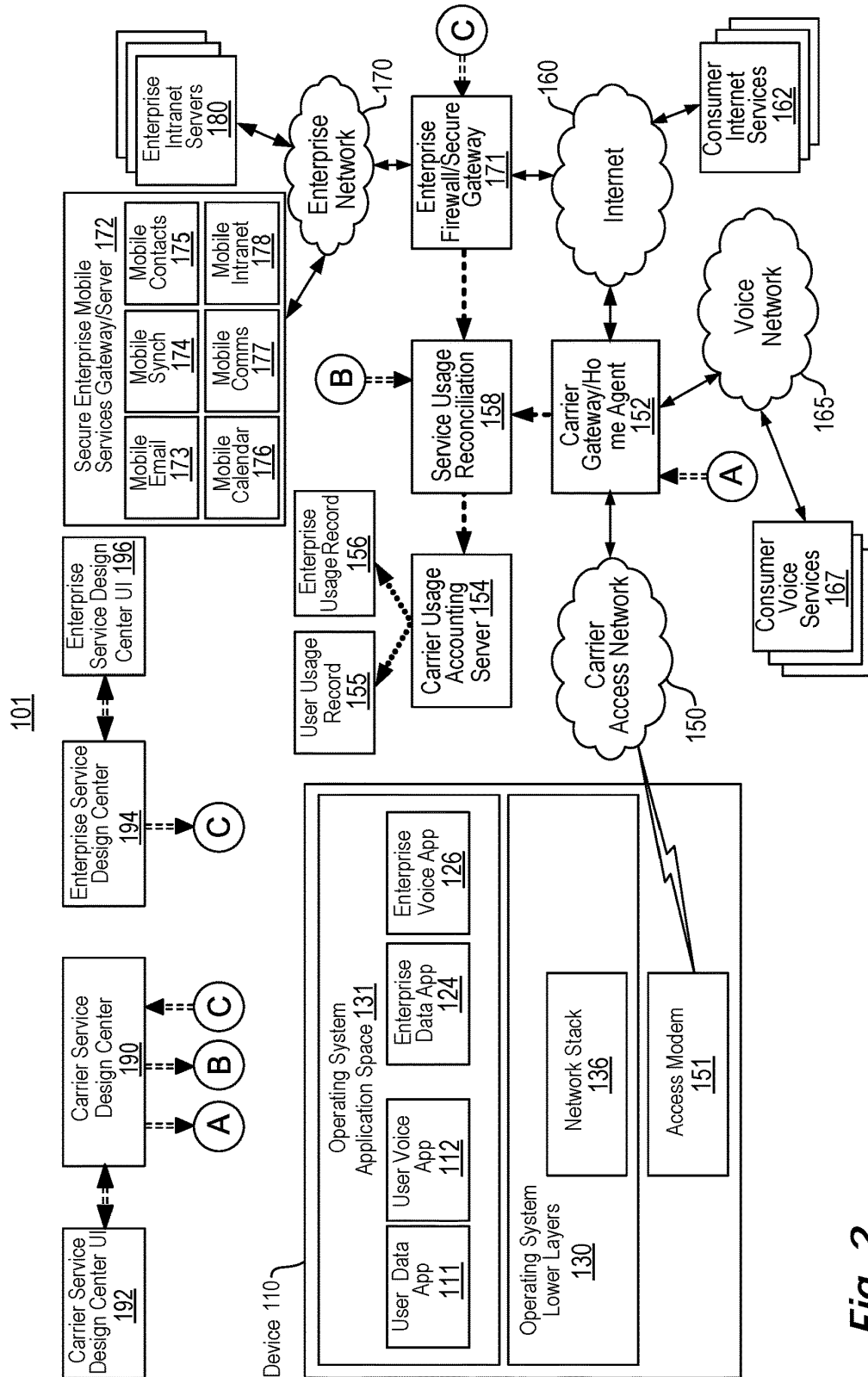


Fig. 2

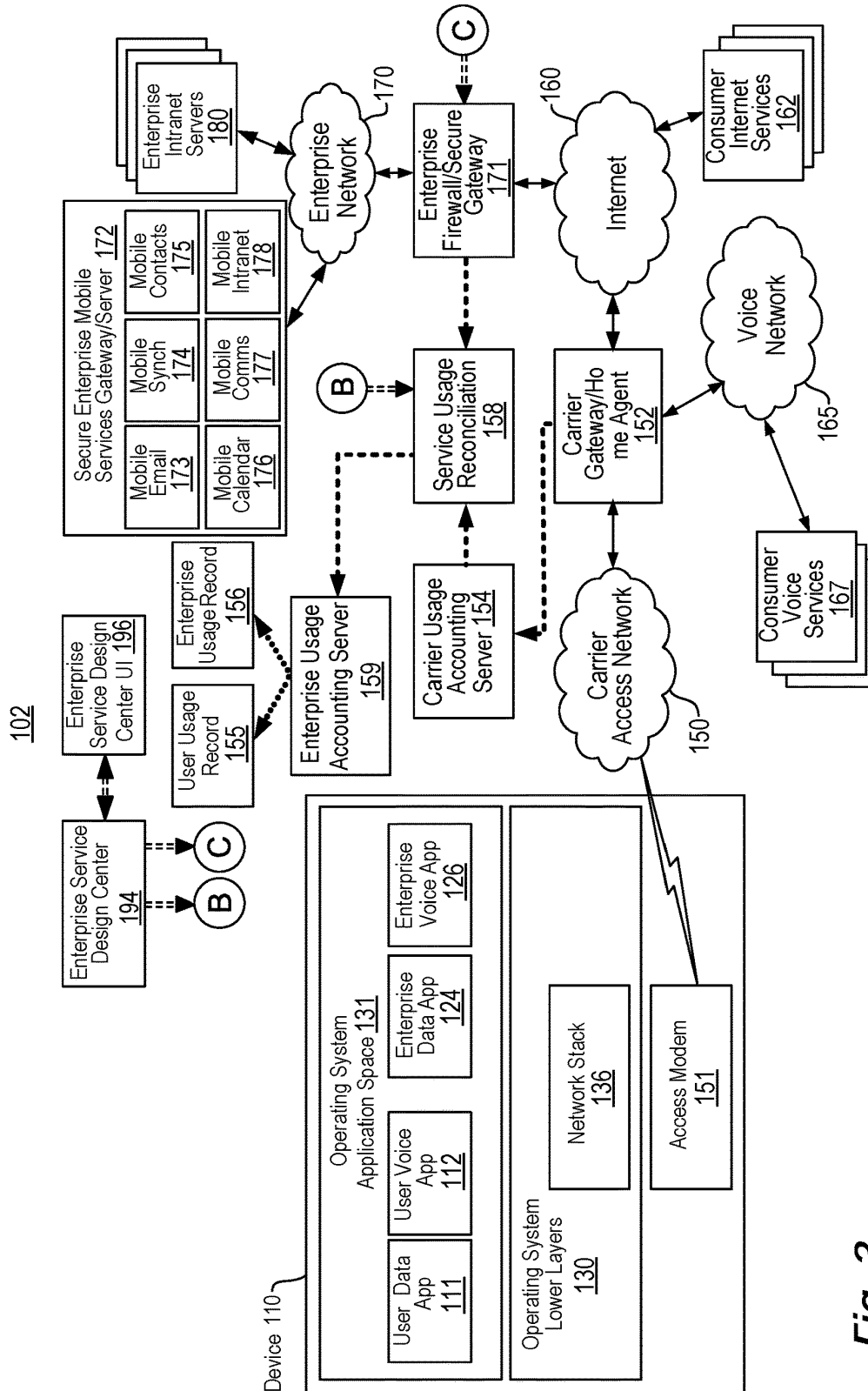


Fig. 3

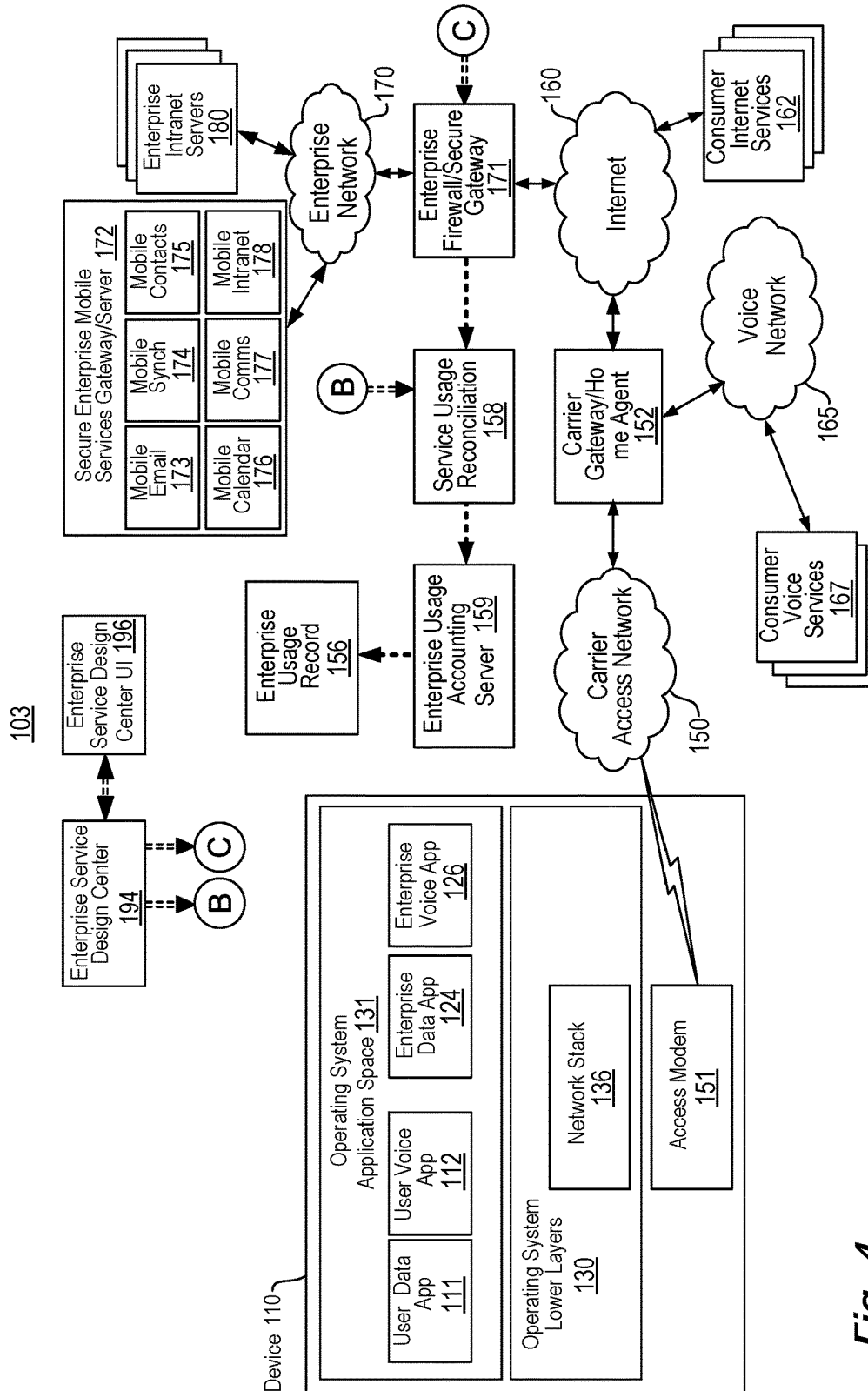


Fig. 4

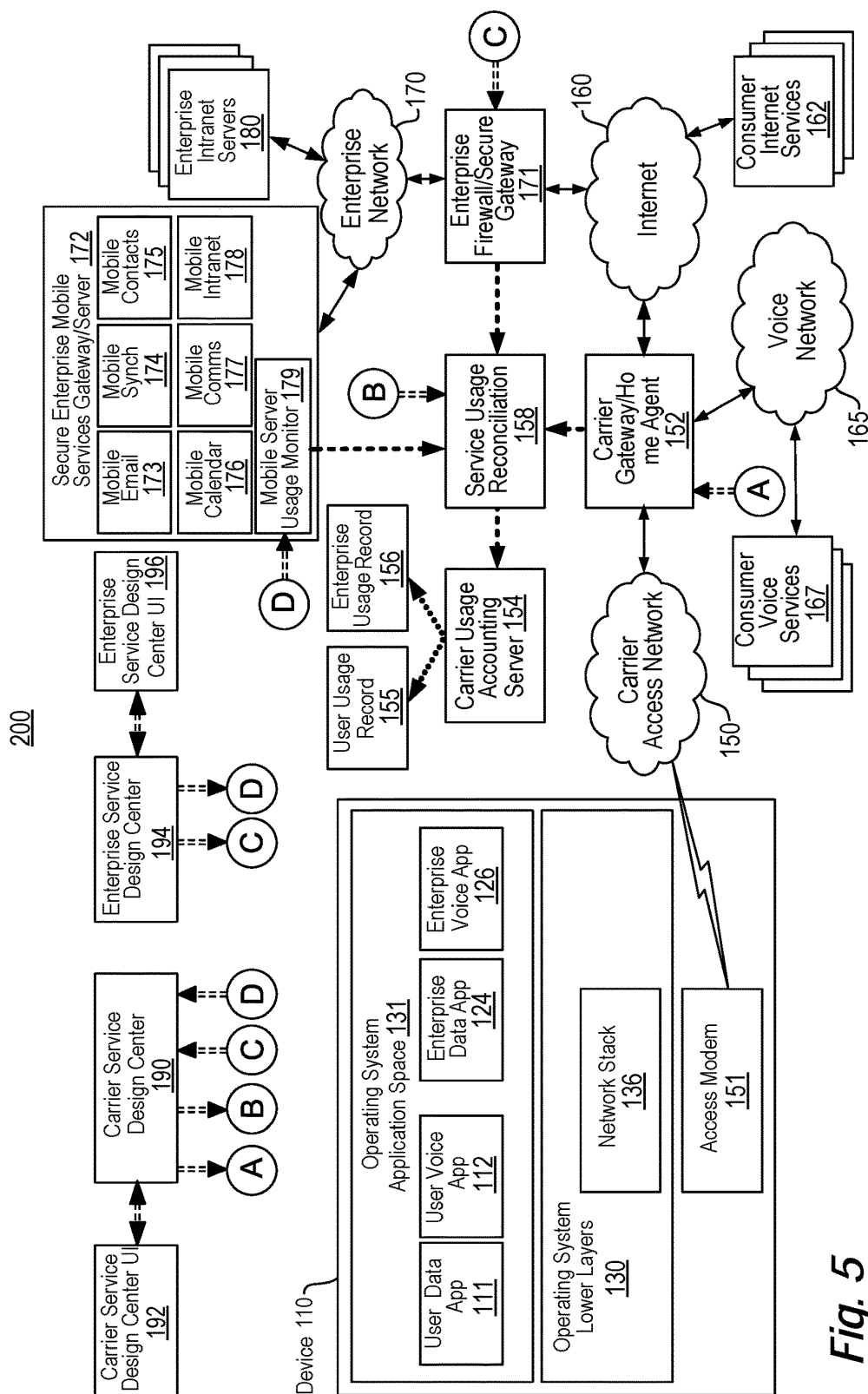


Fig. 5

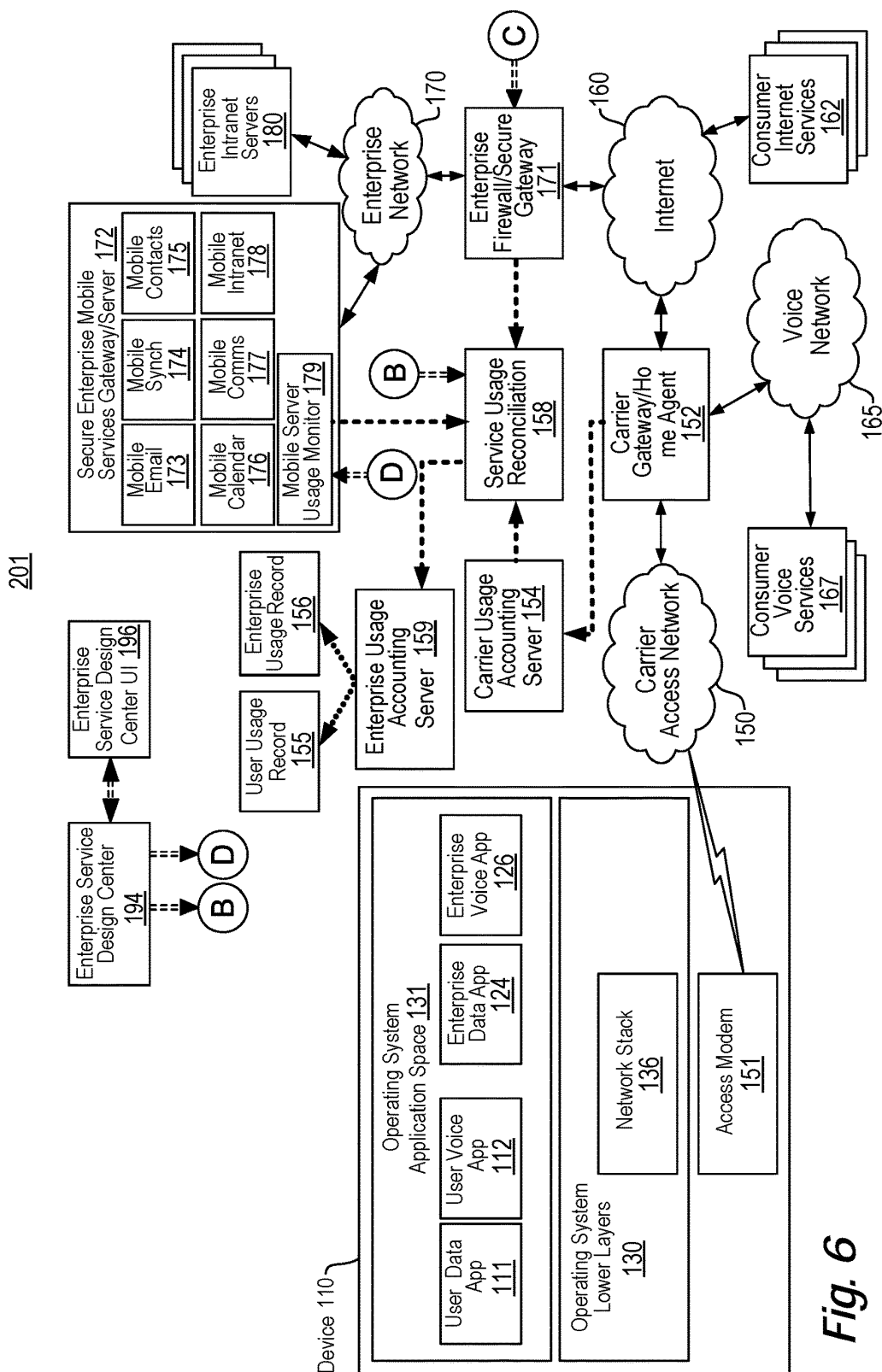


Fig. 6

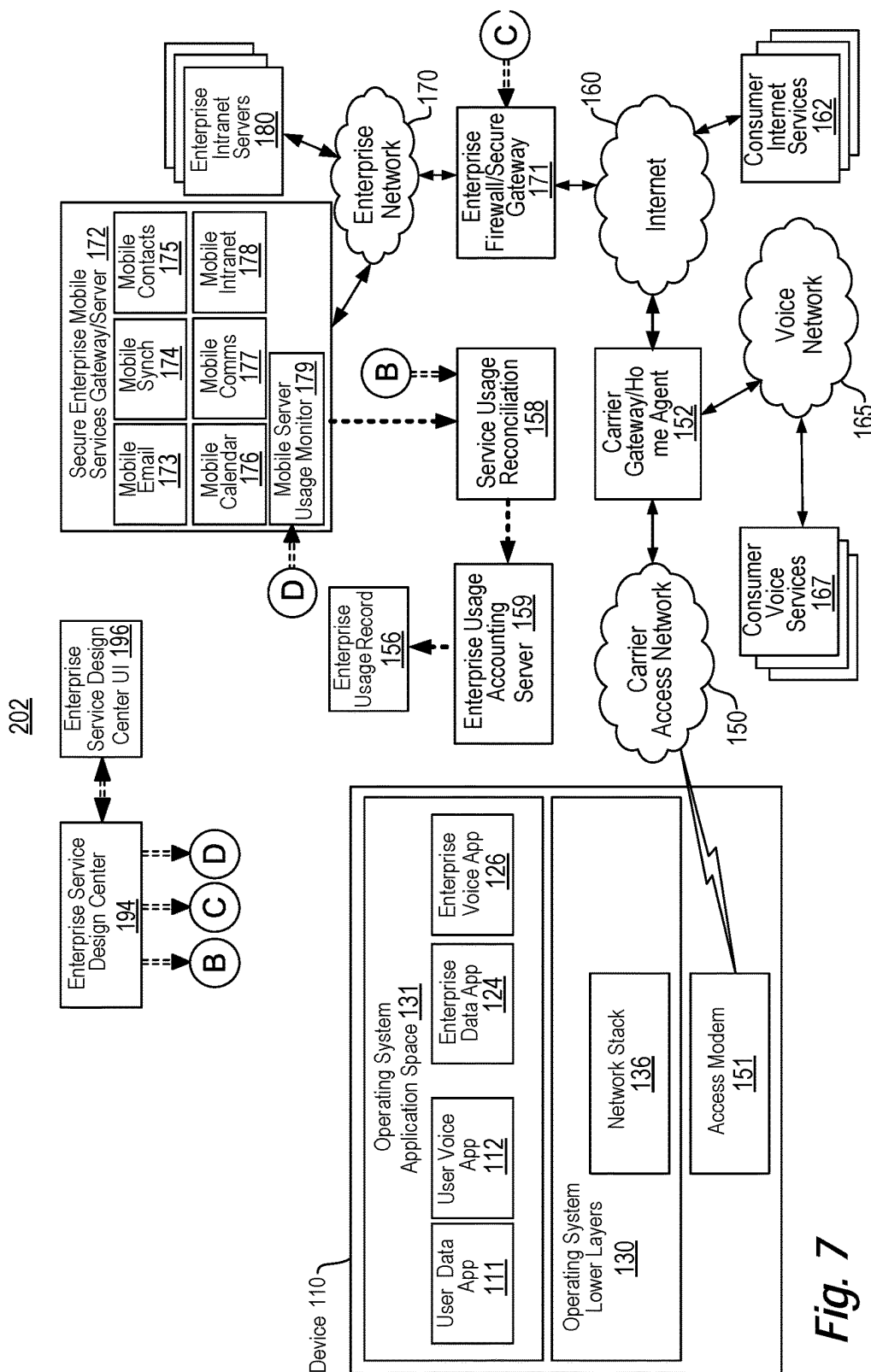


Fig. 7

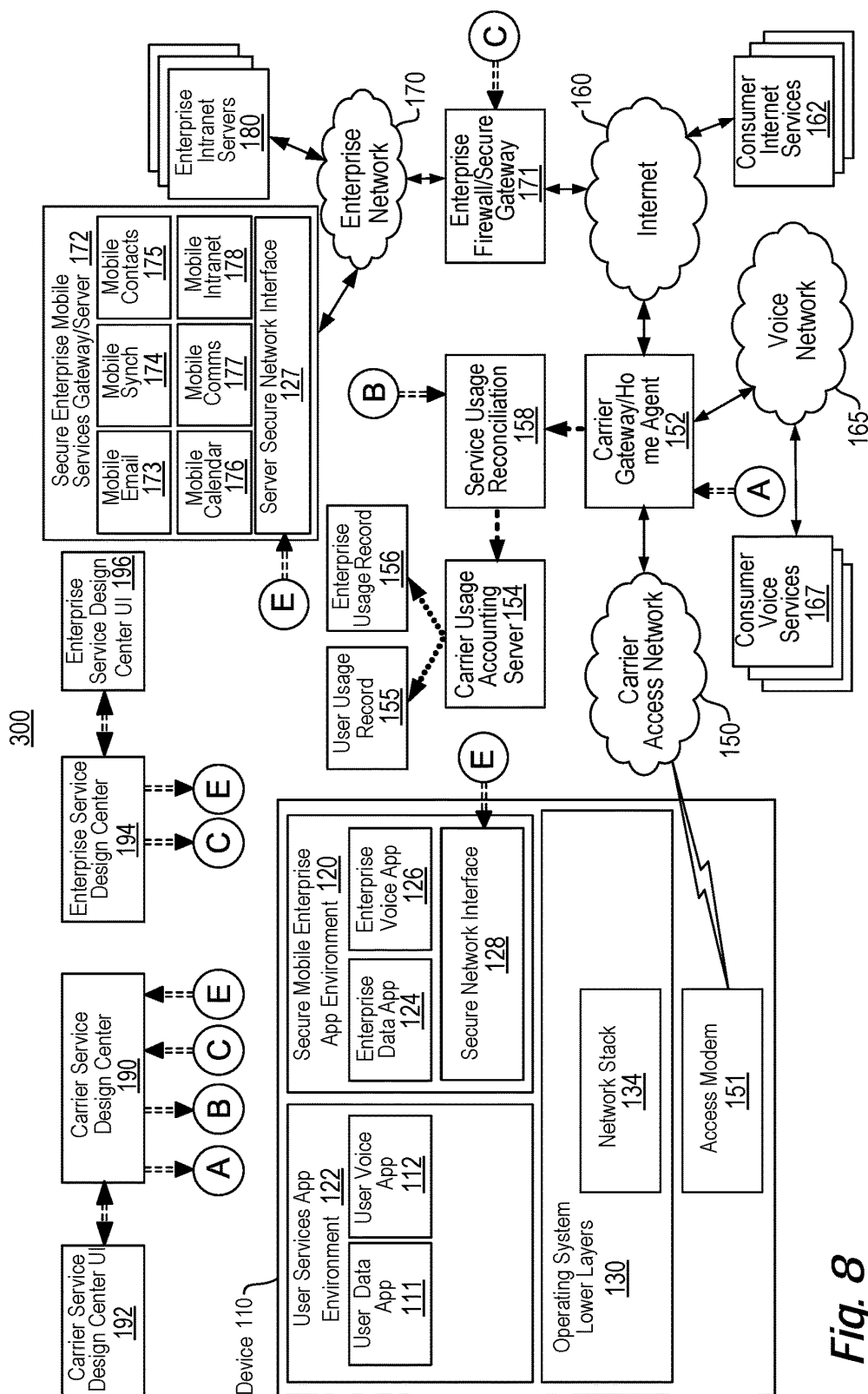


Fig. 8

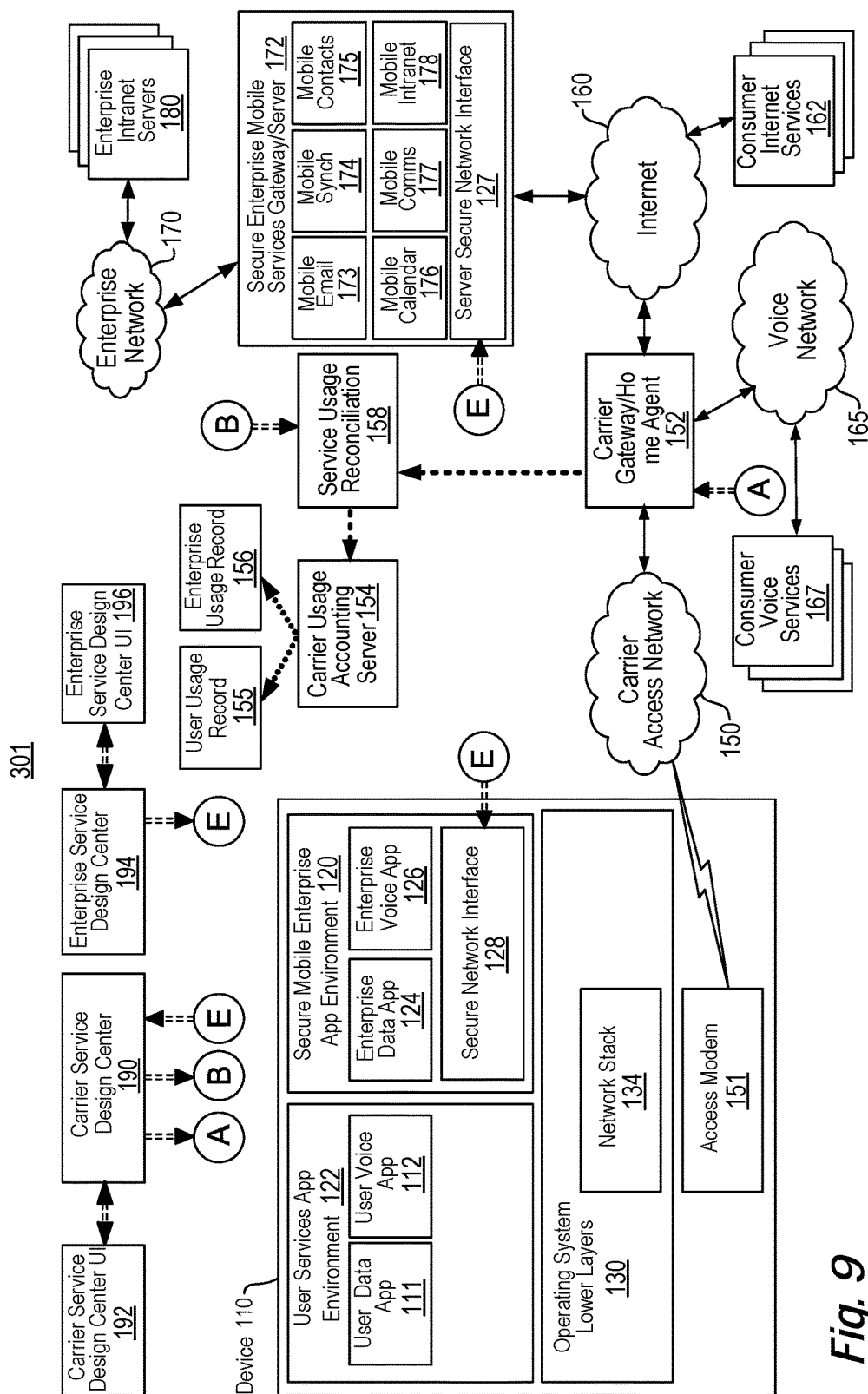
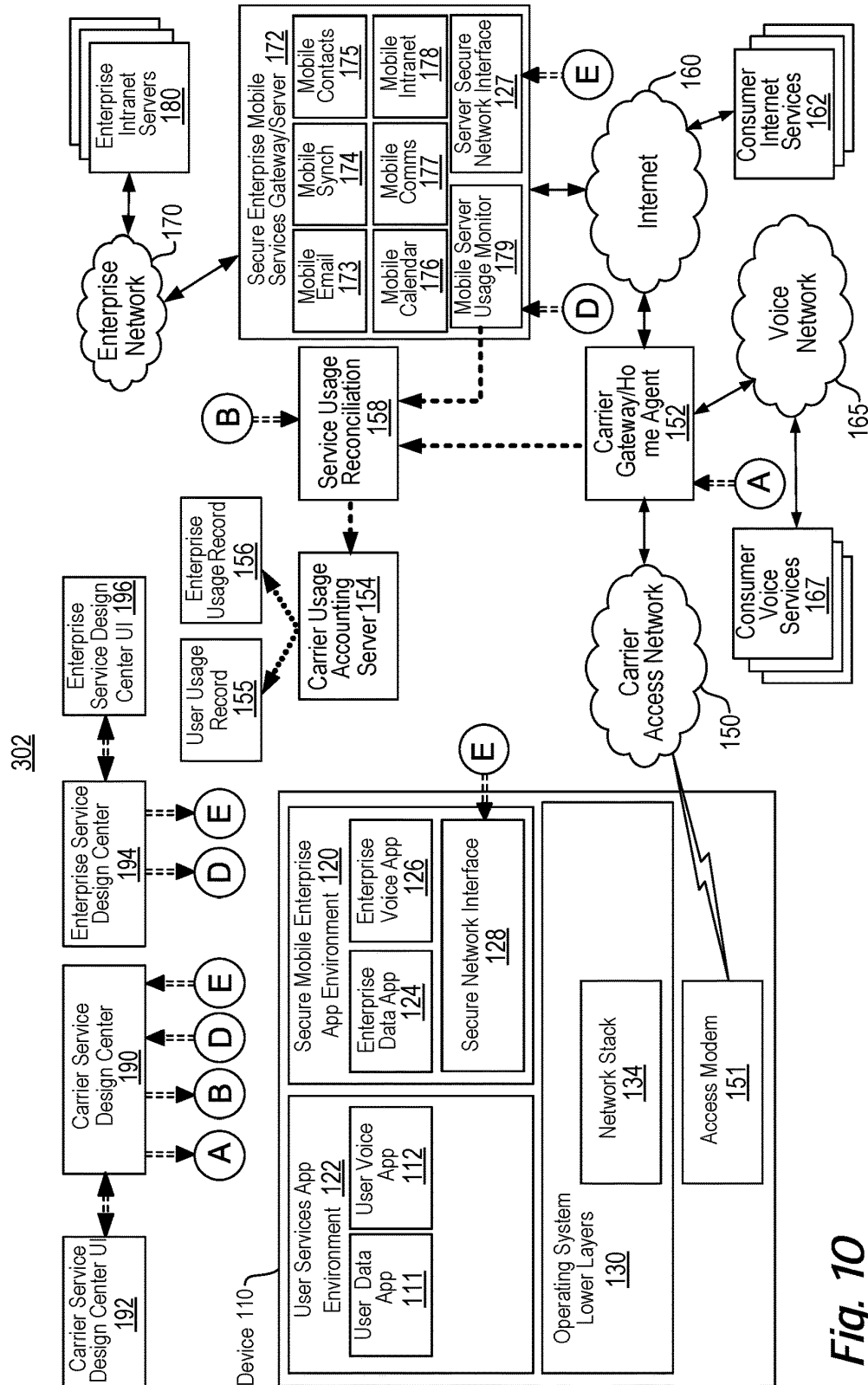


Fig. 9



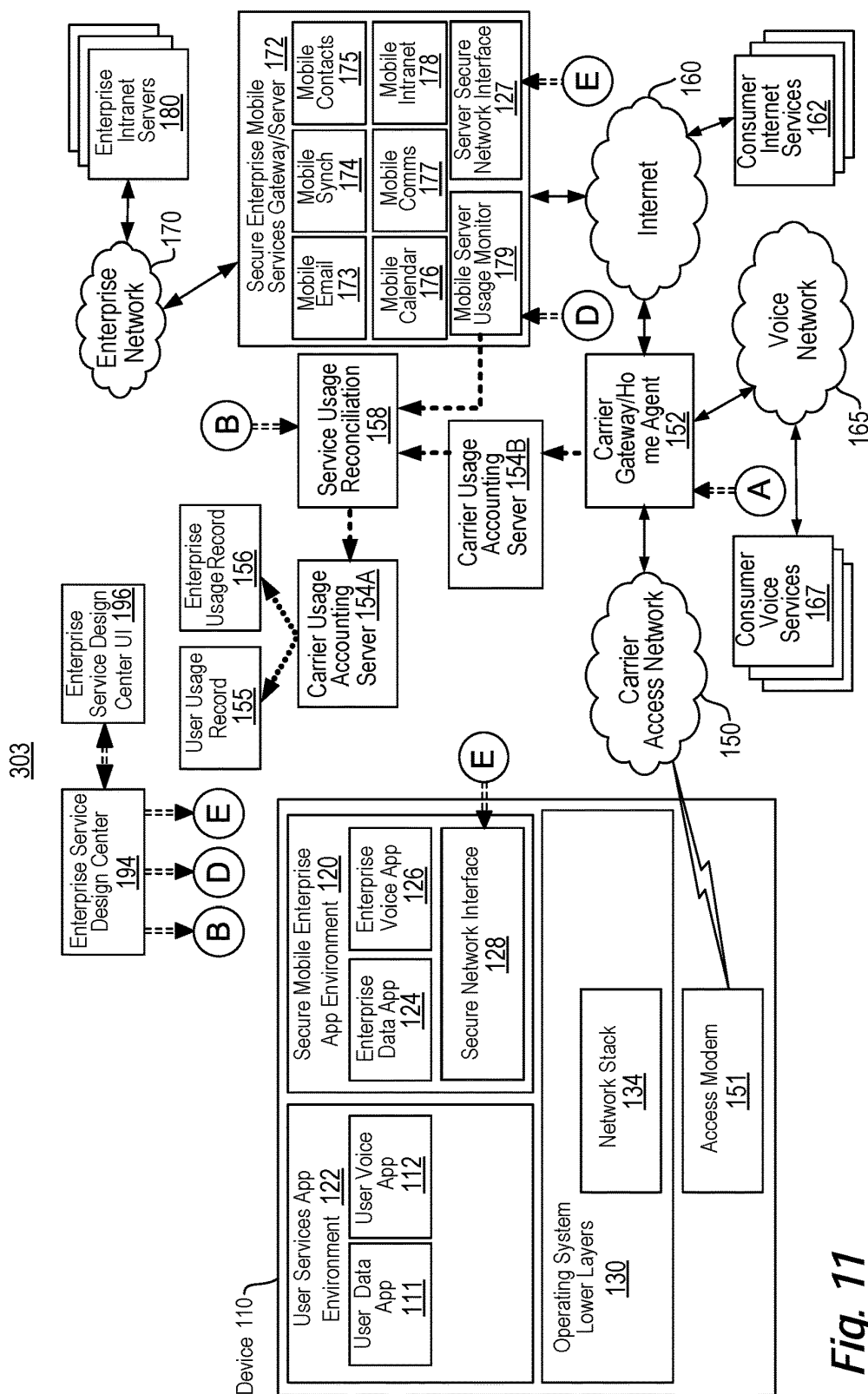


Fig. 11

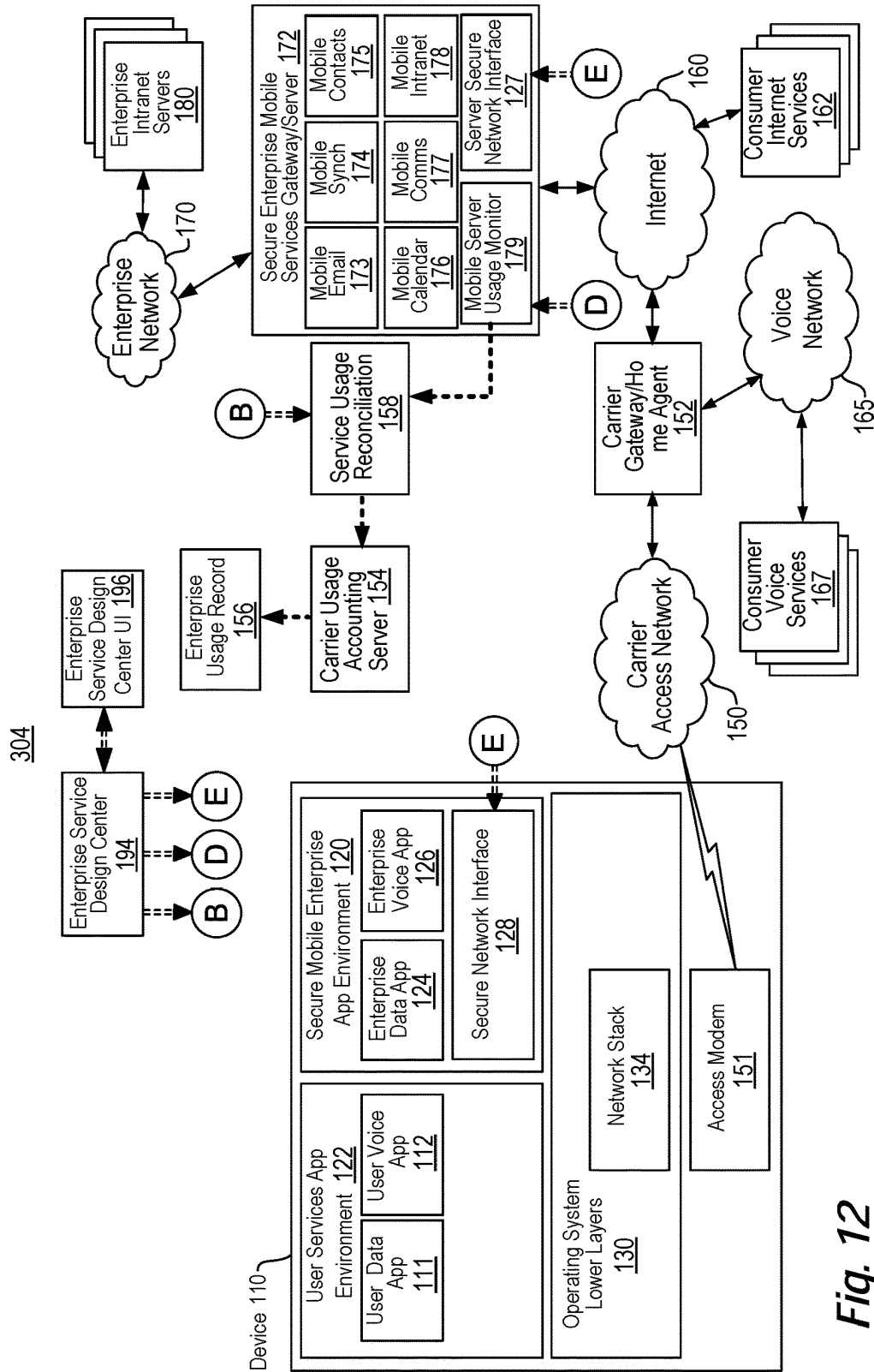


Fig. 12

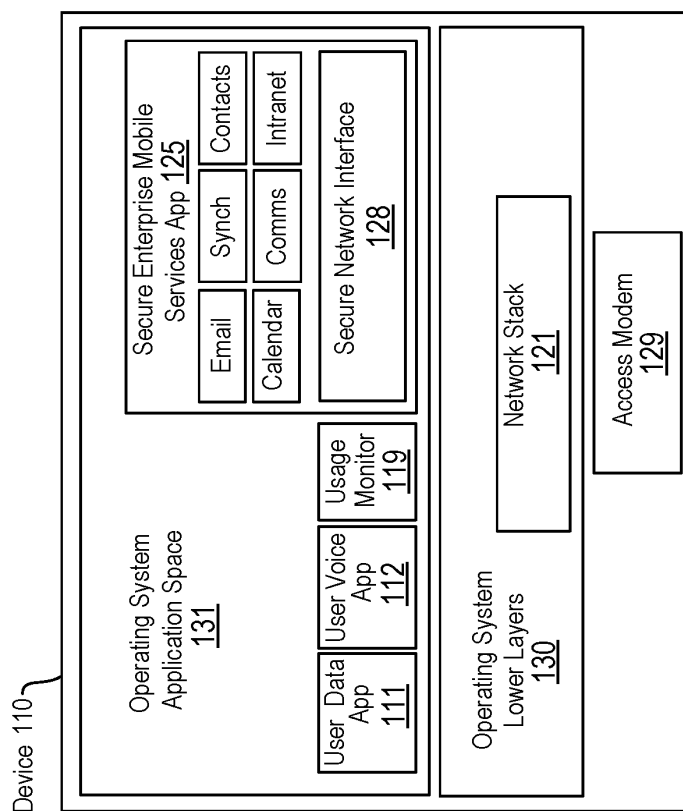


Fig. 13

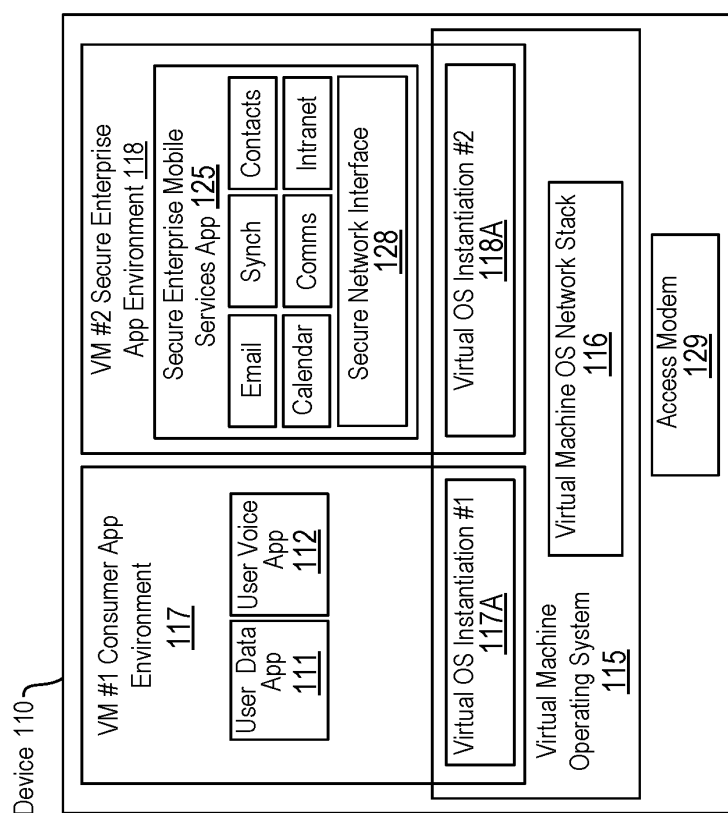


Fig. 14

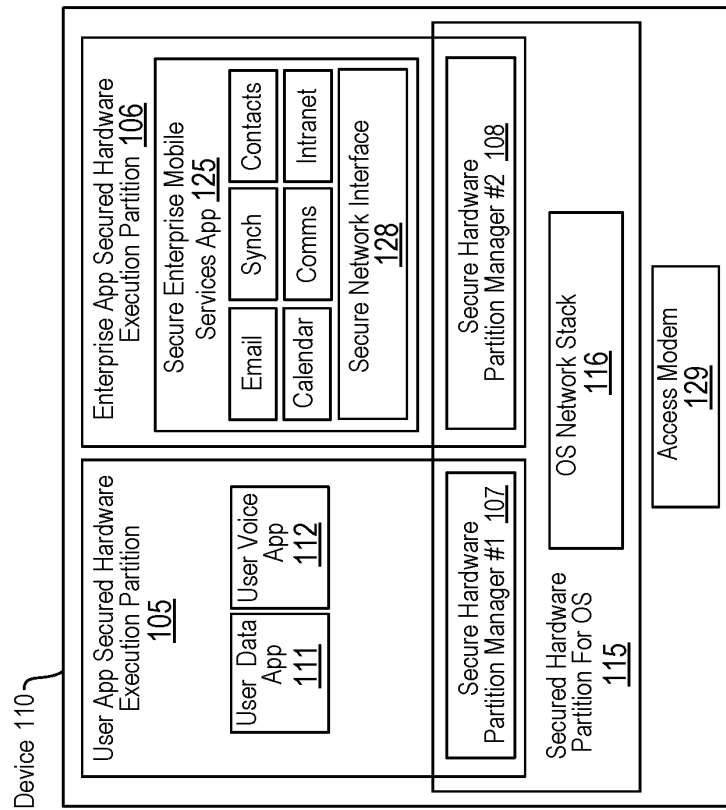


Fig. 15

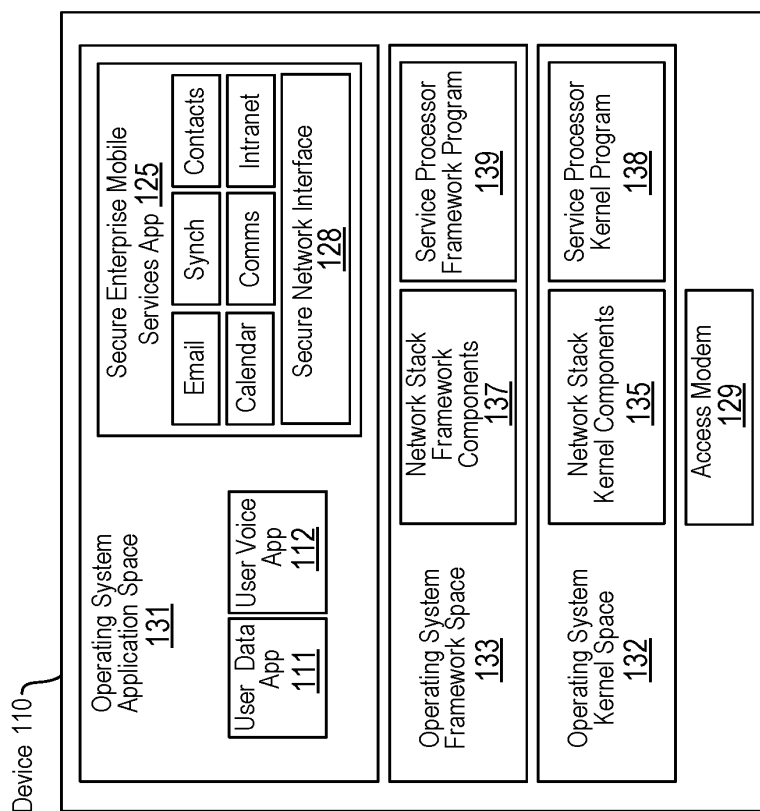


Fig. 16

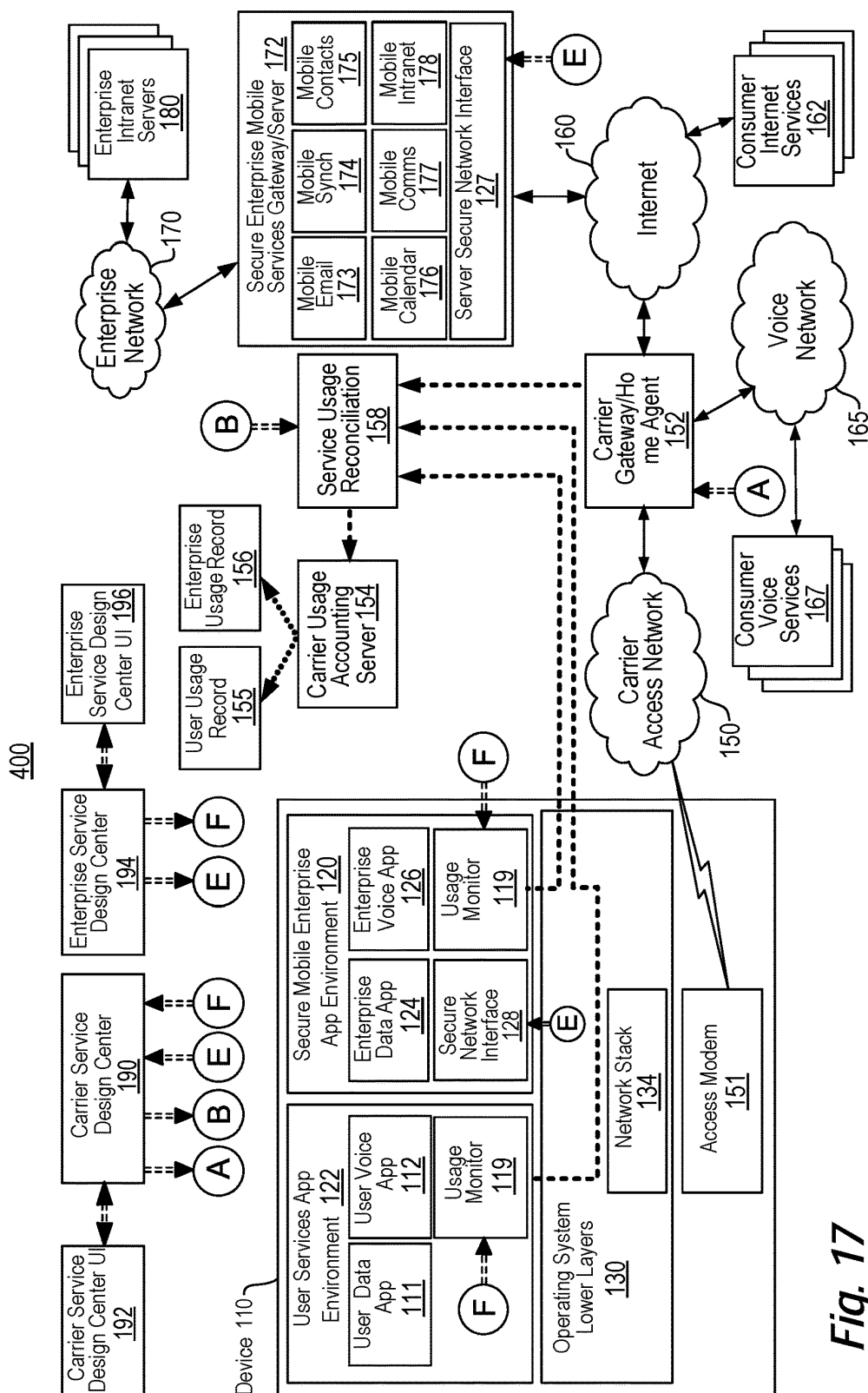
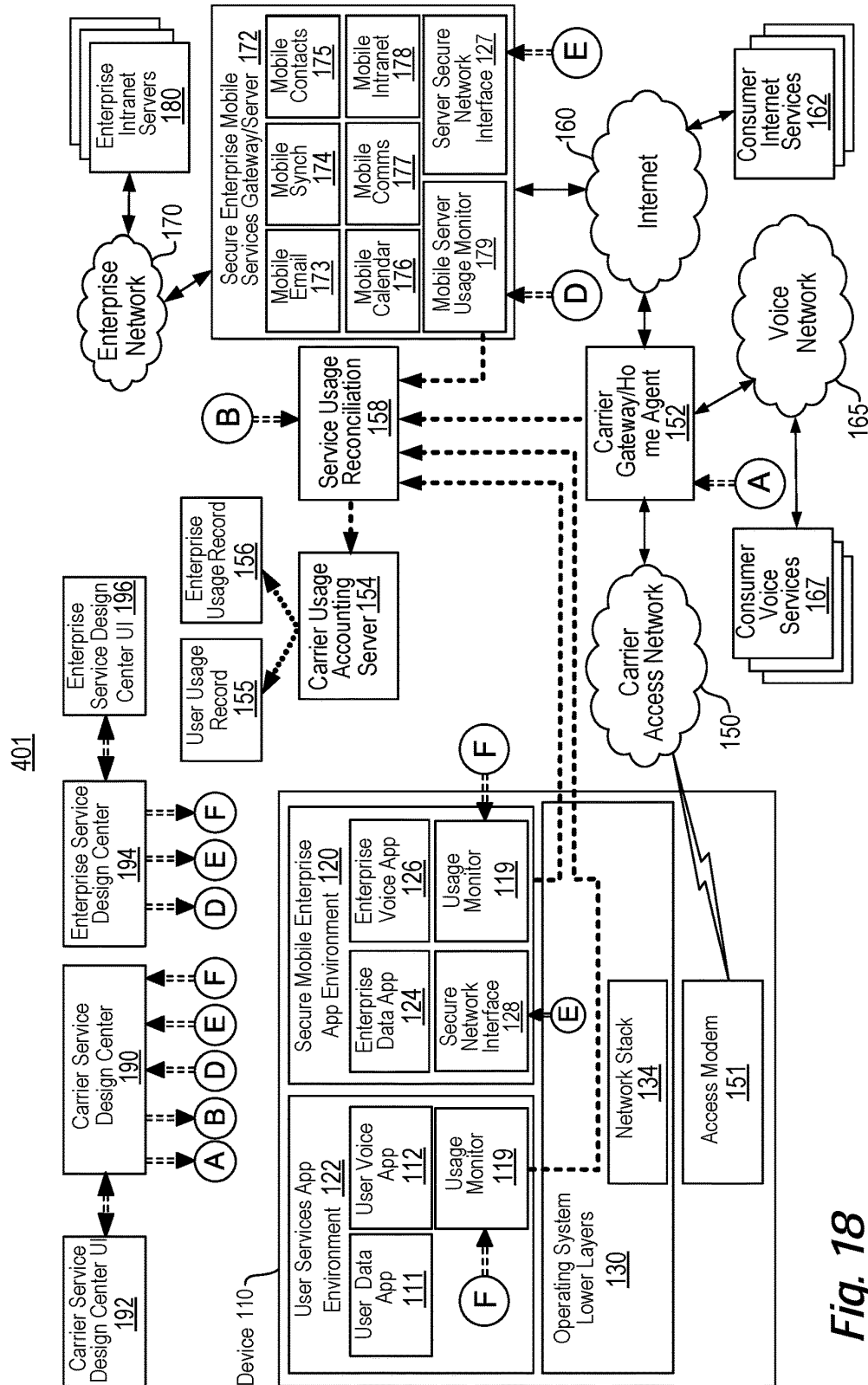
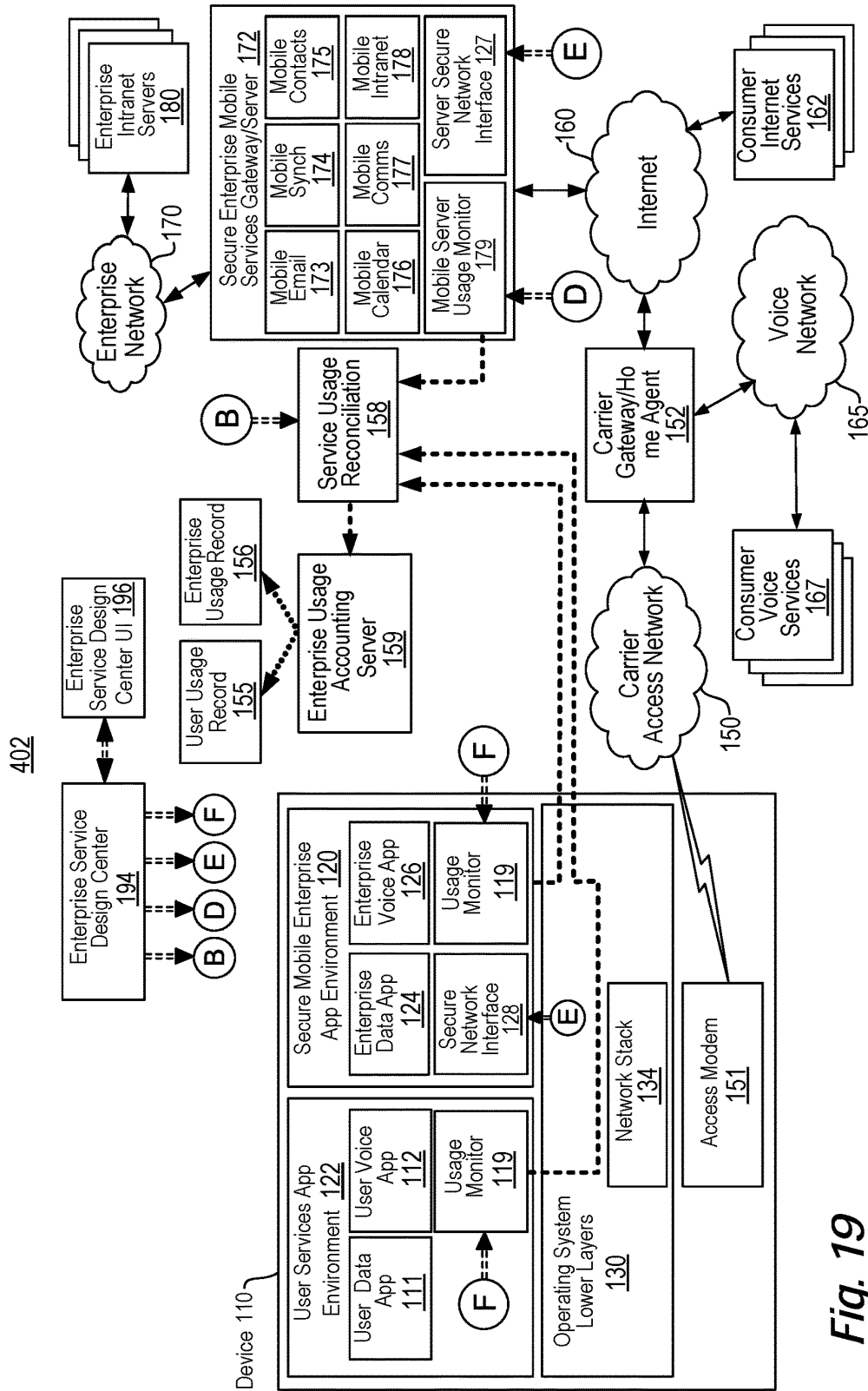


Fig. 17





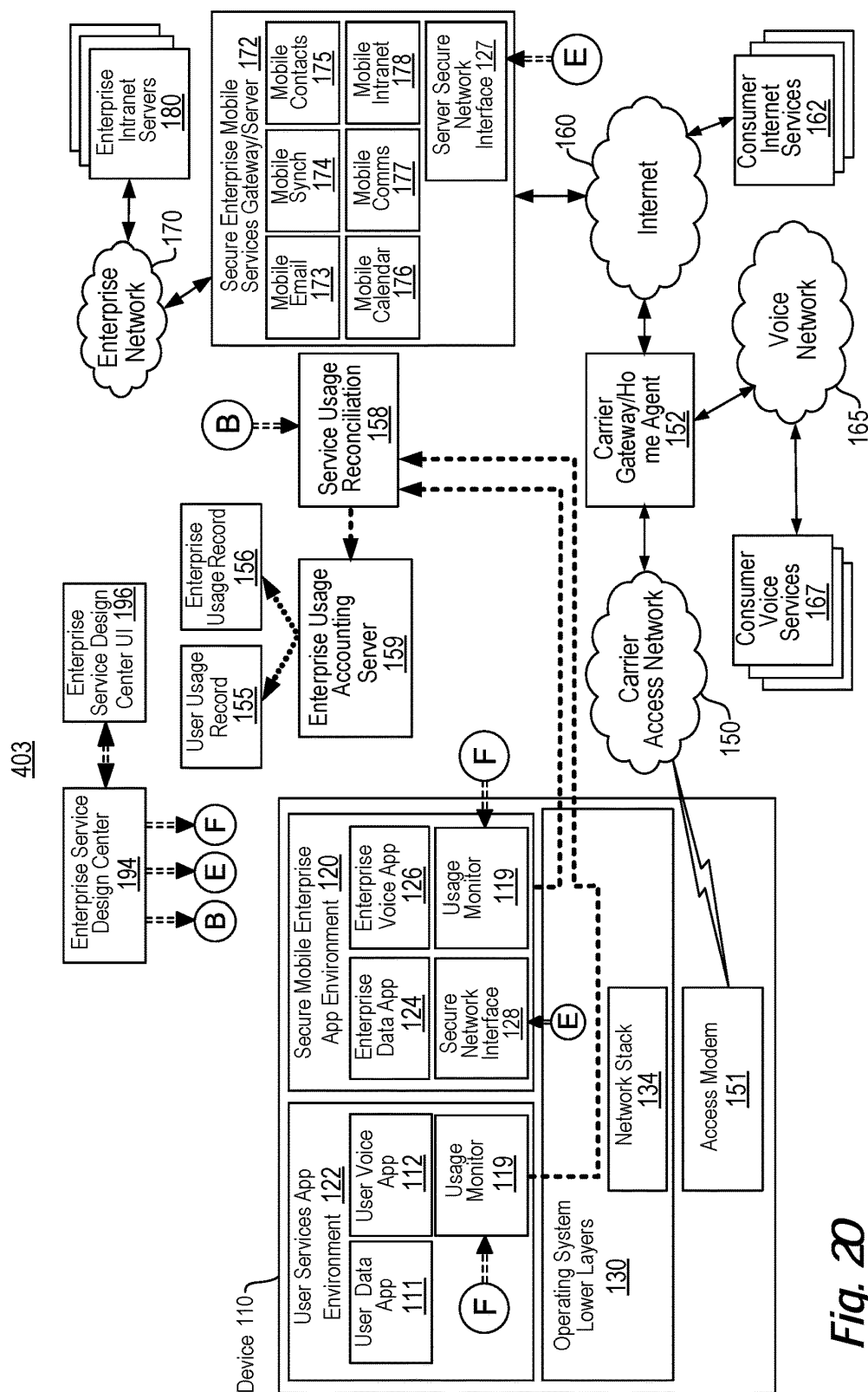


Fig. 20

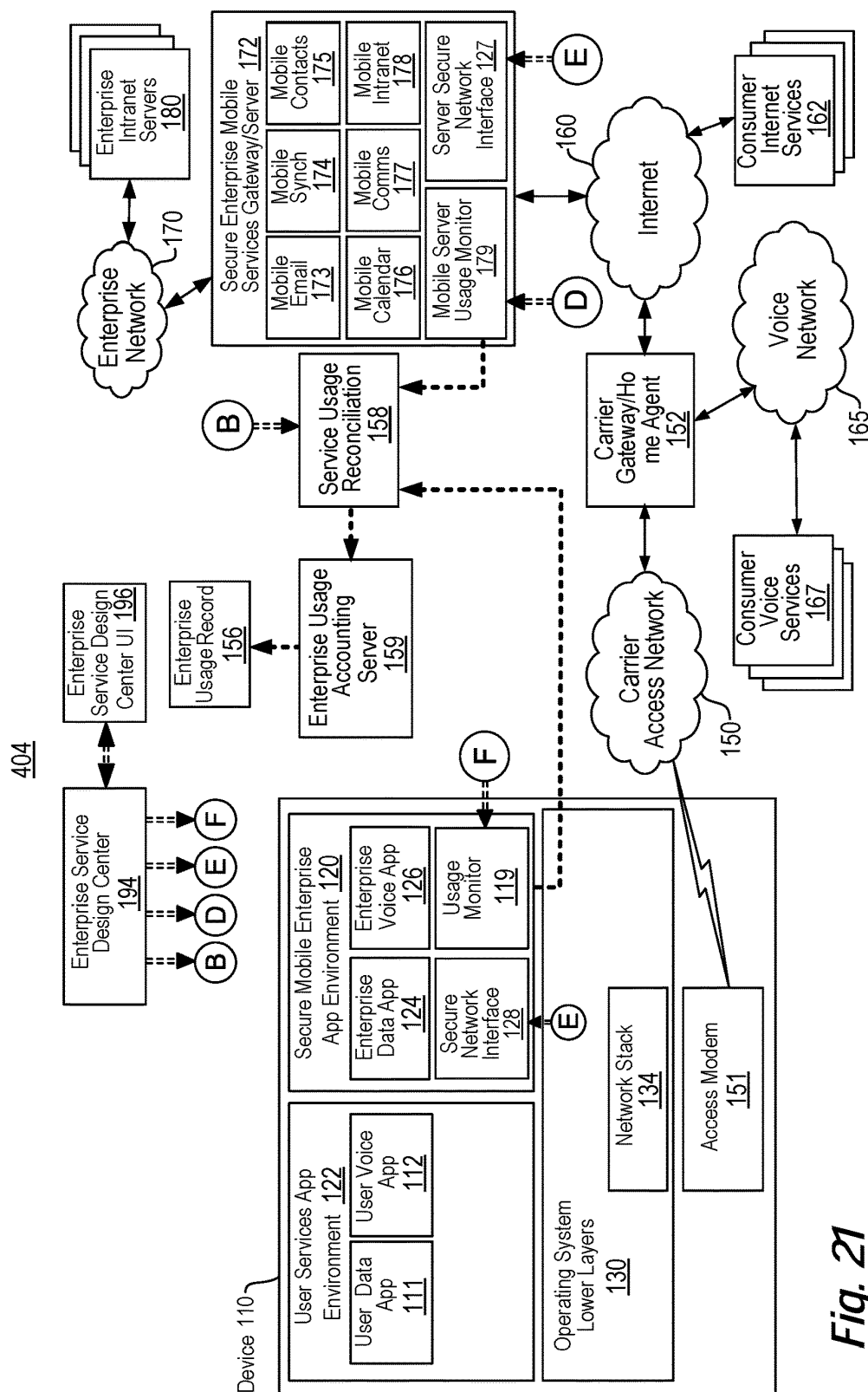


Fig. 21

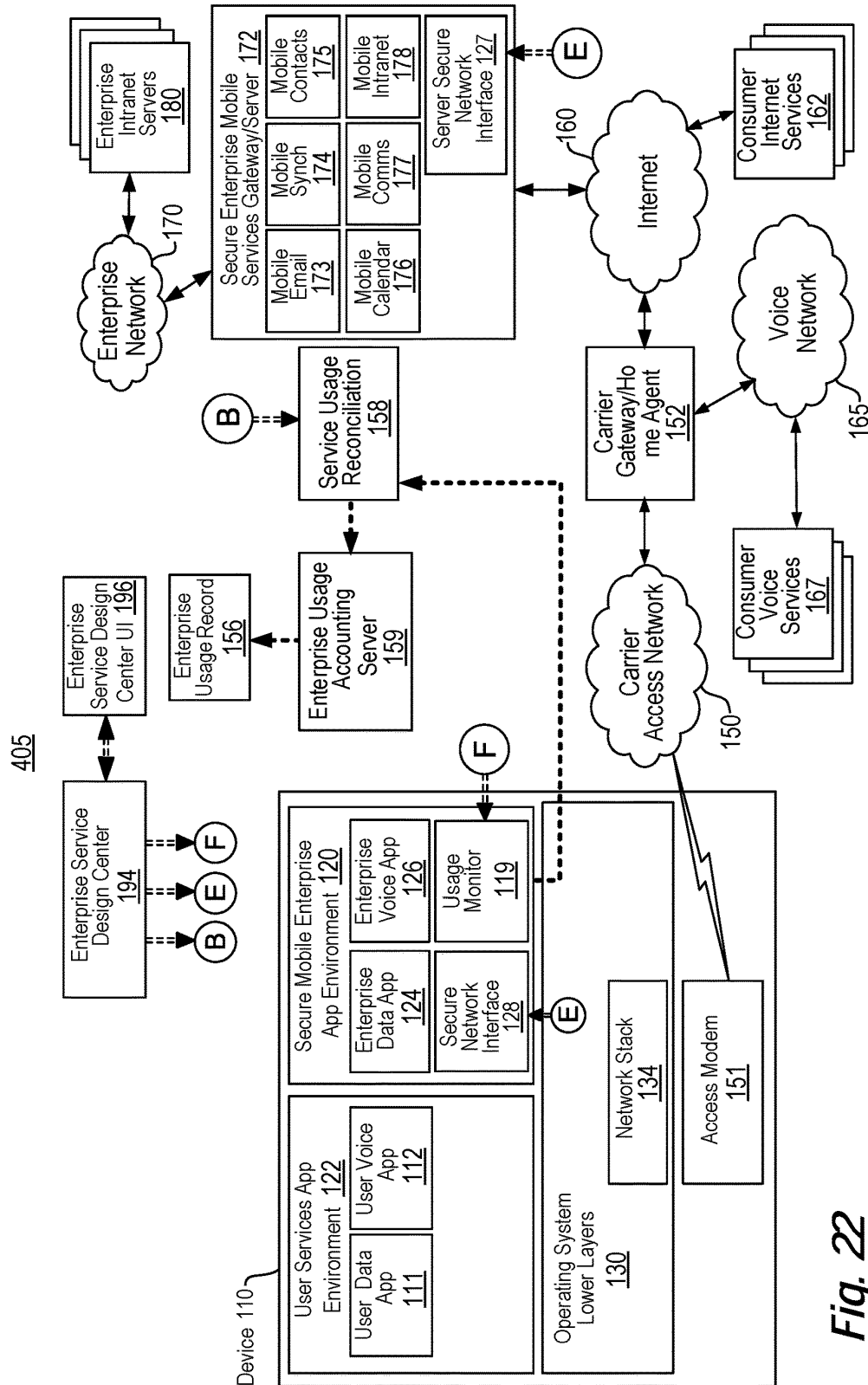


Fig. 22

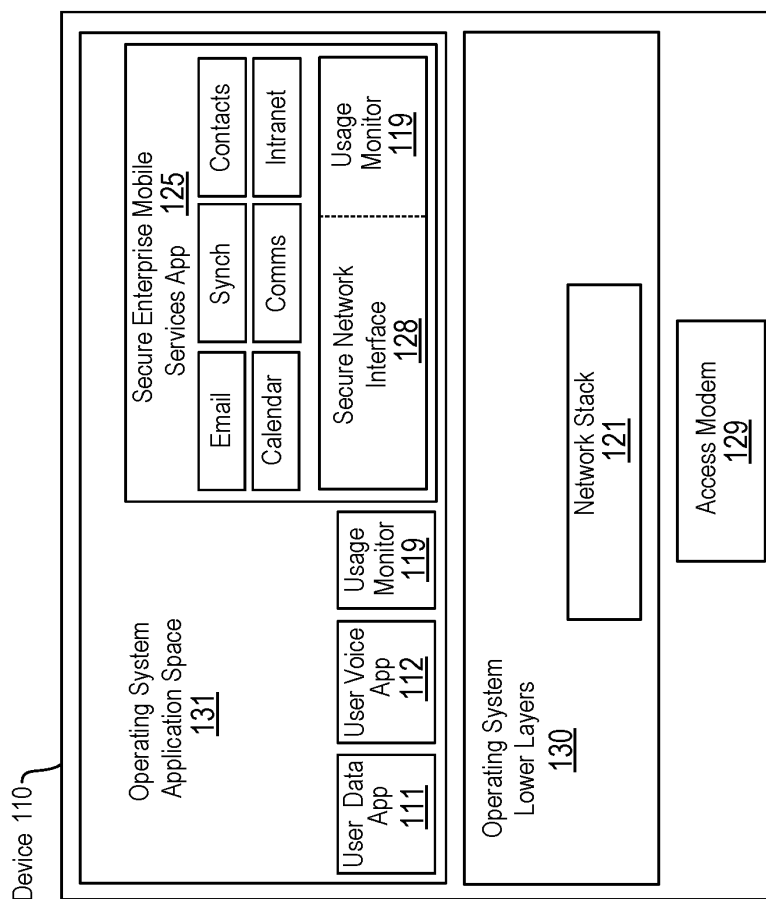


Fig. 23

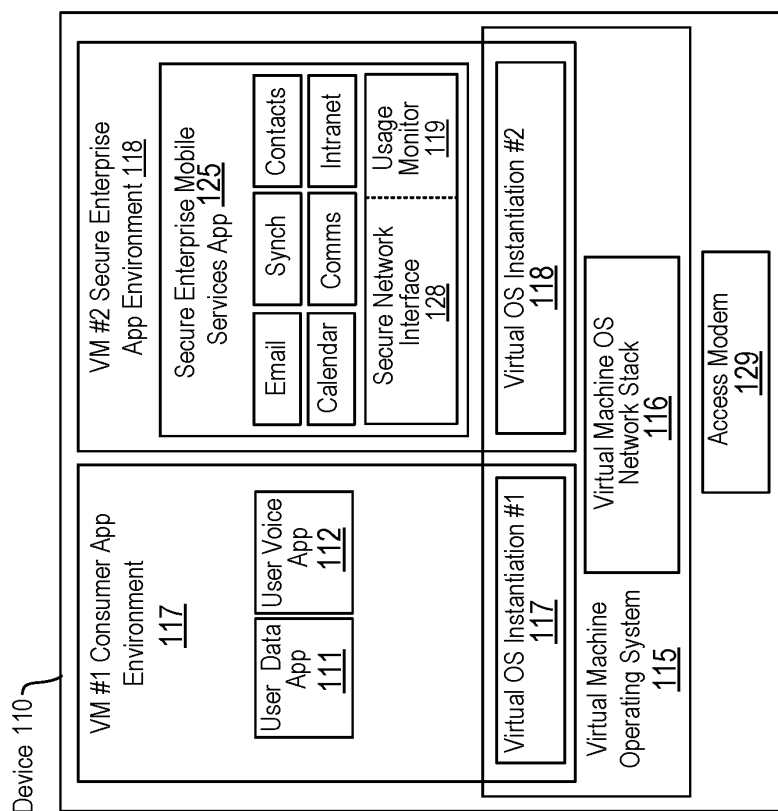


Fig. 24

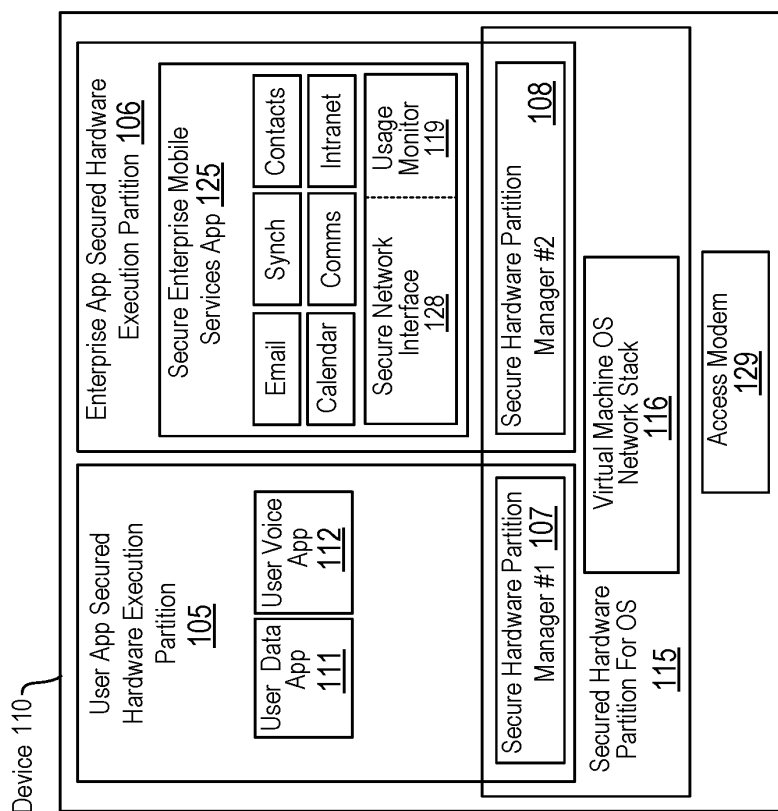


Fig. 25

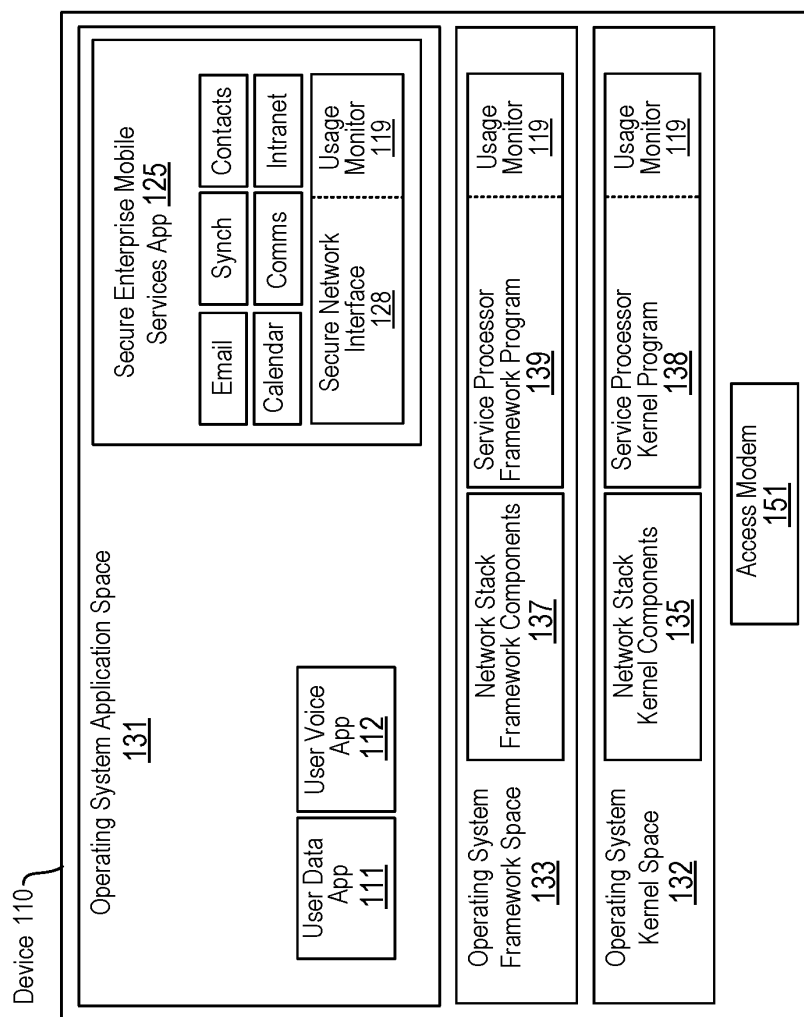


Fig. 26

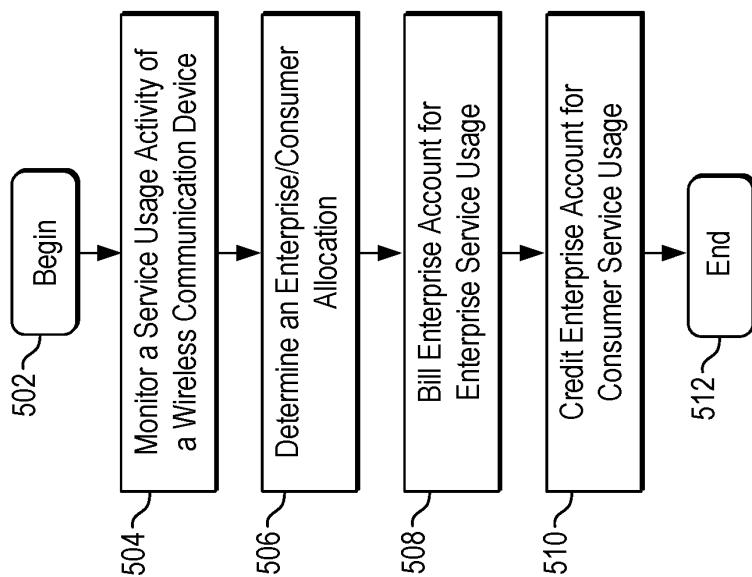


Fig. 28

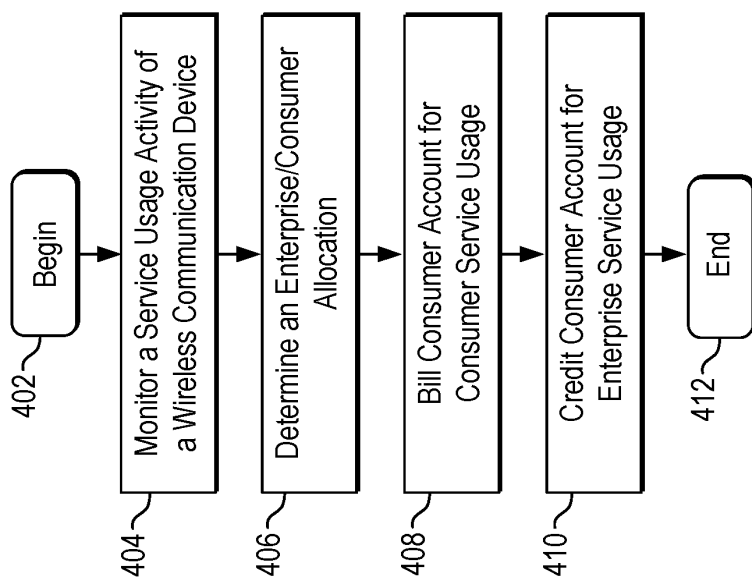
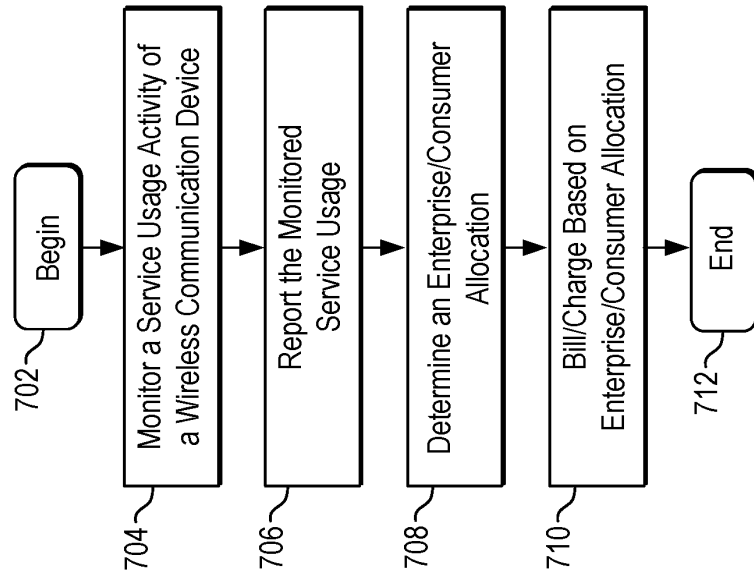
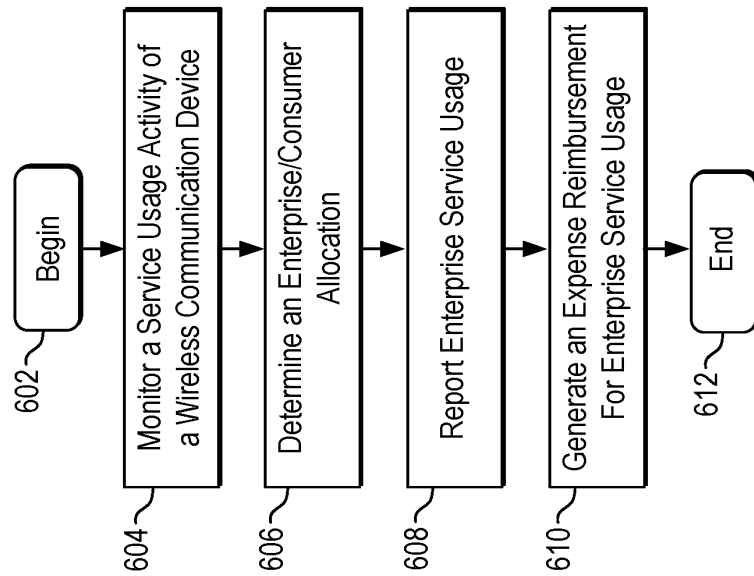


Fig. 27

*Fig. 30**Fig. 29*

1

ENTERPRISE ACCESS CONTROL AND ACCOUNTING ALLOCATION FOR ACCESS NETWORKS

BACKGROUND

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.

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

Various embodiments of the invention are disclosed in the following detailed description and the accompanying drawings.

FIG. 1 illustrates a functional diagram of a network architecture for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments.

FIG. 2 illustrates a functional diagram of another network architecture for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments.

FIG. 3 illustrates a functional diagram of another network architecture for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments.

FIG. 4 illustrates a functional diagram of another network architecture for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments.

FIG. 5 illustrates a functional diagram of another network architecture for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments.

FIG. 6 illustrates a functional diagram of another network architecture for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments.

FIG. 7 illustrates a functional diagram of another network architecture for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments.

FIG. 8 illustrates a functional diagram of another network architecture for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments.

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FIG. 9 illustrates a functional diagram of another network architecture for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments.

FIG. 10 illustrates a functional diagram of another network architecture for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments.

FIG. 11 illustrates a functional diagram of another network architecture for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments.

FIG. 12 illustrates a functional diagram of another network architecture for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments.

FIG. 13 illustrates a functional diagram of a secure device application architecture for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments.

FIG. 14 illustrates a functional diagram of another secure device virtual machine architecture for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments.

FIG. 15 illustrates a functional diagram of another secure device hardware execution partition architecture for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments.

FIG. 16 illustrates a functional diagram of another secure device service processor architecture for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments.

FIG. 17 illustrates a functional diagram of another network architecture for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments.

FIG. 18 illustrates a functional diagram of another network architecture for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments.

FIG. 19 illustrates a functional diagram of another network architecture for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments.

FIG. 20 illustrates a functional diagram of another network architecture for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments.

FIG. 21 illustrates a functional diagram of another network architecture for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments.

FIG. 22 illustrates a functional diagram of another network architecture for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments.

FIG. 23 illustrates a functional diagram of a secure device application architecture with device based service usage monitoring for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments.

FIG. 24 illustrates a functional diagram of a secure device virtual machine architecture with device based service usage

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monitoring for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments.

FIG. 25 illustrates a functional diagram of a secure device hardware execution partition architecture with device based service usage monitoring for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments.

FIG. 26 illustrates a functional diagram of a secure device service processor architecture with device based service usage monitoring for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments.

FIG. 27 illustrates a flow diagram for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments.

FIG. 28 illustrates another flow diagram for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments.

FIG. 29 illustrates another flow diagram for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments.

FIG. 30 illustrates another flow diagram for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments.

DETAILED DESCRIPTION

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.

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.

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Some enterprises only allow certain specialized wireless devices to be used for connection to their enterprise network. Such devices typically contain secure data storage and enterprise program execution environments to protect enterprise information and network access. This approach is generally directed towards maintaining enterprise data integrity and enterprise network security. However, this approach does not address the various problems associated with allocating service usage or billing between consumer or non-enterprise service usage activities and enterprise service usage activities.

Accordingly, there is a need to provide for an enterprise and consumer billing allocation for wireless communication device service usage activities. There is also a need to address various issues with enterprise policies that can vary from employee to employee. For example, roaming policies can be configured differently for a global sales person than for a finance administrator who does not travel as much on enterprise business. Furthermore, some enterprises may not elect to pay for employee wireless communication device purchase or all employee wireless communication service usage needs or desires. As a result, some enterprises would benefit from techniques that allowed such enterprises to piggy back on consumer device or service purchases while maintaining an enterprise and consumer billing allocation for wireless communication device service usage activities.

Also, some consumers prefer to select their own wireless communication device that may not be an enterprise approved wireless communication device or a specialized enterprise device specified by enterprise IT managers. For example, certain enterprises may only offer certain BlackBerry smart phone devices, and certain employees may prefer Apple iPhone and/or various Android based smart phone devices. Another trend suggests that a growing number of enterprise employees desire to use a single wireless communication device for their enterprise mobile communication, enterprise information access, and enterprise network access as well as for, for example, their personal mobile communication, access, and application needs (e.g., consumer/personal, that is, non-enterprise, use of cellular calls, text messaging, web browsing, social networking, games, and various other service usage activities). Such dual persona devices, where a first persona is oriented to enterprise access and/or application needs and a second persona is oriented to personal access and/or application needs, are enabled by the disclosure herein.

As a result, enterprise network managers generally need a way to safely allow consumers to perform consumer mobile access services that the enterprise can specify that will not be paid for by the enterprise. Various network architectures and techniques are described herein that allow an enterprise to determine how much service usage (e.g., how much of a corresponding service bill) should be allocated to device user services or consumer services and how much should be allocated to enterprise services in which the enterprise sponsors the enterprise access. Various design approaches and techniques are described herein for allocating enterprise and consumer billing in a secure manner that works with both specialized enterprise wireless communication devices as well as other wireless communication devices. For example, crediting a user bill with sponsored enterprise service usage is provided using various techniques described herein. As another example, providing enterprise employee reimbursement for enterprise services used on the employee wireless communication device or allowing an enterprise to deduct employee consumer service usage from their paycheck is provided using various tech-

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niques described herein. As yet another example, allowing a consumer to select from an instant activation platform on a wireless communication device that comes pre-loaded with various enterprise services is provided using various techniques described herein. As yet a further example, providing for a capability to install or download an enterprise application that provides secure enterprise mobile services access and allocating enterprise and consumer billing for consumer wireless communication devices is provided using various techniques described herein.

Various techniques for monitoring service usage and providing for secured and verifiable device assisted services (DAS), including DAS based service usage monitoring, are disclosed in co-pending U.S. patent application Ser. No. 12/380,758, entitled VERIFIABLE DEVICE ASSISTED SERVICE USAGE MONITORING WITH REPORTING, SYNCHRONIZATION, AND NOTIFICATION, filed on Mar. 2, 2009, published as U.S. Pub. App. No. 20100191612, co-pending U.S. patent application Ser. No. 12/695,019, entitled DEVICE ASSISTED CDR CREATION, AGGREGATION, MEDIATION and BILLING, filed on Jan. 27, 2010, published as U.S. publication application No. 20100197266, co-pending U.S. patent application Ser. No. 12/695,020, entitled ADAPTIVE AMBIENT SERVICES, filed on Jan. 27, 2010, published as U.S. Pub. App. No. 20100198698, co-pending U.S. patent application Ser. No. 12/694,445, entitled SECURITY TECHNIQUES FOR DEVICE ASSISTED SERVICES, filed on Jan. 27, 2010, published as U.S. Pub. App. No. 20100199325, co-pending U.S. patent application Ser. No. 12/694,451, entitled DEVICE GROUP PARTITIONS AND SETTLEMENT PLATFORM, filed on Jan. 27, 2010, published as U.S. Pub. App. No. 20100197267, which are incorporated herein by reference for all purposes.

In some embodiments, allocating enterprise and consumer billing for service usage activities on a wireless communication device is provided for service usage activities that an enterprise configures as approved and/or sponsored for enterprise billing (e.g., such service usage activities are paid for at least in part by the enterprise) and consumer applications and service usage activities that the device user chooses to use from the wireless communication device and that the enterprise does not sponsor. Various embodiments are disclosed herein describing a wide range of devices that users and enterprises may desire to use for such dual-purpose application scenarios. In some embodiments, devices for such applications can include a less specialized and secure device program execution environment as further described herein.

Accordingly, enterprise and consumer billing allocation for wireless communication device service usage activities is provided. In some embodiments, enterprise and consumer billing allocation for wireless communication device service usage activities includes monitoring a service usage activity of a wireless communication device (e.g., the monitoring can be performed in the wireless communication device and/or the monitoring of enterprise application service usage can be performed using a secure application server in the enterprise network), and determining an enterprise and consumer billing allocation for the monitored service usage activity. In some embodiments the allocation is determined by classifying the service usage activities as associated with a consumer service usage activity (e.g., in a consumer service usage activity list) or associated with an enterprise service usage activity (e.g., in an enterprise service usage activity list; or, as another example, if the monitored service usage activity is not included in the enterprise service usage

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activity list, then it can be automatically classified as a consumer service usage activity by default).

In some embodiments, enterprise and consumer billing allocation for wireless communication device service usage activities includes providing a service design center (SDC) for configuring an enterprise and consumer billing allocation of monitored service usage activities for a plurality of wireless communication devices associated with an enterprise account, and implementing the configured enterprise and consumer billing allocation for monitored service usage activities for the plurality of wireless communication devices associated with the enterprise account.

In some embodiments, enterprise and consumer billing allocation for wireless communication device service usage activities includes monitoring service usage of a wireless communication device, and determining whether a user is acting as a consumer (e.g., personal service usage activities on the wireless communication device) or a professional (e.g., enterprise service usage activities on the wireless communication device, that is, the user is working on the wireless communication device in his or her capacity as an employee for an enterprise, in which the wireless communication device is associated with an enterprise account for the enterprise) based on the monitored service usage activity (e.g., based on place, time of day, application or service activity, and/or other criteria or factors). In some embodiments, enterprise and consumer billing allocation for wireless communication device service usage activities differentially charges and/or allocates billing between the enterprise and the consumer based on a classification of the monitored service usage activity as allocated to the enterprise or to the consumer for billing/charging purposes. Such embodiments enable a dual persona device user experience.

In some embodiments, enterprise and consumer billing allocation for wireless communication device service usage activities includes monitoring a service usage activity of a wireless communication device, and reporting the monitored service usage activity to a network element (e.g., a service controller, a service usage reconciliation function, another service control or billing/charging function in the network, or another network element), in which the network element determines an enterprise and consumer billing allocation for the monitored service usage activity. In some embodiments, the network element (e.g., a service controller, a service usage reconciliation function, another service control or billing/charging function in the network, or another network element) determines an enterprise and consumer billing allocation for the monitored service usage activity. In some embodiments, a service usage reconciliation function determines how much service usage is due to enterprise service usage activities and how much is due to consumer service usage activities. In some embodiments, after determining the allocation between consumer and enterprise service usage activities, the service usage reconciliation function provides the information to a service usage accounting function (e.g., a carrier billing server or an enterprise service usage accounting server), which in turn delivers a consumer usage report or bill and/or an enterprise usage report or bill. In some embodiments, the service usage reconciliation function determines the amount of enterprise service usage and creates a service usage credit record so that a device user's account can be credited or a device user can be compensated or reimbursed for enterprise service usage costs. In some embodiments, a service usage monitor is configured to monitor service usage activities of a device. In some embodiments, the service usage monitor is configured to classify the monitored service usage activities as enterprise

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service usage activities. In some embodiments, the service usage monitor is configured to classify the monitored service usage activities as consumer service usage activities. In some embodiments, the service usage monitor is configured to monitor a first group of service usage activities for service usage allocation to a device user (e.g., using a list of service usage activities associated with a consumer service usage), and a second group of service usage activities for service usage allocation to an enterprise (e.g., using a list of service usage activities associated with an enterprise service usage). In some embodiments, service usage activities (e.g., service activities, such as applications, network, and/or voice based activities that use wireless network service usage resources) are classified using various techniques described herein, such as based on application (e.g., application credential), device (e.g., device credential), time of day, network destination, network traffic protocol and/or port, and various other criteria/factors. In some embodiments, the service usage monitor is implemented in the network (e.g., on one or more network elements in the carrier network and/or enterprise network, as described herein). In some embodiments, the service usage monitor is implemented in the device (e.g., using various techniques described herein, including verifiable and/or secured device-based implementations). In some embodiments, the service usage monitor is implemented using both network-based and device-based techniques, as described herein with respect to various embodiments.

In some embodiments, a set of service activities that will be sponsored by an enterprise (e.g., a specified or configured list of enterprise sponsored service activities) is managed by an enterprise service design center. In some embodiments, a list of service activities and the associated service policies for each service activity are compiled to form an enterprise sponsored service activity policy set. For example, enterprise email, enterprise calendar, and enterprise contacts can be configured as sponsored service activities. In some embodiments, the sponsored enterprise services list includes a list of network destinations that are associated with the services (e.g., an enterprise mail server address and/or an enterprise internal corporate network). For example, the enterprise email can be a sponsored service that is associated with an enterprise sponsored email service policy, which can limit destinations for corporate email, sizes of emails and/or email attachments, and/or other email related usage criteria or factors (e.g., a service usage charging policy).

In some embodiments, the monitored service usage is reported to the reconciliation function by a carrier network service usage monitoring element (e.g., a home agent (HA), access network gateway, or other network element, such as a deep packet inspection (DPI) function). In some embodiments, the monitored service usage is reported to the reconciliation function by an enterprise network service usage monitoring element (e.g., a carrier network gateway or a mobile services gateway/server or other element in the enterprise network that can measure service usage and associate it with a given device credential or application credential). In some embodiments, the monitored service usage is reported to the reconciliation function by an element in the mobile device (e.g., a service usage monitor in a secure enterprise mobile services application or a Service Processor function, which can be securely implemented and/or verified using various techniques described herein).

In some embodiments, a service design center for implementing enterprise and consumer billing allocation for wireless communication device service usage activities is provided. For example, an enterprise manager can use the

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service design center to select one or more services that the enterprise agrees to pay for/is responsible for paying for and to select one or more other services that the employees of the enterprise must agree to pay for/are responsible for paying for (e.g., if the employee elects to use/have such services that are not charged to the enterprise, or included as enterprise services that are charged to or paid for by the enterprise).

In some embodiments, a service design center that facilitates configuration of sponsored enterprise services for implementing enterprise and consumer billing allocation for wireless communication device service usage activities is provided. In some embodiments, a service design center for implementing enterprise and consumer billing allocation for wireless communication device service usage activities includes providing a service design center for a carrier network and another service design center for an enterprise network (e.g., in some cases, these service design centers can be combined).

In some embodiments, an enterprise sponsored service activity policy set is created by an enterprise network administrator through an enterprise service design center user interface (UI). In some embodiments, the enterprise sponsored service activity policy set includes a list of network destination addresses that corresponds to the desired sponsored service activity list, along with an access policy or service usage charging policy for the service activities. In some embodiments, all service activities in the enterprise sponsored service activity policy set receive the same access policies or charging policies. In some embodiments, a first subset of one or more of the service activities in the enterprise sponsored service activity policy set receive access policies or charging policies that are different than that of a second subset of service activities. For example, a sponsored enterprise email service can be in the first subset, and sponsored mobile voice services can be in the second subset, as certain employees (e.g., traveling sales personnel and/or executives) can be granted international and/or roaming mobile voice services, and other employees can be granted more limited sponsored mobile voice services.

In some embodiments, the enterprise network administrator uses the enterprise service design center to create an enterprise sponsored service device group list that includes device credentials or device application credentials that the carrier network and/or the enterprise network can use to identify a device or an application on a device as belonging to the group of devices for which the enterprise desires to sponsor enterprise service activities. In some embodiments, a sponsored service activity policy set is created by an enterprise network administrator through an enterprise service design center UI, and an enterprise sponsored service device group list is created by an enterprise network administrator through an enterprise service design center UI, and the two lists are stored in the enterprise service design center in which they are associated with one another for the purpose of provisioning the carrier network, the enterprise network, and/or the devices to provide the desired enterprise sponsored services policy set to the enterprise sponsored services device group, as described herein with respect to various embodiments.

In some embodiments, the association between an enterprise sponsored services device group and an enterprise sponsored service policy set is used by a service design center to create a provisioning table, in which the provisioning table is a list of the provisioning programming required for the various carrier network elements, enterprise network elements, and/or device elements to implement the

desired sponsored service activity policy set for the enterprise sponsored services device group.

For example, an enterprise can use the service design center to configure certain destinations/services as enterprise services or potentially enterprise services based on various factors (e.g., corporate sites, corporate email/email servers, corporate web pages/intranet, and can, for example, agree to pay for a certain level of general web browsing by usage/time of day and/or other factors, corporate contacts/calendars, corporate videoconferencing; and certain applications, such as web conferencing applications or other applications; certain telephone service usages, etc.). As another example, the service design center can present a configuration interface that allows users to select from one or more service plans that include various consumer and enterprise allocations and/or to select an enterprise only service plan.

In some embodiments, the service design center specifies one or more service plans the device user can select from and these service plan selection options are configured into a configuration interface on a device software application that allows users to select from one or more service plans that includes various consumer and enterprise allocations and/or to select an enterprise only service plan. In some embodiments, the configuration interface is made available directly on the device via a device client that provides a service plan selection user interface that displays one or more service plan options configured in the service design center or the enterprise service design center. In some embodiments, the configuration interface is presented directly on a device user interface (UI) when the user attempts to use an access service usage activity that requires a service plan to be activated or purchased. In some embodiments, the configuration interface presented via the device UI accepts a user response, transmits it to a carrier network element responsible for provisioning a new user service plan that in turn activates the service plan chosen by the user, possibly after confirming service payment credit for the user or enterprise entity. In some embodiments, the carrier network element responsible for provisioning a new user service plan is a carrier usage accounting server. In some embodiments, the carrier network element responsible for provisioning a new user service plan is a consumer internet services element. In some embodiments, the carrier network element responsible for provisioning a new user service plan is a carrier gateway or home agent. In some embodiments the carrier network element responsible for provisioning a new user service plan is a billing system or service plan provisioning system. In some embodiments, the configuration interface is made available to the user in the form of a web site that provides a service plan selection user interface that displays one or more service plan options configured in the service design center or the enterprise service design center.

In some embodiments, the initial configuration of the end-user device includes one or more enterprise access service plans that allow the user to access certain applications or network destinations associated with enterprise access services, and the user can choose from one or more additional consumer oriented service plans offered directly on the device UI by a device software application in communication with a carrier network element responsible for provisioning a new user service plan that in turn activates the service plan chosen by the user, possibly after confirming service payment credit for the user or enterprise entity. In some embodiments, these access service plan options are configured with a service design center. In some embodi-

ments, these access service plan options are configured with an enterprise service design center.

In some embodiments, enterprise data locally stored on the wireless communication device is secured and access to an enterprise network from the wireless communication device is secured so that only authorized devices or applications can access the network. In some embodiments, security for enterprise data and network access is accomplished by connecting the wireless communication device to the enterprise network via a secure mobile services application on the wireless communication device that connects via a secure channel to a secure mobile services gateway server in the enterprise network. In some embodiments, the SDC is programmed to provision the network and/or device apparatus to detect service usage communication with the mobile services gateway server and record that as a usage charge for network services. In some embodiments, such service usage communication with the mobile services gateway server is credited to the user's carrier account or used as a reimbursement to the user bill.

In some embodiments, determining the enterprise and consumer billing allocation for wireless communication device service usage activities is performed using a classifier implemented on the wireless communication device that classifies the monitored service usage activity (e.g., service usage can also be measured by the classifier and/or another function implemented on the wireless communication device, which can similarly be implemented in a secure execution area or in a secure memory), in which the classifier is executed in a secure execution area or a secure memory of the wireless communication device. In some embodiments, the security of the classifier is verified, periodically or at other times, using various techniques, such as by comparing a local service usage measure with a network based service usage measure and/or comparing a secured local service usage measure with another local service usage measure. In some embodiments, a secured application protects one or more enterprise applications (e.g., email, calendar, contacts, intranet access, and/or other enterprise specified applications, such as applications configured as approved or authorized enterprise applications for a particular enterprise by an enterprise manager using a service design center) from unauthorized use or tampering.

In some embodiments, the secure mobile services application also provides for usage monitoring of the enterprise service usage of the device. In some embodiments, the secure mobile services application also provides for service access control for the enterprise services of the device so that enterprise network access policies can be locally enforced on the device.

In some embodiments, security for enterprise data and network access is provided by connecting to the enterprise network via a secure mobile services application executed securely (e.g., in a virtual machine or in a hardware secured execution partition) on the wireless communications device that connects via a secure channel to a secure mobile services gateway server in the enterprise network. In some embodiments, security for enterprise data and network access is provided by connecting to the enterprise network via a secure mobile services application executed on a wireless communications device that includes a service processor, as described herein, that connects via a secure channel to a secure mobile services gateway server in the enterprise network. In some embodiments, the SDC is programmed to provision the network and/or wireless communications device apparatus to detect service usage communication with the mobile services gateway server, and

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record that as a usage charge for network services. In some embodiments, such service usage communication with the mobile services gateway server is credited to the user's carrier account or used as a reimbursement to the user bill.

In some embodiments, the service processor also provides for service usage monitoring of the enterprise service usage of the device, as described herein with respect to various embodiments. In some embodiments, the service processor also provides for service access control for the enterprise services of the device so that enterprise network access policies can be enforced on the device, as described herein with respect to various embodiments.

In some embodiments, enterprise and consumer billing allocation for wireless communication device service usage activities includes associating the wireless communication device and/or an authorized user of the wireless communication device (e.g., using device/user credentials) with an enterprise account (and, in some embodiments, a consumer account), associating an application with a service, and associating the service with the enterprise account (e.g., a service for the wireless communication device that the enterprise agreed to pay for). In some embodiments, enterprise and consumer billing allocation for wireless communication device service usage activities further includes using application-based monitoring and/or control using, for example, device assisted services.

In some embodiments, enterprise and consumer billing allocation for wireless communication device service usage activities includes crediting an associated consumer account for service usage allocated to an enterprise account. In some embodiments, enterprise and consumer billing allocation for wireless communication device service usage activities includes billing the enterprise for service usage allocated to the enterprise account. In some embodiments, enterprise and consumer billing allocation for wireless communication device service usage activities includes reporting to the enterprise (and, in some embodiments, the consumer) service usage allocated to the enterprise account, and the enterprise can, for example, provide an expense reimbursement to the consumer (e.g., employee, partner, associate, or contractor of the enterprise).

In some embodiments, enterprise and consumer billing allocation for wireless communication device service usage activities includes associating the wireless communication device with an enterprise account and a consumer account, associating an application with a service, and associating the service with the consumer account (e.g., a service for the wireless communication device that the consumer, such as an employee of the enterprise, agreed to personally pay for). In some embodiments, enterprise and consumer billing allocation for wireless communication device service usage activities further includes using application-based monitoring and/or control using, for example, device assisted services.

In some embodiments, enterprise and consumer billing allocation for wireless communication device service usage activities includes crediting an associated enterprise account for service usage allocated to a consumer account. In some embodiments, enterprise and consumer billing allocation for wireless communication device service usage activities includes billing the consumer for service usage allocated to the consumer account. In some embodiments, enterprise and consumer billing allocation for wireless communication device service usage activities includes reporting to the enterprise (and, in some embodiments, the consumer) service usage allocated to the consumer account, and the

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enterprise can, for example, deduct the cost for such service usage as an expense from the consumer's periodic/next paycheck.

In some embodiments, enterprise and consumer billing allocation for wireless communication device service usage activities does not require a network element or a device element to control services. For example, a user with a device associated with a bulk service usage plan can be automatically credited for sponsored enterprise service usage. If the bulk service usage plan has a service plan cap associated with the user's consumer service plan, then the service usage classified as sponsored enterprise service usage can be deducted from the total service usage such that the sponsored enterprise service usage does not count towards the user's capped consumer service plan usage. As another example, an enterprise account associated with the wireless communication device and/or user can allow the user to exceed a monthly or other service plan cap for sponsored enterprise service usage (e.g., based on various criteria and/or other factors, such as a more restrictive enterprise service policy to avoid potential misuse of sponsored enterprise services for personal use).

In some embodiments, enterprise and consumer billing allocation for wireless communication device service usage activities is provided using network-based and/or device-based techniques as described herein with respect to various embodiments. For example, using various techniques described herein, an enterprise manager can control the services for wireless communication devices for the enterprise, including access to such services and/or charging for such services (e.g., services used by employees in which some are charged to the enterprise on behalf of the employee and some are charged to the employee as a consumer of such services) and user notification messages. For example, the enterprise manager or another network element/function can cap and/or control service usage for consumer services and/or enterprise services.

In some embodiments, a service usage reconciliation function is provided. In some embodiments, the service usage reconciliation function implements the rules for a billing split for the enterprise and consumer billing allocation for wireless communication device service usage activities, as described herein with respect to various embodiments. In some embodiments, the service usage reconciliation function also facilitates fraud detection, as described herein with respect to various embodiments. Carrier Managed Billing Allocation with Service Usage Monitoring in Carrier Network

FIG. 1 illustrates a functional diagram of a network architecture 100 for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments. In some embodiments, a wireless communication device 110 includes a memory, an application processor (e.g., or more than one application processor or general processor), and a wireless modem, shown as an access modem 151. As shown, the wireless communication device 110 includes an operating system application space 131 for executing applications and communicating wirelessly using operating system lower layers 130, network stack 136, and the access modem 151. As used herein, application space refers to a portion of memory and a portion of a processor operating system execution environment for executing application programs. As also shown, the wireless communications device 110 includes operating system lower layers 130. As used herein, operating system lower layers refers to one or more OS layers that typically implement networking functions (e.g.,

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network stack 136). In some embodiments, operating system lower layers 130 is where certain application data and communications security functions are implemented as described herein. In some embodiments, operating system lower layers 130 is where certain service usage monitoring and reporting functions are implemented as described herein. In some embodiments, operating system application space 131 executes various user applications, including one or more of user data application 111 and user voice application 112, and various enterprise applications, including enterprise data application 124 and enterprise voice application 126. In some embodiments, the execution environment for user applications and enterprise applications is the same (e.g., as shown in FIGS. 1 through 7). For example, a consumer Internet browser can execute in the operating system application space 131 for providing Internet web site browsing or web based email service via network stack 136 and wireless access modem 151 (e.g., a wireless modem), and an enterprise email program can also execute in the operating system application space 131 to communicate with an enterprise email server also via network stack 136 and wireless access modem 151. In some embodiments, the execution environment for user applications and enterprise applications are not the same (e.g., as shown in FIGS. 8 through 12).

In some embodiments, device 110 accesses various network-based voice services, such as consumer voice services 167 and/or enterprise sponsored/paid-for consumer voice services usage, via voice network 165. As shown, voice network 165 is in communication with carrier access network 150 via carrier gateway/home agent (HA) 152. In some embodiments, device 110 accesses various Internet based services, such as consumer Internet services 162 and/or enterprise sponsored/paid-for consumer Internet services usage, via Internet 160.

As also shown in FIG. 1, device 110 is in wireless communication (e.g., 2G/3G/4G access) with carrier access network 150. The carrier provides a carrier usage accounting server 154 (e.g., a carrier billing server) in communication with carrier access network 150. Carrier network access 150 is shown in communication with both Internet 160 and enterprise network 170 via Internet 160. Enterprise network 170 is shown in communication with Internet 160 as via enterprise firewall and secure access gateway 171 for protecting enterprise network 170 from unauthorized access. In some embodiments, to access enterprise network 170 through enterprise firewall and secure access gateway 171, device 110 includes a secure data application or a virtual private network application/function to facilitate secure authorization with enterprise firewall and secure access gateway 171 and to also protect the communication (e.g., encrypt such data communications). As also shown, behind enterprise firewall and secure access gateway 171, enterprise network 170 provides communication with secure enterprise mobile services gateway/server 172 in communication with enterprise network 170. As shown, secure enterprise mobile services gateway server 172 includes various enterprise applications/functions, including as shown, mobile email 173, mobile synchronization 174, mobile contacts 175, mobile calendar 176, mobile communications 177, and mobile intranet 178. In some embodiments, secure enterprise mobile services gateway server 172 provides mobile device mobile access to various enterprise network intranet services via enterprise intranet servers 180. In some embodiments, the enterprise mobile services include email, contacts, calendar, enterprise communications, mobile device synchronization services, intranet internal web sites, internal

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enterprise applications, enterprise file systems, and/or other enterprise networking services. In some embodiments, secure enterprise mobile services gateway server 172 provides optimized mobile application formatting of the enterprise information or synchronization services to synchronize the enterprise database for the above services in an efficient and/or timely manner.

In some embodiments, carrier usage accounting server 154 (e.g., the carrier billing server) communicates (e.g., using secure communication techniques) with service usage reconciliation server function 158 to obtain reconciled service charging reports (e.g., reconciled billing reports) and/or enterprise service usage charging credit reports. In some embodiments, the reconciled service charging reports (e.g., reconciled billing reports) and/or enterprise service usage charging credit reports are processed by carrier usage accounting server 154 and reported as user usage record(s) 155 and/or enterprise usage record(s) 156. For example, mediating such charging and credit reports can be based on various factors as described herein (e.g., by application, time of day/day of week, and/or other factors). For example, the service usage charges that occur due to communication with the servers or services that are part of enterprise network 170, including secure enterprise mobile services gateway server 172 and intranet servers 180, can be counted as an enterprise service usage credit.

In some embodiments, enterprise service design center 194 issues device provisioning instructions for the device credential list from the enterprise services device group, and for each of the credentials, a service control policy is set on enterprise firewall/secure gateway 171 to allow properly authorized devices to reach the desired destinations listed on the enterprise service activity policy set. The provisioning of enterprise firewall/secure gateway 171 with the enterprise service device group credentials and the enterprise service policy set is illustrated in FIG. 1 by the "C" input designator.

In some embodiments, enterprise service design center UI 196 and enterprise service design center 194 are provided as shown in FIG. 1. In some embodiments, enterprise service design center UI 196 and enterprise service design center 194 provide dedicated enterprise control of the network policy provisioning for configuring the service charging, accounting or billing allocation policies for differentiating between enterprise device service usage activities and consumer device service usage activities. Furthermore, in some embodiments, the portion of the enterprise network policy provisioning information that is needed to provision the carrier network elements to implement various techniques for allocating device service usage between enterprise and consumer activities is communicated between enterprise service design center 194 and carrier service design center 190.

A carrier provisioning system is typically not capable of providing direct access to an enterprise network administrator (e.g., carrier or enterprise personnel) for the purpose of provisioning such service charging capabilities. For example, such direct access is often not provided due to concerns related to the risk to the entire network that exists if network provisioning controls are made available to many different administrators to program charging allocation policies for many enterprises. However, as described herein, by isolating the required carrier network provisioning information to a secure service design center UI and policy configuration that only influences a small portion of the carrier network policy provisioning available to the carrier service design center and UI, the risk of causing such problems with the carrier network configuration is significantly reduced.

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Additionally, the process of performing the carrier side of the necessary provisioning is simplified for an administrator or in some cases can be automated.

The service design centers (e.g., carrier service design center **190** and enterprise service design center **194**) are shown in FIG. **1** and various other figures as separate network elements in order to more clearly define and discuss the functions of the service design centers. In some embodiments, enterprise service design center **194** is implemented in various other network elements (e.g., in enterprise network management apparatus, such as management functions of secure enterprise mobile services gateway server **172** or other enterprise network management apparatus). In some embodiments, enterprise service design center **194** is implemented as a securely partitioned and managed device group interface to a subset of the provisioning capabilities of carrier network service design center **190**. In some embodiments, enterprise service design center **194** is implemented as a securely partitioned and managed device group interface to a subset of the provisioning capabilities of a cloud-based secure enterprise mobile services network that is run by a centralized enterprise services provider such as an ASP or MVNO. As would be appreciated by one of ordinary skill in the art in view of the various embodiments described herein, enterprise service design center **194** can be implemented using various network and software/hardware architectures while providing for secure and controlled access as described herein.

In some embodiments, the enterprise service design center administrator creates or imports the enterprise service device group credentials and the enterprise service policy set using enterprise service design center UI **196**. In some embodiments, the information included in the enterprise service device group credentials and the enterprise service policy set is also communicated from enterprise service design center **194** to carrier service design center **190** via the "C" connection designator as shown. For each of the device credentials listed in the enterprise services device group, carrier service design center **190** determines the information it needs to properly provision carrier gateway/home agent **152** with the proper access policy allowances and service usage charging policies to provide enterprise service access and usage credit for communications from device **110** to the enterprise network destination addresses specified in the enterprise service policy set. Programming of this provisioning information to carrier gateway/home agent **152** is indicated by the "A" information connector from carrier service design center **190** to carrier gateway/home agent **152**. In some embodiments, this provisioning (e.g., programming) information sent via provisioning communication link "A" to carrier gateway/home agent **152** includes information to facilitate programming the enterprise device group credentials to: (i) receive the desired access service policy permissions, and (ii) implement the desired service usage accounting/charging policy settings. From the enterprise device group credentials list and the enterprise service activity policy set information provided in "C," carrier service design center **190** determines the information needed to properly provision the service usage reconciliation server function **158**. Programming of this provisioning information to service usage reconciliation server function **158** is indicated by the "B" information connector from carrier service design center **190** to service usage reconciliation server function **158**. In some embodiments, service usage reconciliation function **158** is part of the carrier network, and service usage reconciliation function **158** implements the charging reconciliation rules to determine how much of the

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recorded device **110** service usage to place on the user's usage record or service bill (e.g., consumer service usage cost allocation) and how much to place on the enterprise's usage record or service bill (e.g., enterprise service usage cost allocation).

An enterprise may wish to allow consumer services on an end-user device that also allows an employee to access enterprise services over the access network. In some such embodiments, service design center **190** specifies one or more service plans from which the device user can select, and these service plan selection options are configured into a configuration interface on a device software application (e.g., user data app **111**, user voice app **112** or service processor framework program **139** (shown, e.g., in FIG. **16**)) that allows users to select from one or more service plans, for example, one or more plans with both consumer and enterprise allocations, and/or an enterprise-only service plan. In some embodiments, the configuration interface is made available directly on the device via a device client that provides a service plan selection user interface that displays one or more service plan options configured in service design center **190** or enterprise service design center **194**. In some embodiments, the configuration interface is presented directly on the device user interface (UI) when the user attempts an access service usage activity that requires a service plan to be activated or purchased. In some embodiments, the configuration interface presented to the device UI accepts a user response and assists in sending the user response to a carrier network element responsible for provisioning a new user service plan that in turn activates the service plan chosen by the user, possibly after confirming service payment credit for the user or enterprise entity. In some embodiments, the carrier network element responsible for provisioning a new user service plan is carrier usage accounting server **154**. In some embodiments, the carrier network element responsible for provisioning a new user service plan is consumer Internet services elements **162**. In some embodiments, the carrier network element responsible for provisioning a new user service plan is a carrier gateway/home agent **152**. In some embodiments, the carrier network element responsible for provisioning a new user service plan is a billing system or service plan provisioning system. In some embodiments, the configuration interface is made available to the user in the form of a web site that provides a service plan selection user interface that displays one or more service plan options configured in service design center **190** or enterprise service design center **194**.

In some embodiments, the initial configuration of device **110** includes one or more enterprise access service plans that allow the user to access certain applications or network destinations associated with enterprise access services, and the user can choose from one or more additional consumer-oriented service plans offered directly on the device UI by a device software application (e.g., user data app **111**, user voice app **112**, or service processor framework program **139**) in communication with a carrier network element responsible for provisioning a new user service plan that in turn activates the service plan chosen by the user, possibly after confirming service payment credit for the user or enterprise entity. In some embodiments, these access service plan options are configured using service design center **190**. In some embodiments, these access service plan options are configured using enterprise service design center **194**.

In some embodiments in which a user has selected a consumer-oriented service plan in addition to an enterprise service plan, service usage reconciliation function **158** distinguishes between data usage within the enterprise service

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plan and data usage within the consumer-oriented service plan. In some embodiments, the enterprise does not pay for, backhaul, process, or police data usage associated with the consumer-oriented plan. In some embodiments, service usage reconciliation function 158 determines how much data usage by device 110 is enterprise data usage, and how much data usage by device 110 is consumer data usage. In some embodiments, service usage reconciliation function 158 allocates data usage associated with applications and/or services specified by the enterprise service plan to the enterprise, and data usage associated with applications and/or services specified by the consumer-oriented data plan to the consumer.

The various embodiments described herein with respect to FIG. 1 support a variety of techniques for allocating service usage accounting or billing between enterprise services and consumer services. For example, service usage reconciliation function 158 can report measured total usage, measured consumer usage, and/or measured enterprise usage to carrier usage accounting server 154. In some embodiments, the reconciliation service usage function (e.g., provided by service usage reconciliation function 158 and/or another element/function) implements the business rules that determine how much of the service usage to charge the user (e.g., a consumer service usage allocation) and how much of the service usage to charge the enterprise (e.g., an enterprise service usage allocation). In some embodiments, the service usage reconciliation service usage function records total device service usage, records total enterprise service activity service usage, and then subtracts the enterprise service usage from the total device service usage to determine a consumer service usage (e.g., a consumer service usage allocation). In some embodiments, service usage reconciliation function 158 passes on the enterprise service usage as a credit to the consumer account. In some embodiments, this credit is accounted for by the carrier billing the user at a reduced amount according to the credit and billing the enterprise for an increased amount according to the credit. In some embodiments, the credit is accounted for by communicating the credit to the enterprise so the enterprise can reimburse the consumer (e.g., generating an expense reimbursement for the credit to the consumer as an employee or contractor of the enterprise, directly paying the enterprise allocation of the carrier bill for the consumer, and/or various other approaches as described herein). In some embodiments, the credit is reported to the enterprise so that the enterprise can seek payment for the non-enterprise service usage (e.g., consumer service usage allocation) from the consumer (e.g., who can be an employee or contractor of the enterprise).

As another example, an enterprise allocation can also include providing an allowance for a certain level of monthly usage of data and/or voice. In some embodiments, carrier usage accounting server 154 generates a bill for the associated consumer account (e.g., associated with device 110, such as based on the device/user credentials) that reflects the cost of the service usage allocated to consumer service usage and a credit for the cost of service usage allocated to enterprise service usage (e.g., to offset the cost of the enterprise service usage, which can be billed to the enterprise account associated with the enterprise service usage for the device 110). As described herein, based on an allocation of enterprise and consumer service usage, various techniques for billing/charging and generating credits/reporting (e.g., the enterprise can generate the user/employee monthly expense reimbursements to compensate the user/employee for the determined cost of the enterprise service usage and/or other approaches as described herein) can be

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provided using the network architecture 100 and/or other network architectures, as described herein.

In some embodiments, an enterprise manager manages service usage by specifying an access network service usage limit for a service usage activity (such as data service, voice service, text service, a roaming service, or a more detailed classification of data service such as one or more websites or one or more device applications), and, when that usage limit is reached for a device that is managed by the enterprise manager, a service usage notification message is generated. In some embodiments, the service usage notification message is configured through enterprise service design center UI 196. In some embodiments, the service usage notification message is delivered to device 110. In some embodiments, the service usage notification message is presented to the user via a user interface of device 110.

In some embodiments, the service usage notification message provides information about data usage or the status of device 100. In some embodiments, the service usage notification message is triggered by an event, e.g., detection that device 110 reaches a data usage ceiling, determination that device 110 is roaming, etc. In some embodiments, the service usage notification message provides real-time or near-real-time information about data usage. In some embodiments, the service usage notification message provides information about remaining data usage availability or entitlement. In some embodiments, the service usage notification message comprises a detailed report of enterprise usage by user, user group, device, device group, or location.

In some embodiments, secure enterprise mobile services gateway server 172 is a dedicated enterprise application server for a particular enterprise (e.g., company, government organization, school/university, or another entity). In some embodiments, secure enterprise mobile services gateway server 172 is a carrier or a third party service provider (e.g., a carrier for wireless network services, such as AT&T, Sprint, T-Mobile, and/or various other wireless network service providers/carriers or third party service providers) controlled/managed application server that performs the application server functions for various different enterprises (e.g., as a service/outsourced IT services model). In some embodiments, device 110 is partitioned (e.g., associated with a particular enterprise/MVNO partition and associated enterprise account) based on device credentials and/or VPN to determine a service plan for managing (e.g., to determine how to allocate enterprise/consumer service usage for) device 110. In some embodiments, based on the partition determination of device 110, and the associated service plan for managing device 110, appropriate service usage monitoring and classification can be determined for providing an enterprise and consumer allocation for service usage activities of device 110 based on the associated service plan(s).

For example, by programming the business rules in service usage reconciliation function 158 that determine the service usage accounting allocation between enterprise services and consumer services, many approaches can be provided for creating a service that provides an enterprise service to a device when the device user has selected a consumer service plan or elected to pay for a consumer service plan. As an example, if the device user has chosen a service plan, the enterprise service usage accounted for in enterprise usage record 156 can be billed to the enterprise rather than the consumer. As another example, if the device user has chosen a service plan, the consumer service usage accounted for in user usage record 155 can be billed to the device user rather than the enterprise. As yet another example, if the device user has selected a service plan, the

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enterprise service usage can be communicated to the enterprise (e.g., and/or the device user), and the enterprise can issue a reimbursement to the device user for the enterprise portion of the user's bill, or pay the carrier directly for a portion of the user's bill, thus reducing the amount the user must pay. In some embodiments, the business rules in service usage reconciliation function **158** are programmed to provide the device user with a certain amount of service usage that may or may not be directly related to enterprise services.

For example, the user can be allocated a certain amount of general purpose browsing that includes network destinations that are not specified in the enterprise service activity policy set. In some embodiments, there is a cap to such general purpose browsing, and carrier service design center **190** can provision the network and/or the device to alert the user regarding how much of the enterprise sponsored browsing remains or when the enterprise sponsored internet browsing cap is reached or exceeded. In some embodiments, the business rules in service usage reconciliation function **158** are programmed to deduct the service usage associated with the enterprise sponsored general purpose browsing, up to the specified cap, from the user's bill. In this way, the user can be allocated an allowance for services that either the enterprise sponsors to account for enterprise related service usage that may not be included in the enterprise service activity policy set or that the enterprise simply desires to sponsor to reduce the device user's consumer service plan billing.

In a similar manner, services other than browsing that are not necessarily associated with enterprise service usage can also be sponsored by the enterprise by properly provisioning the business rules in service usage reconciliation function **158**. For example, a catch-all enterprise sponsored allowance (e.g., or cap) for "bulk" internet usage can be provided. The fact that the user is provided with such an allowance may be pointed out to the user if the user disputes how much of his or her device service usage cost should be covered by the enterprise and how much the user should cover personally. Another example is to provide a certain amount of voice minutes to any phone number or to phone numbers not in the enterprise service activity policy set.

In some embodiments, the business rules in service usage reconciliation function **158** are provisioned so that the enterprise specifically does not allow, sponsor, or pay for certain device service usage activities. In some embodiments, these service usage activities can include access to network destinations, applications, or services that pose security risks to enterprise data stored on device **110** or pose security risks to enterprise network **170**. In some embodiments, these activities include access to network destinations, applications, or services that the enterprise does not wish to sponsor or that are potentially associated with user activity that violates enterprise policy or laws. For example, the business rules may be configured to allow only transmission of business data on approved networks, e.g., excluding free or unknown WiFi hotspots, or only when device **110** is connected to the network via a VPN. In some embodiments, such service usage activities that violate enterprise security policies or other service usage policies are blocked by the business rules programmed into the network or the device as specified in the enterprise service activity policy set.

By programming the business rules in service usage reconciliation function **158** that determine the service usage accounting allocation between enterprise services and consumer services, many approaches can be provided for cre-

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ating a service that provides an enterprise service to a device when the device user has not selected a consumer service plan or elected to pay for a consumer service plan. For example, if the device user has not chosen to select or pay for a consumer service plan, carrier gateway/home agent **152** can be programmed to allow service usage for the enterprise service policy set but deny all other access until the user chooses a consumer service plan. In some embodiments, when/if the consumer chooses a consumer service plan then access would be expanded beyond just the enterprise services, because when the service plan activation occurs, consumer service policy set in carrier gateway/home agent **152** will be updated to allow service (e.g., as the carrier administrator user of carrier service design center **190** programs a different set of consumer service access policies for each consumer service plan that can be chosen). In some embodiments, the user is allocated a certain amount of general purpose data access or voice minutes as described above even though the user does not have a consumer data plan. Another example is to provide the user with a certain monetary allowance that is sponsored by the enterprise rather than a service usage amount.

Although enterprise service design center **194** is shown provisioning mobile server usage counter **179** (e.g., shown in FIG. 5) and enterprise firewall/secure gateway **171**, it should be understood that not all device provisioning connections as shown from secure enterprise mobile services gateway/server **172** to device **110** are shown for device functions including secure mobile services application access, communication link provisioning (e.g., cryptographic encryption keys, VPN settings, and various other security/communication provisioning), security programs, service control programs, and program settings for enterprise service applications, such as email, calendar, contacts, mobile synchronization services, and traffic control. As shown, the labeled provisioning connections are provided as exemplary embodiments to assist in identifying the network elements that are provisioned for network access control and network service usage charging reporting. Those of ordinary skill in the art will appreciate that these additional device provisioning functions are not necessarily specifically called out with provisioning connection labels in each figure, and it will be apparent to one of ordinary skill in the art which of these device provisioning functions and connections are needed from enterprise service design center **194** and device **110**. It will also be apparent to one of ordinary skill in the art in view of the various embodiments described herein that the various device provisioning connections and device element programming configurations needed to provision these device functions can be managed by secure enterprise mobile services gateway/server **172** via a device management communications link. It will also be apparent to one of ordinary skill in the art that, in some embodiments, the flow of policy provisioning information for the various device elements that participate in establishing service usage monitoring and reporting policies or service access control policies starts in enterprise service design center **194** and flows through secure enterprise mobile services gateway/server **172** over a device management link, and through the device management link on device **110** to the device **110** functional elements that need to be provisioned. In various embodiments described herein, the device elements that are provisioned in some embodiments to set up enterprise services, service usage monitoring and reporting policies, or service usage access control policies include one or more of enterprise data application **124**, enterprise voice application **126**, secure mobile enterprise application environment **120**

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(shown, e.g., in FIG. 8), secure network interface 128 (shown, e.g., in FIG. 8), secure enterprise mobile services application 125 (shown, e.g., in FIG. 13), virtual machine #2 secure enterprise application environment 118 (shown, e.g., in FIG. 14), enterprise application secured hardware execution partition 106 (shown, e.g., in FIG. 15), device service usage monitor 119 (shown, e.g., in FIG. 17), service processor framework program 139 (shown, e.g., in FIG. 16), and/or service processor kernel program 138 (shown, e.g., in FIG. 16).

In some embodiments, service usage reconciliation function 158, or secure enterprise mobile services gateway/server 172, or another similar network function, is programmed to review traffic usage patterns of mobile device 110 for the purpose of determining if the device may have fallen into unauthorized hands or if the device secure enterprise communications and data management software may have been hacked or tampered with in a way that endangers enterprise security or causes the enterprise to be billed for usage that is not enterprise usage. For example, service usage reconciliation function 158 (e.g., or secure enterprise mobile services gateway/server 172) can be programmed to monitor “bulk” enterprise service usage for the enterprise device group and trigger a fraud detection alert for a device that exhibits enterprise usage that is higher than a pre-determined “normal” limit. As another example, service usage reconciliation function 158 can be programmed to monitor “bulk” enterprise service usage for the enterprise device group and trigger a fraud detection alert for a device that exhibits enterprise usage access patterns that are determined to be outside of “normal” limits. Examples of usage patterns can include usage as a function of time of day, duration of usage, usage above a certain limit for a subset of service usage activities, and/or usage above a certain limit for all service usage activities.

In some embodiments, enterprise service design center 194 is configured to receive or accept a specification for an access network service usage limit (e.g., a service amount in minutes, bytes, or cost) for a service usage activity (such as a data service, a voice service, a text service, a roaming service, or a more detailed classification of a data service, such as one or more websites or one or more device applications), and the service usage limit is applied to one or more devices 110 or device groups (or users or user groups) managed by enterprise service design center 194. In some embodiments, enterprise service design center 194 is further configured to receive service usage records for device 110, which is managed by enterprise service design center 194, from a network element configured to monitor and report device 110 service usage (e.g., carrier usage accounting server 154, enterprise firewall/security gateway 171, or another network element), and when the usage limit is reached, to generate a service usage notification message. In some embodiments, enterprise service design center 194 is configured to deliver the service usage notification message to enterprise service design center UI 196. In some embodiments, enterprise service design center 194 is configured to deliver the service usage notification message to a software application of device 110 (e.g., service processor framework program 139 or user data app 111) for presentation to the device user through a user interface of device 110.

In some embodiments, enterprise service design center 194 is configured to receive or accept a specification for an access network service notification event consisting of a network access pattern achieved or attempted by device 110 that belongs to a device group (or user group) managed by enterprise service design center 194, wherein the network

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access pattern is access attempted or achieved by one or more pre-defined device applications, or access attempted or achieved by device 110 to one or more network destinations, websites or network servers. In some embodiments, enterprise service design center 194 is further configured to receive service usage records for device 110, which is managed by enterprise service design center 194, from a network element configured to monitor and report device 110 service usage (e.g., carrier usage accounting server 154, enterprise firewall/security gateway 171, or another network element), and when the service usage indicates that the network access pattern has occurred, enterprise service design center 194 is further configured to send a notification message to enterprise service design center UI 196.

Carrier Managed Billing Allocation with Service Usage Monitoring in Carrier Network and Enterprise Firewall/Gateway

FIG. 2 illustrates a functional diagram of another network architecture 101 for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments. Network architecture 101 of FIG. 2 is similar to network architecture 100 of FIG. 1, except that in network architecture 101 of FIG. 2, service usage reconciliation function 158 receives service usage information from enterprise firewall/secure gateway 171 in addition to carrier gateway/home agent 152. This allows for various techniques that augment the capabilities of carrier gateway/home agent 152. For example, in networks in which it is impractical or infeasible for carrier gateway/home agent 152 to keep track of the service usage accounting allocation between the enterprise service policy set and consumer services for the devices in the device group, service usage reconciliation function 158 can receive total device service usage from carrier gateway/home agent 152, and receive the enterprise service usage from enterprise firewall/secure gateway 171. With this information, service usage reconciliation service usage function 158 can perform the allocation between enterprise service usage and consumer service usage without any detailed service usage reports from carrier gateway/home agent 152.

There are several reasons that the carrier network may not support numerous enterprise service customers with an enterprise/consumer allocation architecture that requires carrier gateway/home agent 152 to perform the necessary traffic classification or service usage classification as in the FIG. 1 embodiment. For example, these reasons can include: (i) carrier gateway/home agent 152 does not have the detailed service usage classification capability (e.g., deep packet inspection function(s)) required to allocate service usage between the enterprise service policy set and consumer services for the devices in the device group, (ii) carrier gateway/home agent 152 is capable of performing the service monitoring required but can only do it for a limited number of devices (e.g., scaling issues), and/or (iii) there are too many device groups being managed by enterprise partners of the carrier creating a situation where the number of specialized profiles that must be supported by carrier gateway/home agent 152 is larger than can be accommodated by the profile management capacity of the gateway system (e.g., scaling issues). As would now be apparent to those of ordinary skill in the art in view of the embodiments described herein, there are other reasons that can make it advantageous to provide the enterprise service usage from the enterprise network.

In some embodiments, provisioning with the service design centers and UIs for the embodiment shown in FIG. 2 is similar to that of FIG. 1. In some embodiments, the billing

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allocation capabilities of the two embodiments are similar if carrier gateway/home agent 152 is fully capable of differentiating service usage between the enterprise service policy set and the consumer services, but if not, then as discussed above, the billing allocation capabilities of the FIG. 2 embodiment can be preferable in such environments.

Because the enterprise service usage is monitored by the enterprise network elements in the embodiments depicted in FIG. 2, various service accounting or billing policies are available to the enterprise or carrier. For example, the amount of service usage resulting from enterprise services that occur during roaming conditions can be accounted for even when the carrier network does not receive detailed classification of service usage from roaming network partners. The business rules programmed into service usage reconciliation function 158 that are determined by the enterprise service activity policy set can break-out enterprise-service-related roaming charges separately from consumer-service-related roaming charges so that the enterprise-service-related roaming charges are sponsored or paid by the enterprise and consumer roaming service usage activities are not subsidized or are only partially subsidized. In addition, in some embodiments, secure enterprise mobile services gateway/server 172 includes the capability to determine if device 110 is roaming so that the access control policies specified in the enterprise service activity policy set can include modification or denial of access to enterprise network 170 services allowed by enterprise firewall/secure gateway 171 or secure enterprise mobile services gateway/server 172 during roaming conditions even though the access is not controlled by the carrier home network.

In some embodiments, an active network detection function is included on the device to assist the network policy enforcement elements to determine the type of network the device is connected to or to determine if the device is on a home or roaming network, as described herein. For example, the service usage policy allowances provided by the enterprise service activity policy set can be programmed so that the allowances change depending on the availability of a particular network or set of networks, the time of day, the congestion state of a network, or the current cost of service on the network. For example, if the carrier home network is not available and only a roaming network is available, the allowance may be decreased or removed. As another example, if a certain network type is not available but another network type is (e.g., 2G is available instead of 3G or 3G is available instead of 4G), then the allocation can be reduced. As yet another example, if a variable charging policy is in place with the carrier for access when the network is busy or during certain times of day, then the enterprise sponsored allowance can be reduced during times of higher charging.

Enterprise Managed Billing Allocation with Service Usage Monitoring in Carrier Network and Enterprise Firewall/Gateway

FIG. 3 illustrates a functional diagram of another network architecture 102 for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments. Network architecture 102 of FIG. 3 is similar to network architecture 101 of FIG. 2, except that in network architecture 102 of FIG. 3, service usage reconciliation function 158 receives overall device service usage information from carrier usage accounting server 154 and also receives enterprise device service usage information from enterprise firewall/secure gateway 171. In some embodiments, there is no interaction between the provisioning of the carrier network

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and the provisioning of the enterprise network, and it is assumed that service usage reconciliation function 158 and enterprise usage accounting server 159 are both under the control of the enterprise administrator. This approach allows for various techniques that provide for enterprise allocation of consumer service usage and enterprise service usage without the need to interface to the carrier network other than to get the overall usage summary. For example, service usage reconciliation function 158 can receive total or "bulk" usage from carrier usage accounting server 154, receive enterprise service usage from enterprise firewall/secure gateway 171, and determine the amount of consumer service usage, enterprise service usage, and/or an enterprise service usage credit.

In some embodiments, provisioning with the service design centers and UIs for the embodiment shown in FIG. 3 is similar to that of FIG. 1 except that no provisioning of enterprise service parameters is required in the carrier network. The billing allocation capabilities are also similar if carrier gateway/home agent 152 is fully capable of differentiating service usage between the enterprise service policy set and the consumer services, but if not, then as discussed above, the billing allocation capabilities of the FIG. 3 embodiment can be preferable in such environments. For example, using network architecture 102, the enterprise can deal directly with its employees without the need to bring the carrier into the consumer-versus-enterprise allocation process. As an example, the enterprise could have a policy in which consumers purchase their own mobile device services and then get credit for enterprise mobile device services at the end of each billing period. This credit can be provided back to the employee in the form of an expense reimbursement or an increase in their next paycheck.

Enterprise Usage Credit with Service Usage Monitoring in Enterprise Firewall/Gateway

FIG. 4 illustrates a functional diagram of another network architecture 103 for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments. Network architecture 103 of FIG. 4 is similar to network architecture 102 of FIG. 3, except that in network architecture 103 of FIG. 4, service usage reconciliation server function 158 receives no overall device service usage information from the carrier network. As shown in FIG. 4, the source of service usage information is enterprise network 170 (e.g., via the enterprise firewall/secure gateway 171). In some embodiments, there is no interaction between the provisioning of the carrier network and the provisioning of the enterprise network, and it is assumed that service usage reconciliation function 158 and enterprise usage accounting server 159 could both be under the control of the enterprise administrator. For example, network architecture 103 of FIG. 4 can be less dependent on the carrier than network architecture 102 of FIG. 3 in that no billing information feed is provided. Using various techniques described herein, an enterprise service usage credit can be determined, and the determined enterprise service usage credit can be reimbursed to the device user.

Carrier Managed Billing Allocation with Service Usage Monitoring in Carrier Gateway/Home Agent and Enterprise Mobile Services Gateway Server

FIG. 5 illustrates a functional diagram of another network architecture 200 for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments. Network architecture 200 of FIG. 5 is similar to network architecture 101 of FIG. 2, except that in network architecture

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ture 200 of FIG. 5, secure enterprise mobile services gateway/server 172 includes mobile server usage monitor 179, and the enterprise service usage reports from this function are sent to service usage reconciliation function 158 instead of usage reports being sent from enterprise firewall/secure gateway 171. In some embodiments, various specialized needs of monitoring, recording, and reporting enterprise service usage are confined to the special-purpose secure enterprise mobile services gateway/server 172 rather than requiring the often more general-purpose enterprise firewall/secure gateway 171 to perform these functions.

Enterprise Managed Billing Allocation with Service Usage Monitoring in Carrier Network and Enterprise Mobile Services Gateway Server

FIG. 6 illustrates a functional diagram of another network architecture 201 for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments. Network architecture 201 of FIG. 6 is similar to network architecture 102 of FIG. 3, except that in network architecture 201 of FIG. 6, secure enterprise mobile services gateway/server 172 includes mobile server usage monitor 179, and the enterprise service usage reports from this function are sent to service usage reconciliation function 158 instead of usage reports being sent from enterprise firewall/secure gateway 171. For example, this approach allows for the specialized needs of monitoring, recording, and reporting enterprise service usage to be performed by the special-purpose secure enterprise mobile services gateway/server 172 rather than requiring the often more general-purpose enterprise firewall/secure gateway 171 to perform such functions.

Enterprise Usage Credit with Service Usage Monitoring in Enterprise Mobile Services Gateway Server

FIG. 7 illustrates a functional diagram of another network architecture 202 for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments. Network architecture 202 of FIG. 7 is similar to network architecture 103 of FIG. 4, except that in network architecture 202 of FIG. 7, secure enterprise mobile services gateway/server 172 includes mobile server usage counter 179, and the enterprise service usage reports from this function are sent to service usage reconciliation function 158 instead of usage reports being sent from enterprise firewall/secure gateway 171. For example, this approach allows for the specialized needs of monitoring, recording and reporting enterprise service usage to be performed by the special-purpose secure enterprise mobile services gateway/server 172 rather than requiring the often more general-purpose enterprise firewall/secure gateway 171 to perform such functions.

Carrier Managed Billing Allocation with Device Mobile Enterprise Services Application Environment and Service Usage Monitoring in Carrier Network

FIG. 8 illustrates a functional diagram of another network architecture 300 for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments. As shown, secure mobile enterprise application environment 120 and secure network interface 128 within secure mobile enterprise application environment 120 are included in device 110. Also, server secure network interface 127 is included in secure enterprise mobile services gateway/server 172. In some embodiments, secure mobile enterprise application environment 120 protects sensitive enterprise information that is stored on device 110 (e.g., email text and

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downloads, calendar information, contacts, intranet data, or any other enterprise data) and provides a secure communication channel function to allow for authentication with server secure network interface 127 on secure enterprise mobile services gateway/server 172. As also shown, a user services application environment in device 110 includes various user applications, such as user data application 111 and user voice application 112.

In some embodiments, provisioning of the various network architecture elements to facilitate the allocation between enterprise service usage accounting or billing and consumer service usage accounting or billing is established as follows. The device portion of secure network interface 128 and the enterprise server portion of server secure network interface 127 are provisioned with connection "E." In some embodiments, this provisioning operation with the connection labeled "E" includes programming information for secure network interface 128 to direct enterprise network 170 access traffic associated with application functions running in secure mobile enterprise application environment 120 to enterprise network 170 destinations that are to be sponsored (and, in some embodiments, possibly intermediate network routes) according to the enterprise services policy set, including, for example, the addresses (e.g., IP, IP/port or other higher layer address identifiers) of secure enterprise mobile services gateway/server 172 or enterprise intranet servers 180. In some embodiments, the provisioning operation designated with the connection label "E" also establishes the parameters required for the secure communication of information between secure network interface 128 and server secure network interface 127. In some embodiments, this provisioning step sets up the policies for the authentication process, data encryption, and cryptographic key exchange processes take place to establish secure communication between secure mobile enterprise application environment 120 and secure enterprise services gateway/server 172.

In some embodiments, the enterprise network destinations that are to be sponsored according to the enterprise services policy set identified by provisioning connection "E" are also communicated to carrier service design center 190. For example, this allows carrier service design center 190 to determine and transmit the proper provisioning information to establish the access control policies or service usage accounting policies for these aspects of the enterprise services policy set. Carrier service design center provisioning connections "A" communicate the provisioning information (programming) to carrier gateway/home agent 152. Carrier service design center provisioning connections "B" communicate the provisioning information (programming) to service usage reconciliation function 158.

In some embodiments, the provisioning operation associated with the provisioning connection label "C" provisions enterprise firewall/secure gateway 171 to admit devices 110 with device credentials or application credentials that belong to the desired enterprise services device group associated with the enterprise service policy set. In some embodiments, the provisioning information labeled as "C" includes enterprise network 170 destinations that are to be sponsored (and, in some embodiments, possibly intermediate network routes) according to the enterprise services policy set. In some embodiments, the provisioning information labeled as "C" includes only the network destinations for secure enterprise mobile services gateway/server 172, and devices 110 are not allowed access to other parts of enterprise network 170.

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In some embodiments, network architecture **300** for providing enterprise and consumer billing allocation for wireless communication device service usage activities includes executing an enterprise application as a secure enterprise data application **124** in secure mobile enterprise application environment **120** of device **110** in which the secure applications are in network communication (e.g., secure network communication, such as via a virtual private network (VPN) or other secure network communication techniques) with secure enterprise mobile services gateway/server **172** (e.g., executing an enterprise server side of the enterprise authorized/sponsored applications, such as an enterprise email server, an enterprise calendar server, an enterprise contacts server, and/or an enterprise network access server) of the enterprise. In some embodiments, the secure enterprise mobile services gateway/server **172** performs application monitoring that includes counting application service usage (e.g., bytes used in communicating with the device's execution of secure enterprise application **124**). In some embodiments, secure enterprise mobile services gateway/server **172** performs application monitoring that further includes classifying application service usage (e.g., classifying secure enterprise application **124** by application/service usage activity such as based on application name or using signed code/hash techniques, by time of day/day of week, enterprise server, destinations, enterprise intranet, and/or other factors).

Carrier Managed Billing Allocation with Device Mobile Enterprise Services Application Environment and Mobile Services Gateway Server with Service Usage Monitoring in Carrier Network

FIG. **9** illustrates a functional diagram of another network architecture **301** for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments. Network architecture **301** of FIG. **9** is similar to network architecture **300** of FIG. **8**, except that in network architecture **301** of FIG. **9**, secure enterprise mobile services gateway/server **172** is located between the Internet **160** and enterprise network **170**. For example, this approach allows for server secure network interface **127** of secure enterprise mobile services gateway/server **172** to restrict access to enterprise network **170** and enterprise intranet servers **180** based on device authentication and/or various other security techniques (e.g., secure access, authentication, and/or communication techniques), as would be apparent to one of ordinary skill in the art in view of the various embodiments described herein.

Carrier Managed Billing Allocation with Device Mobile Enterprise Services Application Environment and Mobile Services Gateway Server with Service Usage Monitoring in Carrier Network and Mobile Services Gateway Server

FIG. **10** illustrates a functional diagram of another network architecture **302** for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments. Network architecture **302** of FIG. **10** is similar to network architecture **301** of FIG. **9**, except that in network architecture **302** of FIG. **10**, secure enterprise mobile services gateway/server **172** includes mobile service usage monitor **179** that reports enterprise service usage to the service usage reconciliation function **158**. In some embodiments, various specialized needs of monitoring, recording, and reporting enterprise service usage are confined to the special-purpose enterprise mobile services gateway/server **172** rather than requiring the often more general-purpose enterprise firewall/

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secure gateway **171** and/or other network elements/functions to perform such functions.

Enterprise Managed Billing Allocation with Device Mobile Enterprise Services Application Environment and Mobile Services Gateway Server with Service Usage Monitoring in Mobile Services Gateway Server

FIG. **11** illustrates a functional diagram of network architecture **303** for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments. Network architecture **303** of FIG. **11** is similar to network architecture **302** of FIG. **10**, except that network architecture **303** of FIG. **11** includes another carrier usage accounting server **154B** that reports service usage to service usage reconciliation function **158**. In some embodiments, carrier usage accounting server **154B** receives overall or bulk service usage data from carrier gateway/home agent **152** and forwards such information to service usage reconciliation function **158**. Service usage reconciliation function **158** reconciles the overall or bulk service usage received from carrier accounting server **154B** and the enterprise service usage received from mobile server usage monitor **179** and provides such reconciled service usage information to carrier usage accounting server **154A**.

Enterprise Usage Credit with Device Mobile Enterprise Services Application Environment and Mobile Services Gateway Server with Service Usage Monitoring in Mobile Services Gateway Server

FIG. **12** illustrates a functional diagram of network architecture **304** for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments. Network architecture **304** of FIG. **12** is similar to network architecture **303** of FIG. **11**, except that in network architecture **304** of FIG. **12**, the only service usage reported to service usage reconciliation function **158** is the enterprise service usage received from mobile server usage monitor **179**. In some embodiments, service usage reconciliation function **158** reconciles the enterprise service usage received from mobile server usage monitor **179** and provides such reconciled service usage information to carrier usage accounting server **154**, which generates enterprise service usage record(s) **156**. Device Configurations without Service Usage Monitoring and Reporting

FIG. **13** illustrates a functional diagram of a secure device application architecture for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments. As shown, device **110** includes an operating system application space **131**, operating system lower layers **130** including network stack **121**, and access modem (e.g., wireless modem) **129**. As also shown, operating system application space **131** includes various user applications, such as user data application **111** and user voice application **119**, and service usage monitor **119**. Operating system application space **131** also includes secure enterprise mobile services application **125**, which includes various enterprise applications, such as email, synchronization, contacts, calendar communications, and intranet. Secure enterprise mobile services application **125** also includes secure network interface **128** (e.g., for securely communicating with an enterprise network).

FIG. **14** illustrates a functional diagram of another secure device virtual machine architecture for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments. FIG. **14** is similar to FIG. **13**, except that in

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FIG. 14 the user applications are executed/stored within virtual machine (VM) #1 consumer application environment 117, and secure enterprise mobile services application 125 is included within virtual machine (VM) #2 secure enterprise application environment 118. Device 110 also includes virtual machine operating system 115 that includes virtual OS instantiation #1 117A for VM #1 consumer application environment 117 and virtual OS instantiation #2 118A for VM #2 secure enterprise application environment 118. As also shown, virtual machine operating system 115 includes virtual machine OS network stack 116.

FIG. 15 illustrates a functional diagram of another secure device hardware execution partition architecture for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments. FIG. 15 is similar to FIG. 14, except that in FIG. 15 hardware partitions are provided instead of virtual partitions. As shown, the user applications are executed/stored within user application secured hardware execution partition 105 and secure enterprise mobile services application 125 is included within enterprise application secured hardware execution partition 106. Device 110 also includes secured hardware partition for OS 115 that includes secure hardware partition manager #1 107 for user application secured hardware execution partition 105 and secure hardware partition manager #2 108 for enterprise application secured hardware execution partition 106. As also shown, secured hardware partition for OS 115 includes OS network stack 116.

FIG. 16 illustrates a functional diagram of another secure device service processor architecture for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments. As similarly described herein with respect to various embodiments, the device architecture of FIG. 16 includes service processor framework program 139 (e.g., framework space agent/function) and network stack framework components 137 in operating system framework space 133, and service processor kernel program 138 (e.g., kernel space agent/function) and network stack kernel components 135 in operating system kernel space 132. In some embodiments, the service processor functions provide a user interface function to communicate to a user of device 110 whether or not a service usage activity is an approved/authorized service usage activity, or whether it is a disallowed service usage activity for device 110 (e.g., the enterprise has disallowed the usage of device 110 for such service usage activities, such as online gaming and/or certain other online activities or certain long distance calling or voice usage during certain days, such as weekends) or whether such would/will be charged/billed to the user as a consumer under the user's consumer plan. In some embodiments, the service processor functions provide a user interface function to communicate to a user of device 110 an associated cost of certain service usage activities allocated to consumer service usage. In some embodiments, the service processor functions provide a user interface function to communicate to a user of device 110 an associated credit of certain service usage activities allocated to enterprise service usage. In some embodiments, the service processor functions provide a user interface function to communicate to a user of device 110 various other information as described herein with respect to providing an enterprise and consumer allocation for service usage activities. In some embodiments, the service processor shown in FIG. 16 communicates with a service controller, such as described herein with respect to various embodiments.

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Carrier Managed Billing Allocation with Device Mobile Enterprise Services Application Environment and Mobile Services Gateway Server with Service Usage Monitoring in Carrier Network and on Device

FIG. 17 illustrates a functional diagram of another network architecture 400 for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments. Network architecture 400 of FIG. 17 is similar to network architecture 302 of FIG. 10, except that as shown in FIG. 17, device 110 also includes service usage monitor 119 (e.g., agent/function) in secure mobile enterprise application environment 120. In some embodiments, service usage monitor 119 performs application monitoring that includes counting application service usage for secure data application 124 and secure voice application 126 (and, in some embodiments, for also counting application service usage for user applications that are not enterprise or secure enterprise applications 124 or 126). In some embodiments, counting application service usage includes counting bytes or network connection time used in communicating via carrier access network 150 during the device's execution of monitored data applications. In some embodiments, counting application service usage includes counting voice network connection time used in communicating via carrier access network 150 during the device's execution of monitored voice applications. In some embodiments, service usage monitor 119 performs application monitoring that further includes classifying application service usage for secure enterprise applications 124, 126 (e.g., classifying various secure enterprise applications 124, 126 and in some embodiments, including ambient services classification/determination, by application/service usage activity such as based on application name or using signed code/hash techniques, by time of day/day of week, enterprise server, destinations, enterprise intranet, and/or other factors).

In some embodiments, carrier usage accounting server 154 communicates (e.g., using secure communication techniques) with service usage monitor 119 to mediate billing/charging and credit reports, for example, using the various approaches and techniques as described herein.

In some embodiments, service usage monitor 119 and/or another function/agent executed in secure mobile enterprise application environment 120 of device 110 blocks user access for non-enterprise activities that the user has not agreed to pay for.

Because the enterprise service usage is monitored by the device network elements in the embodiments depicted in FIG. 17, various service accounting or billing policies are available to the enterprise or carrier. For example, the amount of service usage resulting from enterprise services that occur during roaming conditions may be accounted for even when the carrier network does not receive detailed classification of service usage from roaming network partners. The business rules programmed into service usage reconciliation function 158 that are determined by the enterprise service activity policy set can break-out enterprise service related roaming charges separate from consumer service related roaming charges. In addition, in some embodiments, the device secure mobile enterprise environment includes an access control function so that the access control policies specified in the enterprise service activity policy set can be enforced on roaming networks that have access that is not controlled by the carrier home network.

For example, the allowances provided by the enterprise service activity policy set can be programmed so that the allowances change depending on the availability of a par-

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ticular network or set of networks, the time of day, the congestion state of a network, or the current cost of service on the network. As another example, if the carrier home network is not available and only a roaming network is available, the allowance can be decreased or removed. As yet another example, if a certain network type is not available but another network type is (e.g., 2G is available instead of 3G or 3G is available instead of 4G), then the allocation can be reduced. As yet a further example, if a variable charging policy is in place with the carrier for access when the network is busy or during certain times of day, then the enterprise sponsored allowance can be reduced during times of higher charging. As described herein, in some embodiments, an active network detection function can be included on the device to assist the network policy enforcement to determine the type of network the device is connected to or to determine if the device is on a home or roaming network. As also described herein, in some embodiments, a network busy state monitor function can be included on the device to assist the network policy enforcement to determine the network busy state or state of network congestion. Carrier Managed Billing Allocation with Device Mobile Enterprise Services Application Environment and Mobile Services Gateway Server with Service Usage Monitoring in Carrier Network, on Device, and in Enterprise Mobile Services Gateway Server

FIG. 18 illustrates a functional diagram of another network architecture 401 for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments. Network architecture 401 of FIG. 18 is similar to network architecture 400 of FIG. 17, except that in network architecture 401 of FIG. 18, secure enterprise mobile services gateway/server 172 includes mobile server usage counter 179, and the enterprise service usage reports from this function are sent to service usage reconciliation function 158. In some embodiments, various specialized needs of monitoring, recording, and reporting enterprise service usage are confined to the special-purpose secure enterprise mobile services gateway/server 172.

Enterprise Managed Billing Allocation with Device Mobile Enterprise Services Application Environment and Mobile Services Gateway Server with Service Usage Monitoring on Device and in Enterprise Mobile Services Gateway Server

FIG. 19 illustrates a functional diagram of another network architecture 402 for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments. Network architecture 402 of FIG. 19 is similar to network architecture 401 of FIG. 18, except that network architecture 402 of FIG. 19 does not include the service usage feed from carrier gateway/home agent 152, and service usage reconciliation function 158 relies solely on a device service usage feed from device 110 usage monitors 119 and secure enterprise mobile services gateway/server 172 mobile service usage monitor 179. In some embodiments, service usage reconciliation function 158 and enterprise service usage accounting server 159 are under the control of the enterprise or the carrier. For example, an enterprise entity can establish enterprise service and consumer service usage allocation accounting without the need to tie into the carrier network for usage feeds and usage accounting. Using various techniques described herein, an enterprise service usage credit can be determined, and the determined enterprise service usage credit can be reimbursed to the device user.

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Enterprise Managed Billing Allocation with Device Mobile Enterprise Services Application Environment and Mobile Services Gateway Server with Service Usage Monitoring on Device

FIG. 20 illustrates a functional diagram of another network architecture 403 for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments. Network architecture 403 of FIG. 20 is similar to network architecture 402 of FIG. 19, except that in network architecture 403 of FIG. 20, service usage reconciliation function 158 receives feeds from device 110 service usage monitors 119 and there is no feed from the secure enterprise mobile services gateway server.

Enterprise Usage Credit with Device Mobile Enterprise Services Application Environment and Mobile Services Gateway Server with Service Usage Monitoring on Device and in Enterprise Mobile Services Gateway Server

FIG. 21 illustrates a functional diagram of another network architecture 404 for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments. Network architecture 404 of FIG. 21 is similar to network architecture 402 of FIG. 19, except that in network architecture 404 of FIG. 21, there is no service usage monitor function 119 in user services application environment 122 providing service usage reports/information to service usage reconciliation function 158, and enterprise usage accounting server 159 only generates enterprise usage records 156.

Enterprise Usage Credit with Device Mobile Enterprise Services Application Environment and Mobile Services Gateway Server with Usage Monitoring on Device

FIG. 22 illustrates a functional diagram of another network architecture 405 for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments. Network architecture 405 of FIG. 22 is similar to network architecture 404 of FIG. 21, except that network architecture 405 of FIG. 22 does not include mobile server usage monitor 179 providing enterprise service usage reports/information to service usage reconciliation function 158.

Device Configurations with Service Usage Monitoring and Reporting

In some embodiments, secure enterprise mobile services application 125 and network stack 121 can be implemented in access modem 129, as described below with respect to FIGS. 23 through 26.

FIG. 23 illustrates a functional diagram of a secure device application architecture with device-based service usage monitoring (and in some embodiments, access control) for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments. FIG. 23 is similar to FIG. 13 except that in FIG. 23 usage monitor 119 is provided as shown, and secure enterprise mobile services application 125 and network stack 121 can be implemented in access modem 129 as also shown.

FIG. 24 illustrates a functional diagram of a secure device virtual machine architecture with device-based service usage monitoring (and in some embodiments, access control) for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments. FIG. 24 is similar to FIG. 14 except that in FIG. 24, usage monitor 119 is provided as shown, and secure enterprise mobile services application 125 and virtual machine OS network stack 116 can be implemented in access modem 129 as also shown.

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FIG. 25 illustrates a functional diagram of a secure device hardware execution partition architecture with device-based service usage monitoring (and in some embodiments access control) for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments. FIG. 25 is similar to FIG. 15 except that in FIG. 25 usage monitor 119 is provided as shown, and secure enterprise mobile services application 125 and virtual machine OS network stack 116 can be implemented in access modem 129 as also shown.

FIG. 26 illustrates a functional diagram of a secure device service processor architecture with device based service usage monitoring (and in some embodiments, access control) for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments. FIG. 26 is similar to FIG. 16 except that in FIG. 26 usage monitor 119 is provided as shown, and secure enterprise mobile services application 125, service processor framework 139, and service processor kernel program 138, can be implemented in the access modem 129 as also shown.

In some embodiments, service processor framework program 139 (or service processor kernel program 138) interacts with network stack framework components 137 or network stack kernel components 135 to inspect traffic for service usage classification and service policy enforcement (e.g., access control policy enforcement, traffic control policy enforcement, service usage accounting, charging policy enforcement, or service notification policy enforcement) purposes. In some embodiments, one or more of network stack framework components 137 and network stack kernel components 135 provides classification information on one or more traffic flows to service processor framework program 139 (or service processor kernel program 138). In some embodiments, service processor framework program 139 (or service processor kernel program 138) seeks to match the classification information to one or more classification parameters contained in the service policy definitions in order to determine the service policy enforcement actions that may be required for a traffic flow. In some embodiments, a traffic flow is a flow of data packets. In some embodiments, a traffic flow is a flow of one or more data packets that are associated with a device application, the association of a traffic flow to a device application being identified by network stack framework components 137 or network stack kernel components 135 or service processor framework program 139 (or service processor kernel program 138). In some embodiments, the service usage classification determines that the traffic flow is associated with a combination of one or more of: a device application, a network destination, a traffic type, a content type, a QoS level, a roaming network, a home network.

In some embodiments, the association of traffic flow to a specific device application is used to determine a service policy enforcement action that is dependent on the specific device application. In some embodiments, a specific device application identifier (e.g., an application name, application signature, application hash or application certificate) forms an application credential that is used to index a service policy enforcement action that is intended to be implemented following a service usage activity or attempted service usage activity by the specific device application. In some embodiments, a specific device application is verified as consistent with an application credential in order to ensure that an application service policy enforcement action intended to be applied to the specific device application is applied to the correct application. In some embodiments, the

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verification that a specific application is consistent with an application credential associated with a service policy enforcement action is performed in service processor framework program 139 (or service processor kernel program 138) to ensure that ensure that an application service policy enforcement action intended to be applied to the specific device application is applied to the correct application. In some embodiments, the verification that a specific application is consistent with an application credential associated with a service policy enforcement action is performed in network stack framework components 137 or network stack kernel components 135, and service processor framework program 139 (or service processor kernel program 138) ascertains the application credential verification to ensure that ensure that an application service policy enforcement action intended to be applied to the specific device application is applied to the correct application.

In some embodiments, the association of traffic flow to a specific device application is used to determine a service policy enforcement action that is dependent on the specific device application, and service processor framework program 139 (or service processor kernel program 138) instructs network stack framework components 137 or network stack kernel components 135 to implement the service policy enforcement action on the traffic flow associated with the specific device application. In some embodiments, the association of traffic flow to a specific device application is used to determine a service policy enforcement action that is dependent on the specific device application, and service processor framework program 139 (or service processor kernel program 138) implements the service policy enforcement action. In some embodiments, a traffic flow is buffered pending classification (e.g., buffered in one or more of network stack framework components 137, network stack kernel components 135, service processor framework program 139, or service processor kernel program 138). In some embodiments, upon classification of the traffic flow (e.g., determination of an association of the traffic flow to a specific device application), a service policy enforcement action that is dependent on the specific device application is determined by service processor framework program 139 (or service processor kernel program 138) and implemented in one or more of network stack framework components 137, network stack kernel components 135, service processor framework program 139, and service processor kernel program 138. In some embodiments, the service policy enforcement action for the traffic flow is implemented in service processor framework program 139 (or service processor kernel program 138). In some embodiments, service processor framework program 139 (or service processor kernel program 138) instructs a device UI program that displays a device service notification (e.g., a service usage notification, a service plan offer notification, or an indication of a service usage event or attempted service usage event that requires a user notification) to implement the service policy enforcement action for the traffic flow. In some embodiments, service processor framework program 139 (or service processor kernel program 138) instructs a service usage monitor (e.g., accounting traffic to bulk classification or a more detailed classification of service usage) to implement the service policy enforcement action for the traffic flow.

In some embodiments, the network destination of a traffic flow is used to determine if a service policy enforcement action that is dependent on a specific network destination should be applied to the traffic flow. In some embodiments, a traffic flow is inspected by network stack framework components 137 or network stack kernel components 135,

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and one or more traffic characteristics (e.g., an address, a socket/flow tuple, a layer-7 packet information, or a packet header string) are passed to service processor framework program 139 (or service processor kernel program 138), wherein the one or more traffic characteristics are matched against one or more classification parameters contained in a service policy definition, and if a match is present then a service policy enforcement action is implemented for the traffic flow. In some embodiments, a traffic flow is inspected by service processor framework program 139 (or service processor kernel program 138), and one or more traffic characteristics (e.g., an address, a socket/flow tuple, a layer-7 packet information, or a packet header string) are matched against one or more classification parameters contained in a service policy definition, and if a match is present then a service policy enforcement action is implemented for the traffic flow. In some embodiments, the service policy enforcement action for the traffic flow is implemented in service processor framework program 139 (or service processor kernel program 138). In some embodiments, service processor framework program 139 (or service processor kernel program 138) instructs network stack framework components 137 or network stack kernel components 135 to implement the service policy enforcement action for the traffic flow. In some embodiments, the service policy enforcement action for the traffic flow is implemented by a device UI program that displays a device service notification (e.g., a service usage notification, a service plan offer notification, or an indication of a service usage event or attempted service usage event that requires a user notification). In some embodiments, the service policy enforcement action for the traffic flow is implemented by a service usage monitor (e.g., accounting traffic to bulk classification or a more detailed classification of service usage).

In some embodiments, an enterprise manager can define or select service plan policies that confine enterprise-sponsored access services to a pre-defined list of device applications. For example, an enterprise manager might choose to define or select a service plan wherein only corporate applications may be accessed (e.g., email, contacts, intranet services, text, and/or voice). In such embodiments, enterprise service design user interface 196 may be used by the enterprise manager to define or select the allowable applications that are to have access. In some embodiments, an enterprise access manager may define or select a different set of applications to be accessible when device 110 is roaming than when device 110 is on a home network or on a WiFi network. In some embodiments, an enterprise manager may define or select a set of applications that are to be not allowed access when a device is on a certain network (e.g., a roaming network). For example, many modern smart phone, tablet, and laptop operating systems have background services that have the potential to incur large roaming charges during roaming conditions (e.g., Google Android "gallery" functions that share device data with the Google network, Microsoft "system" functions that do the same, software update programs, etc.). In such cases, enterprise service design center 194 may be used to specify the device applications that are not allowed to access the network during certain network conditions.

In some embodiments, the identification and network access control for a device application is performed with a device software program or agent (e.g., service processor framework program 139 or service processor kernel program 138), and enterprise service design center 194 programs the device agent with the application identification parameters and associated access policies. In some embodi-

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ments, the device agent identifies the application using an application name, certificate, signature, or hash for an application running on the device and a policy instruction stored on the device.

In some embodiments, the identification and network access control for a device application is performed with one or more network access policy enforcement elements (e.g., carrier gateway/home agent 152, carrier usage accounting server 154, enterprise firewall/security gateway 171), and enterprise service design center 194 causes the one or more network access policy enforcement elements to be provisioned with the application identification parameters and associated access policies. In some embodiments, the one or more network access policy enforcement elements identify an application by observing the traffic headers inserted by the application. In some embodiments, the one or more network access policy enforcement elements identify an application by observing the network destinations or destination patterns accessed by the application. In some embodiments, the one or more network access policy enforcement elements identify an application by routing or tunneling the application traffic to one or more network gateways or servers associated with the application (e.g., APN routes, dedicated application addressing, or a device agent that steers the application traffic to a server). In some embodiments, the device assists in this routing or tunneling with a device agent that is programmed to route or re-direct the traffic for an application.

In some embodiments, an enterprise manager can define or select service plan policies that confine enterprise-sponsored access services to a pre-defined list of network destinations, servers, or resources. For example, an enterprise manager might choose to define or select a service plan wherein only corporate network destinations may be accessed (e.g., email server, contacts server, intranet servers, text service servers, and VOIP servers). In some embodiments, enterprise service design center interface 196 may be used by an enterprise manager to define or select the allowable network destinations that device 110 may access. In some embodiments, the enterprise access manager may define or select a different set of network destinations when device 110 is roaming than when device 110 is on a home network or on a WiFi network. In some embodiments, an enterprise manager may define or select a set of network destinations that device 110 cannot access when device 110 is on a certain network (e.g., a roaming network). For example, many websites and enterprise services exhibit network access service usage behavior that can incur large roaming charges during roaming conditions (e.g., software update websites or servers, contact database synchronization websites, email download synchronization websites, video conference websites, etc.). In such cases, enterprise service design center 194 may be used to specify the device applications, services, and/or websites that are not to be accessed or used during certain network connection conditions.

In some embodiments, a device agent identifies the network destination and applies the appropriate access policy by comparing traffic characteristics with pre-defined characteristics in the access policy instructions provisioned on device 110, and then applies the corresponding traffic control rule, and enterprise service design center 194 performs the provisioning of the device agent. In some embodiments, the identification and network access control for a network destination is performed with one or more network access policy enforcement elements (e.g., carrier gateway/home agent 152, carrier usage accounting server 154, enterprise

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firewall/security gateway 171) and enterprise service design center 194 performs the provisioning of the one or more network elements.

In some embodiments, enterprise service design center 194 is configured to receive or accept a specification for an access network service usage limit (e.g., a service amount in minutes, bytes, or cost) for a service usage activity (such as a data service, a voice service, a text service, a roaming service, or a more detailed classification of data service such as one or more websites or one or more device applications), and the service usage limit is applied to one or more devices 110 or device groups (or users or user groups) managed by enterprise service design center 194. In some embodiments, enterprise service design center 194 is further configured to receive service usage records for device 110, which is managed by enterprise service design center 194, from a device-based element that monitors and reports device 110 service usage (e.g., one or more device usage monitors 119, device service processor framework program 139, or service processor kernel program 138, network stack 134, or access modem 151), and when the usage limit is reached a service usage notification message is generated. In some embodiments, enterprise service design center 194 is configured to deliver the service usage notification message to enterprise service design center UI 196. In some embodiments, enterprise service design center 194 is configured to deliver the service usage notification message to a device 110 software application (e.g., service processor framework program 139 or user data app 111) for presentation to the device user via a user interface.

In some embodiments, enterprise service design center 194 is configured to receive or accept a specification for an access network service usage limit (e.g., a service amount in minutes, bytes, or cost) for a service usage activity (such as a data service, a voice service, a text service, a roaming service, or a more detailed classification of data service such as one or more websites or one or more device applications), and the service usage limit is applied to one or more devices 110 or device groups (or users or user groups) managed by enterprise service design center 194. In some embodiments, enterprise service design center 194 is further configured to receive service usage records for device 110, which is managed by the enterprise service design center 194, from a device-based element configured to monitor and report device 110 service usage (e.g., one or more device usage monitors 119, device service processor framework program 139 or service processor kernel program 138, network stack 134, or access modem 151), and when the usage limit is reached a restriction or limitation on further usage is applied by the service design center by provisioning one or more network elements responsible for enforcing network access policy (e.g., carrier gateway/home agent 152, carrier usage accounting server 154, enterprise firewall/security gateway 171). In some embodiments, enterprise service design center 194 is configured to send the user a notification message or a message to contact an enterprise manager.

In some embodiments, secure network interface 128 on device 110 is configured with a VPN device client function to securely communicate between one or more approved enterprise applications (e.g., enterprise data app 124, enterprise voice app 126, secure enterprise mobile services app 125) and a counterpart VPN function that secures access to enterprise network 170 (e.g., enterprise firewall/security gateway 171 or server secure network interface 127). In some embodiments, a device software application or agent (e.g., service processor framework program 139 or service processor kernel program 138, secure network interface 128,

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secure hardware partition manager 108) is configured to identify network access activity associated with individual applications and allow network access to one or more approved enterprise applications when a VPN device client function is in operation, or not allow network access to one or more approved enterprise applications when a VPN device client function is not in operation. In some embodiments, service design center 190 or enterprise service design center 194 is configured to provision a device 110 software application or agent (e.g., service processor framework program 139 or service processor kernel program 138, secure network interface 128, secure hardware partition manager 108) with application access policy rules to identify network access activity associated with individual applications and allow network access to one or more approved enterprise applications when a VPN device client function is in operation, or not allow network access to one or more approved enterprise applications when a VPN device client function is not in operation. In this manner, enterprise applications that might be subject to spoofing by network elements, websites, servers, or programs operating outside the secure enterprise environment are not placed in communication with such network elements.

In some embodiments, a device software application or agent (e.g., service processor framework program 139 or service processor kernel program 138, secure network interface 128, secure hardware partition manager 108) is configured to identify network access activity associated with individual applications and not allow network access to one or more non-approved applications when a VPN device client function is in operation, or allow network access to one or more non-approved applications when a VPN device client function is not in operation. In some embodiments, service design center 190 or enterprise service design center 194 is configured to provision a device 110 software application or agent (e.g., service processor framework program 139 or service processor kernel program 138, secure network interface 128, secure hardware partition manager 108) with application access policy rules to identify network access activity associated with individual applications and not allow network access to one or more non-approved applications when a VPN device client function is in operation, or allow network access to one or more enterprise applications when a VPN device client function is not in operation. In this manner, applications that might maliciously access enterprise network resources when the VPN is running are not permitted to do so.

In some embodiments, the application access policy rules are enforced by allowing or not allowing an application to access the network. In some embodiments, the application access policy rules are enforced by allowing or not allowing the application to run. In some embodiments, the identification of approved enterprise applications associated with traffic flows is confirmed or secured by identifying the application certificate and comparing it to an application signature or hash on the device. In some embodiments, the identity of an approved enterprise application is confirmed by inspecting an application certificate, signature or hash that is provided by service design center 190 or enterprise service design center 194.

In some embodiments, secure network interface 128 is configured with a split-tunnel VPN device client function, wherein an enterprise side of the split tunnel is configured to securely communicate between one or more enterprise applications (e.g., enterprise data app 124, enterprise voice app 126, secure enterprise mobile services app 125) and a counterpart VPN function that secures access to the enter-

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prise network **170** (e.g., enterprise firewall/security gateway **171** or server secure network interface **127**), and a consumer side of the split tunnel is configured to communicate without encryption for access network services provided to consumer applications on the device. In some embodiments, a device software application or agent (e.g. service processor framework program **139** or service processor kernel program **138**, secure network interface **128**, secure hardware partition manager **108**) is configured to identify network access activity associated with individual applications and route or direct traffic associated with one or more enterprise applications to the enterprise side of the split VPN tunnel, and route or direct traffic associated with one or more consumer applications to the consumer side of the VPN tunnel. In some embodiments, service design center **190** or enterprise service design center **194** is configured to provision a device **110** software application or agent (e.g., service processor framework program **139** or service processor kernel program **138**, secure network interface **128**, secure hardware partition manager **108**) with application access policy rules to identify network access activity associated with individual applications and specify which applications are to be routed or directed to the enterprise side of the VPN tunnel and which applications are to be routed or directed to the consumer side of the VPN tunnel. In some embodiments, the identification of applications associated with traffic flows is secured by identifying the application certificate and comparing it to an application signature or hash on the device. In some embodiments, the application certificate, signature or hash is provided by service design center **190** or enterprise service design center **194**.

In some embodiments, the policy rules only enable secure applications on device **110** to access enterprise data. In some embodiments, an enterprise manager sets policy rules that do not allow secure applications on device **110** to upload data to unsecure destinations.

In some embodiments, service design center **190** is configured to provide enterprise service design center **194**. In some embodiments, enterprise service design center **194** comprises a policy management system configured to select a set of access network policies to be enforced for one or more device groups (or user groups) where the set of access network policies consists of a subset of the full set of access network policies capable of being enforced by the access network policy enforcement elements. In some embodiments, the subset of the full set of policies capable of being enforced by the access network policy enforcement elements comprises a pre-defined subset of the policy configuration capabilities. In some embodiments, the enterprise service design center policy management subset limitations for enterprise service design center **194** provide the ability to define and manage one or more of the policies that define a service policy set or service plan that is applied to a given device, user, device group or user group. In some embodiments, the enterprise service design center policy management subset limitations for enterprise service design center **194** can provide the ability to enroll a device, user, device group or user group in a set limited to one or more pre-defined service policy configurations or service plans.

As an example embodiment, the enterprise service design center policy management subset limitations for enterprise service design center **194** may provide the following policy definition and management capabilities for a device (or user) or device group (or user group): specify service usage limits (caps) for bulk access service or for a specific classification of access service activities, require all traffic or certain traffic associated with enterprise-critical applications or content to

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be communicated via an enterprise VPN, define controls for which applications that can access the network or certain defined destinations on the network, specify network destinations that are allowed or not allowed, specify roaming service limitations, specify WiFi networks that are allowed or not allowed, specify security settings in the device access control or I/O access control ports, specify service usage notification triggers and notification content associated with the triggers (e.g., warnings when a specified service usage activity occurs, access is not allowed for a given attempted service usage activity, or service usage reaches a limit), and other such examples that are allowed to be managed under the policy management subset limitations. In some embodiments, the charging rates for such services may not be allowed to be managed under the policy management subset limitations.

In some embodiments, enterprise service design center **194** has an allowable subset of the full set of policies capable of being enforced by the access network policy enforcement elements that comprises a pre-defined set of one or more access network policy configurations (e.g., service plans). As an example embodiment, the set of pre-configured service plans may be defined for a certain implementation of enterprise service design center **194** comprising multiple pre-defined service plans, each of which provides variations in one or more of service notification policy, access control policy, service classification policy, service QoS policy, or service charging policy.

In some embodiments, enterprise service design center **194** is configured to allow a service design administrator to select one or more pre-configured access network policy configurations (or service plans) to be applied to a device, a user, a device group or a user group.

In some embodiments, enterprise service design center **194** comprises a device enrollment management system configured to enroll a device credential into a device group (or a user credential into a user group), where the set of device credentials (or user credentials) that enterprise service design center **194** is capable of managing is a subset of the device credentials (or user credentials) allowed on the access network. In some embodiments, the subset of device credentials (or user credentials) that are subject to management by enterprise service design center **194** is defined using service design center **190**.

As an example embodiment, the set of pre-defined service plans that are made available to a first enterprise service design center **194** implementation managed by a first enterprise entity might consist of three service plans, wherein the first service plan comprises network policies (e.g., access policies, charging policies, or notification policies) that provide for limited or restricted home network access service but do not provide for roaming access services, the second service plan comprises network policies that provide for unlimited or unrestricted home network access service and also provide for limited roaming access services, and the third service plan comprises network policies that provide for unlimited or unrestricted home network access service and also provide for unlimited or unrestricted roaming access services. In another example embodiment, on the same carrier access network as the previous example, a second enterprise service design center **194** implementation managed by a second enterprise entity might consist of two service plans, wherein the two service plans might be the same as two of the service plans from the previous example embodiment, or they might be completely different.

Given these examples, it will now be understood and appreciated by one of ordinary skill in the art that enterprise

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service design center 194 provides a convenient means of designing and distributing custom service plans to different enterprise entities that meet the needs of each enterprise entity, wherein the various policy definition capabilities disclosed herein can be used in a large number of combinations to create the service plans, with the number of combinations of service plan design capabilities being too numerous to list here. It will also now be understood and appreciated by one of ordinary skill in the art that each enterprise can effectively manage its devices (or users) and device groups (or user groups) to provide the appropriate level of policy control needed by the enterprise in a simplified manner, without the need to manage all the full policy capabilities of the access network.

For example, the embodiments of service design center 190 and enterprise service design center 194 disclosed herein support a carrier network business process wherein a carrier network manager utilizes service design center 190 to create a set of access network policies that consist of a subset of the full set of access network policies capable of being enforced by the access network policy enforcement elements (referred to as specialized enterprise service plans), and the specialized enterprise service plans are designed and offered to meet the special needs of one or more enterprise entities. In some embodiments, an enterprise manager uses enterprise service design center 194 to apply the one or more specialized enterprise service plans to one or more devices (or users) or device groups (or user groups) that belong to the enterprise entity's mobile device inventory (or employee list). The different needs of various employee groups (or device types) can be among the factors that determine which service plan is assigned to a given user group (or device group). The specific needs of an employee can assist in determining which user group (or device group) the employee should be assigned to. The carrier manager can also create other specialized enterprise service plans for other enterprise entities to meet varied needs among enterprise market customers.

In some embodiments, an enterprise manager controls access network usage, costs, and access limits for an employee user group (e.g., a group of devices that could be as small as a single device or as large as all devices under the enterprise manager's control). In some embodiments, the enterprise manager establishes at least two user groups and establishes and manages different network-access policies for different employee user groups. For example, the enterprise manager may set and manage different policies for data usage on WiFi, 3G, 4G, or other networks for different employee user groups. Likewise, the enterprise manager may set different roaming privileges for different employee user groups.

In some embodiments, an enterprise manager sets expenditure ceilings by limiting allowed data usage for secure business applications to enforce security rules. In some embodiments, an enterprise manager tracks enterprise data access to improve compliance records. For example, the enterprise manager can track enterprise data usage by employee, device, application, location, network, or time of day.

Process Flows for Providing Enterprise and Consumer Billing Allocation for Wireless Communication Device Service Usage Activities

FIG. 27 illustrates a flow diagram for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments. At 402, the process begins. At 404, a service usage activity of a wireless communication device (e.g.,

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application based service usage that uses a wireless network in which the wireless communication device has an associated service plan) is performed. In some embodiments, the monitoring is performed on the wireless communication device. In some embodiments, the monitoring is performed by a network element, such as a secure application server for monitoring enterprise applications, as described herein with respect to various embodiments. At 406, an enterprise/consumer allocation is determined. In some embodiments, the monitored service usage activity is reported to a network element that determines the enterprise/consumer allocation based on the associated service plan that includes a defined enterprise/consumer allocation based on various factors, such as can be performed by a carrier billing server as described herein with respect to various embodiments. At 408, an associated consumer account is billed for the consumer service usage. At 410, the consumer account is credited for the enterprise service usage. At 412, the process is completed.

FIG. 28 illustrates another flow diagram for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments. At 502, the process begins. At 504, a service usage activity of a wireless communication device (e.g., application based service usage that uses a wireless network in which the wireless communication device has an associated service plan) is performed. At 506, an enterprise/consumer allocation is determined. At 508, an associated enterprise account is billed for the enterprise service usage. At 510, the enterprise account is credited for the consumer service usage. At 512, the process is completed.

FIG. 29 illustrates another flow diagram for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments. At 602, the process begins. At 604, a service usage activity of a wireless communication device (e.g., application based service usage that uses a wireless network in which the wireless communication device has an associated service plan) is performed. At 606, an enterprise/consumer allocation is determined. At 608, the enterprise service usage is reported. At 610, an expense reimbursement for the enterprise service usage is generated (e.g., by the enterprise for the consumer, who is, for example, an employee of the enterprise). At 612, the process is completed.

FIG. 30 illustrates another flow diagram for providing enterprise and consumer billing allocation for wireless communication device service usage activities in accordance with some embodiments. At 702, the process begins. At 704, a service usage activity of a wireless communication device (e.g., application based service usage that uses a wireless network in which the wireless communication device has an associated service plan) is performed. At 706, the monitored service usage is reported. At 708, an enterprise/consumer allocation is determined. At 710, a bill/charge based on the enterprise/consumer allocation is generated. At 712, the process is completed.

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. In particular, many of the embodiments are not limited to supporting an enterprise/consumer split. As would be appreciated by one of ordinary skill in the art, the disclosed embodiments may be applied, for example, when a sponsor entity subsidizes a cost associated with an end-

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user device's use of a sponsored (or ambient) data service or application, and the user pays for the end-user device's use of non-sponsored (or non-ambient) data services or applications. The sponsor entity may use enterprise service design center 194 to configure devices that may use the sponsored service, policies applicable to the sponsored service, etc. Moreover, the disclosed embodiments may be applied when a first sponsor subsidizes a cost associated with an end-user device's use of a first sponsored data service or application, a second sponsor subsidizes a cost associated with the end-user device's use of a second sponsored data service or application, and the user pays for the end-user device's use of non-sponsored data services or applications. The sponsor entities may use one or more enterprise service design centers to configure aspects of the sponsored services. As would be appreciated by one of ordinary skill in the art, there are many other environments in which the disclosed embodiments are useful or applicable.

Several advantageous combination embodiments are now disclosed for allocating enterprise service usage accounting and personal service usage accounting. These combinations are for example purposes, are not meant to be exhaustive or limiting in any way; as will be apparent to one of ordinary skill in the art, these combinations represent only a fraction of the embodiments provided herein.

In some embodiments, a network system for classifying the accounting of access network service usage for an end user device comprises (i) a first service design center configured to receive an accounting split classification policy defining the classification rules for dividing an overall access network service usage into an enterprise service usage allocation and a personal service usage allocation, (ii) a network provisioning instruction translator configured to receive the accounting split classification policy and translate it to a set of network service usage classification and reporting instructions for one or more network elements responsible for classifying service usage, (iii) a network provisioning system for communicating the set of network service usage classification and reporting instructions to the one or more network elements responsible for classifying service usage, (iv) the one or more network elements responsible for classifying service usage configured to classify service usage to determine the enterprise service usage allocation and the personal service usage allocation, and generate service usage reports, and (v) a service usage accounting system that receives the service usage reports and (a) accrues the enterprise service usage allocation, and (b) accrues the personal service usage allocation.

In some embodiments, the network system for classifying the accounting of access network service usage for an end user device can be augmented wherein the first network access notification message policy is associated with a first device group defined by a first list of device credentials or a first user group defined by a first list of user credentials, and the service design center is further configured to obtain a second network access notification message policy comprising a plurality of second network access trigger conditions and, for each of the plurality of second network access trigger conditions, an associated second network access notification message, the second network access notification message policy associated with a second device group defined by a second list of device credentials or a second user group defined by a second list of user credentials.

In some embodiments, the network system for classifying the accounting of access network service usage for an end user device further comprises a master service design center

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configured to define a first notification policy design capability set for the first service design center, the first notification policy design capability set comprising a first subset of a master policy capability set. This embodiment can be further augmented wherein the master service design center is further configured to define a second notification policy design capability set for a second service design center, the second notification policy design capability set comprising a second subset of the master policy capability set, the second subset of the master policy capability set either identical to or different from the first subset of the master policy capability set.

In some embodiments, the network system for classifying the accounting of access network service usage for an end user device is further augmented wherein the first service design center is hosted on an operator network. In some embodiments, the network system for classifying the accounting of access network service usage for an end user device is optimized for smaller enterprise data center deployments wherein the first service design center is hosted on an enterprise business network.

In some embodiments, the network system for classifying the accounting of access network service usage for an end user device can be augmented wherein the enterprise service usage allocation comprises a classification of service usage that specifies one or more enterprise device software applications. In some embodiments, the enterprise applications can be one or more of email, calendar, contacts, enterprise intranet (e.g., a secure intranet browser with a secure SSL connection or other secure connection to enterprise services), mobile device synchronization or mobile enterprise communications.

In some embodiments, the network system for classifying the accounting of access network service usage for an end user device can be augmented wherein the enterprise service usage allocation comprises a classification of service usage that specifies one or more enterprise network destinations.

In some embodiments, the network system for classifying the accounting of access network service usage for an end user device can be augmented wherein the enterprise service usage allocation comprises a classification of service usage that specifies one or more enterprise network destinations and the one or more enterprise network destinations comprise an address or identifier for a secure enterprise gateway. In some embodiments, the enterprise gateway comprises a VPN server.

In some embodiments, the network system for classifying the accounting of access network service usage for an end user device can be augmented wherein the enterprise service usage allocation comprises a classification of service usage that specifies one or more enterprise network destinations and the one or more enterprise network destinations comprise an address or identifier for one or more secure enterprise mobile services gateways or servers comprising one or more of an email server, a calendar server, a contacts server, an enterprise intranet access server, a mobile device synchronization services server or a mobile enterprise communication server.

In some embodiments, the network system for classifying the accounting of access network service usage for an end user device can be augmented wherein the one or more network elements responsible for classifying service usage and generating service usage reports comprises a service usage monitor located in a wireless operator network.

In some embodiments, the network system for classifying the accounting of access network service usage for an end user device can be augmented wherein the one or more

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network elements responsible for classifying service usage and generating service usage reports comprises a service usage monitor located in an enterprise access network.

In some embodiments, the network system for classifying the accounting of access network service usage for an end user device can be augmented wherein the one or more network elements responsible for classifying service usage and generating service usage reports comprises a service usage monitor located on a wireless device.

In some embodiments, the network system for classifying the accounting of access network service usage for an end user device can be augmented wherein the service usage accounting system is located in an enterprise network.

In some embodiments, the network system for classifying the accounting of access network service usage for an end user device can be augmented wherein the service usage accounting system is managed by an enterprise manager under the control of the entity that manages an enterprise business.

In some embodiments, the network system for classifying the accounting of access network service usage for an end user device can be augmented wherein the service usage accounting system is located in an operator network.

In some embodiments, the network system for classifying the accounting of access network service usage for an end user device can be augmented wherein the service usage accounting system is managed by an operator manager under the control of the entity that manages a network operator.

In some embodiments, the network system for classifying the accounting of access network service usage for an end user device can be augmented wherein the service usage accounting system is further configured to credit a user account with a service usage credit or monetary credit associated with the accrued enterprise service usage allocation.

In some embodiments, the network system for classifying the accounting of access network service usage for an end user device can be augmented wherein the service usage accounting system is further configured to debit a user account with a service usage debit or monetary cost associated with the accrued personal service usage allocation.

In some embodiments, the network system for classifying the accounting of access network service usage for an end user device can be augmented wherein the service usage accounting system is further configured to credit an enterprise account with a service usage credit or monetary credit associated with the accrued personal service usage allocation.

In some embodiments, the network system for classifying the accounting of access network service usage for an end user device can be augmented wherein the service usage accounting system is further configured to debit an enterprise account with a service usage debit or monetary cost associated with the accrued enterprise service usage allocation.

In some embodiments, the network system for classifying the accounting of access network service usage for an end user device can be augmented by further configuring the service design center to: (i) receive a personal service plan offer comprising one or more service plans for personal network access services accounted to the personal service usage allocation, (ii) configure a device user interface service plan offer notification message, (iii) communicate the device user interface service plan offer notification message to one or more device groups comprising a collection of devices identified by device credentials, (iv) receive a ser-

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vice plan selection option from an end user device user in response to the device user interface service plan offer notification message, and (v) cause one or more network elements responsible for activating service plans to activate the service plan selection chosen by the end user device user.

In some embodiments the end-user device system in communication with the network system for classifying the accounting of access network service usage comprises: (i) a device software application environment comprising: (a) an enterprise application execution environment configured with: (1) an enterprise application execution memory and data memory to support secure execution of enterprise software applications, the enterprise software applications comprising applications approved to execute in the secure execution environment and to communicate with secure enterprise services, (2) a secure enterprise communication link configured to provide communication between the enterprise software applications and enterprise network services, the enterprise network services comprising enterprise network resources and servers, (b) a personal application execution environment configured with execution memory and data memory to support execution of personal software applications not approved to execute in the secure execution environment, (ii) a personal service plan selection user interface comprising a notification software agent configured to receive personal service plan offer from a network element and display the service plan offers, the personal service plan offer comprising one or more service plans for personal network access services accounted to a personal service usage allocation, and receive a service plan selection option from an end user device user and forward the service plan selection option to a network element.

In some embodiments, the end-user device system can be augmented wherein the secure enterprise communication link comprises a VPN client in communication with an enterprise VPN gateway.

In some embodiments, the end-user device system can be augmented wherein the enterprise network services comprise access to one or more secure enterprise mobile services gateways or servers comprising one or more of an email server, a calendar server, a contacts server, an enterprise intranet access server, a mobile device synchronization services server or a mobile enterprise communication server.

In some embodiments, the end-user device system can be augmented wherein the enterprise application execution environment is further configured to: (i) acquire a device software application signature prior to allowing execution of the device software application in the virtual machine operating environment, (ii) compare the signature to an approved list of signatures, (iii) allow the application to execute if it is on the list, and (iv) not allow the application to execute if it is not on the list.

In some embodiments, the end-user device system can be augmented wherein enterprise application execution environment comprises a virtual machine operating environment.

In some embodiments, the end-user device system can be augmented wherein enterprise application execution environment comprises a secure CPU hardware execution partition.

In some embodiments, the end-user device system can be augmented wherein enterprise application execution environment comprises a secure operating system execution partition.

In some embodiments, the end-user device system can be augmented wherein enterprise application execution environment comprises a secure memory area protected by an

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enterprise application software program that encrypts the enterprise data stored on device memory and runs a secure encrypted communication protocol for communication with a secure mobile enterprise services gateway server.

Several advantageous combination embodiments are now disclosed for providing enterprise control of network access service to an end user device. These combinations are for example purposes, are not meant to be exhaustive or limiting in any way; as would be appreciated by one of ordinary skill in the art, these combinations represent only a fraction of the advantageous embodiment combinations provided herein.

In some embodiments, a network system for providing network access service control for an end user device comprising: (i) a first service design center configured to receive from an administrator user or a configuration file a first network access policy comprising a first set of network access service permissions associated with an end user device or end user device user, (ii) a network provisioning instruction translator configured to receive the first network access policy and translate it to a set of network access policy enforcement instructions for one or more network elements responsible for controlling network access, (iii) a network provisioning system for communicating the set of network access policy enforcement instructions to the one or more network elements responsible for controlling network access, (iv) the one or more network elements responsible for controlling network access configured to execute the set of network access policy enforcement instructions to enforce network access service permissions and limits.

In some embodiments, the network system for providing network access service control can be augmented wherein the first network access policy is associated with a first device group defined by a first list of device credentials or a first user group defined by a first list of user credentials, and the service design center is further configured to obtain a second network access policy comprising a second set of network access service permissions and, the second network access policy associated with a second device group defined by a second list of device credentials or a second user group defined by a second list of user credentials.

In some embodiments, the network system for classifying the accounting of access network service usage for an end user device further comprises a master service design center configured to define a first network access policy design capability set for the first service design center, the first network access policy design capability set comprising a first subset of a master policy capability set. This embodiment can be further augmented wherein the master service design center is further configured to define a second network access policy design capability set for a second service design center, the second network access policy design capability set comprising a second subset of the master policy capability set, the second subset of the master policy capability set either identical to or different from the first subset of the master policy capability set.

In some embodiments, the network system for providing network access service control can be augmented wherein the first network access policy defines a set of one or more service usage limits or service cost limits.

In some embodiments, the network system for providing network access service control can be augmented wherein the first network access policy defines a set of one or more roaming network service usage limits or service cost limits.

In some embodiments, the network system for providing network access service control can be augmented wherein the first network access policy defines a set of one or more network type restrictions, wherein a network type comprises

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one or more of a cellular network, a 2G network, a 3G network, a 4G network, a WiFi network, a particular WiFi network APN, roaming cellular network, a particular cellular operator network.

In some embodiments, the network system for providing network access service control can be augmented wherein the first network access policy defines a set of one or more device application software network access restrictions.

In some embodiments, the network system for providing network access service control can be augmented wherein the first network access policy defines a set of one or more network destination access restrictions.

In some embodiments, the network system for providing network access service control can be augmented wherein the first network access policy defines a set of one or more enterprise network destination allowances or restrictions.

In some embodiments, the network system for providing network access service control can be augmented wherein the first network access policy defines a set of one or more enterprise network destination allowances or restrictions communicated over a secure VPN communication link.

In some embodiments, the network system for providing network access service control can be augmented wherein the first network access policy defines a set of one or more application or network destination allowances or restrictions communicated over a non-secure communication link.

In some embodiments, the network system for providing network access service control can be augmented wherein the first network access policy defines a set of one or more personal application or network destination allowances or restrictions.

In some embodiments, the network system for providing network access service control can be augmented wherein the first network access policy defines a set of one or more geographic location allowances or restrictions.

In some embodiments, the network system for providing network access service control can be augmented wherein the one or more network elements responsible for controlling network access comprises a service usage monitor located in a wireless operator network.

In some embodiments, the network system for providing network access service control can be augmented wherein the one or more network elements responsible for controlling network access comprises a service usage monitor located in an enterprise access network. In some embodiments, the one or more network elements responsible for controlling network access comprises a service usage monitor located in an enterprise access network comprise a VPN gateway wherein all device traffic is communicated from the device to the VPN gateway configured to control the device traffic. In some embodiments, the VPN gateway performs service usage classification to identify and control enterprise traffic. In some embodiments, the VPN gateway performs service usage classification to identify and control personal traffic.

In some embodiments, the network system for providing network access service control can be augmented wherein the one or more network elements responsible for controlling network access comprises a service usage monitor located on a wireless device.

INCORPORATION BY REFERENCE

The following U.S. applications are hereby incorporated by reference for all purposes: application Ser. No. 13/248,028, filed Sep. 28, 2011, entitled ENTERPRISE ACCESS CONTROL AND ACCOUNTING ALLOCATION FOR

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ACCESS NETWORKS; application Ser. No. 12/380,780, entitled AUTOMATED DEVICE PROVISIONING AND ACTIVATION, filed Mar. 2, 2009; application Ser. No. 12/380,778, filed Mar. 2, 2009, entitled VERIFIABLE DEVICE ASSISTED SERVICE USAGE BILLING WITH INTEGRATED ACCOUNTING, MEDIATION ACCOUNTING, AND MULTI-ACCOUNT; Provisional Application No. 61/206,354, entitled SERVICES POLICY COMMUNICATION SYSTEM AND METHOD, filed Jan. 28, 2009; Provisional Application No. 61/206,944, entitled SERVICES POLICY COMMUNICATION SYSTEM AND METHOD, filed Feb. 4, 2009; Provisional Application No. 61/207,393, entitled SERVICES POLICY COMMUNICATION SYSTEM AND METHOD filed Feb. 10, 2009; Provisional Application No. 61/207,739, entitled SERVICES POLICY COMMUNICATION SYSTEM AND METHOD filed Feb. 13, 2009; and Provisional Application No. 61/387,243, entitled ENTERPRISE AND CONSUMER BILLING ALLOCATION FOR WIRELESS COMMUNICATION DEVICE SERVICE USAGE ACTIVITIES filed Sep. 28, 2010.

The invention claimed is:

1. A method of operating a wireless end-user device, the method comprising:
 - providing first access policy information indicative of an execution environment policy;
 - providing second access policy information indicative of a security policy;
 - based on the first access policy information indicative of the execution environment policy:
 - requiring a first set of device application instances to run in a secure application environment on the wireless end-user device, and to not run outside of the secure application environment;
 - based on the second access policy information indicative of the security policy:
 - establishing a first secure tunnel to a network tunnel endpoint; and
 - directing all network data communications to and from the first set of device application instances, which are running only in the secure application environment, through the first secure tunnel.
2. The method of claim 1, wherein the security policy defines a first configuration indicating that a second set of device application instances are not allowed to use the first secure tunnel.

3. The method of claim 2, wherein the first set of device application instances are used on behalf of an enterprise and the second set of device application instances are personal to a user of the wireless end-user device.

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4. The method of claim 3, further comprising: associating the first set of device application instances with the enterprise.
5. The method of claim 3, further comprising: associating the second set of device application instances as being personal to the user.
6. The method of claim 1, wherein the first secure tunnel forms a portion of a virtual private network, VPN.
7. A wireless end-user device comprising:
 - a processor configured to:
 - provide first access policy information indicative of an execution environment policy;
 - provide second access policy information indicative of a security policy;
 - based on the first access policy information indicative of the execution environment policy:
 - require a first set of device application instances to run in a secure application environment on the wireless end-user device, and to not run outside of the secure application environment;
 - based on the second access policy information indicative of the security policy:
 - establish a first secure tunnel to a network tunnel endpoint; and
 - direct all network data communications to and from the first set of device application instances, which are running only in the secure application environment, through the first secure tunnel.
8. The wireless end-user device of claim 7, wherein the security policy defines a first configuration indicating that a second set of device application instances are not allowed to use the first secure tunnel.
9. The wireless end-user device of claim 8, wherein the first set of device application instances are used on behalf of an enterprise and the second set of device application instances are personal to a user of the wireless end-user device.
10. The wireless end-user device of claim 9, wherein the processor is further configured to:
 - associate the first set of device application instances with the enterprise.
11. The wireless end-user device of claim 9, wherein the processor is further configured to:
 - associate the second set of device application instances as being personal to the user.
12. The wireless end-user device of claim 7, wherein the first secure tunnel forms a portion of a virtual private network, VPN.

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