US007653414B2

(12) **United States Patent**
Pan

(10) **Patent No.: US 7,653,414 B2**
(45) **Date of Patent: Jan. 26, 2010**

(54) **SYSTEM, METHOD, AND DEVICE FOR PROVIDING COMMUNICATIONS USING A DISTRIBUTED MOBILE ARCHITECTURE**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 605 days.

(21) Appl. No.: **11/362,395**

(22) Filed: **Feb. 24, 2006**

(65) **Prior Publication Data**

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(51) **Int. Cl.**
H04M 1/00 (2006.01)

(52) **U.S. Cl.** **455/560**; 455/561; 455/445

(58) **Field of Classification Search** 455/428, 455/445, 560–561
See application file for complete search history.

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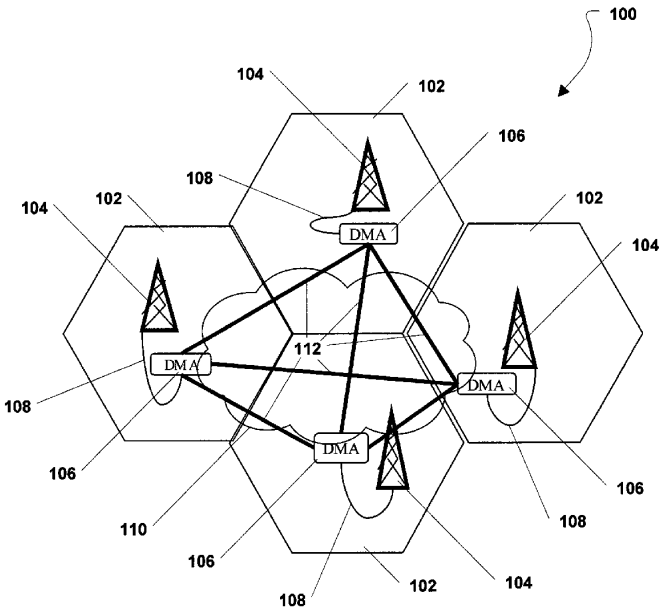
Assistant Examiner—Vladimir Magloire
(74) *Attorney, Agent, or Firm*—Toler Law Group

(57) **ABSTRACT**

An authentication, authorization, and accounting module of a first distributed mobile architecture system is disclosed and includes a destination preference register. The destination preference register includes a preferred call path for calls to be routed outside of a distributed mobile architecture network that is accessible to the first distributed mobile architecture system. The preferred call path can be selected from a group comprising a voice over Internet protocol (VoIP) call path, a mobile switching center (MSC) call path, and an integrated services digital network (ISDN) call path. Further, calls that are placed outside of the distributed mobile architecture network from the first distributed mobile architecture system can be established via the preferred call path. Additionally, calls that are routed outside of the distributed mobile architecture network from a mobile subscriber in communication with the first distributed mobile architecture system can be established via the preferred call path.

21 Claims, 24 Drawing Sheets



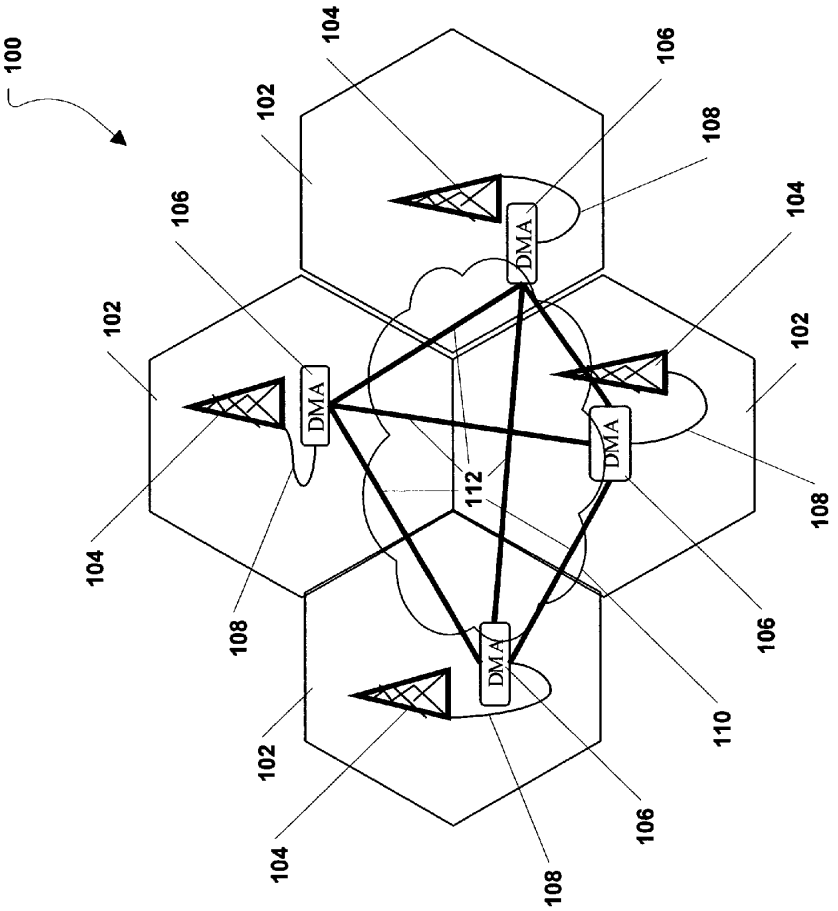


FIG. 1

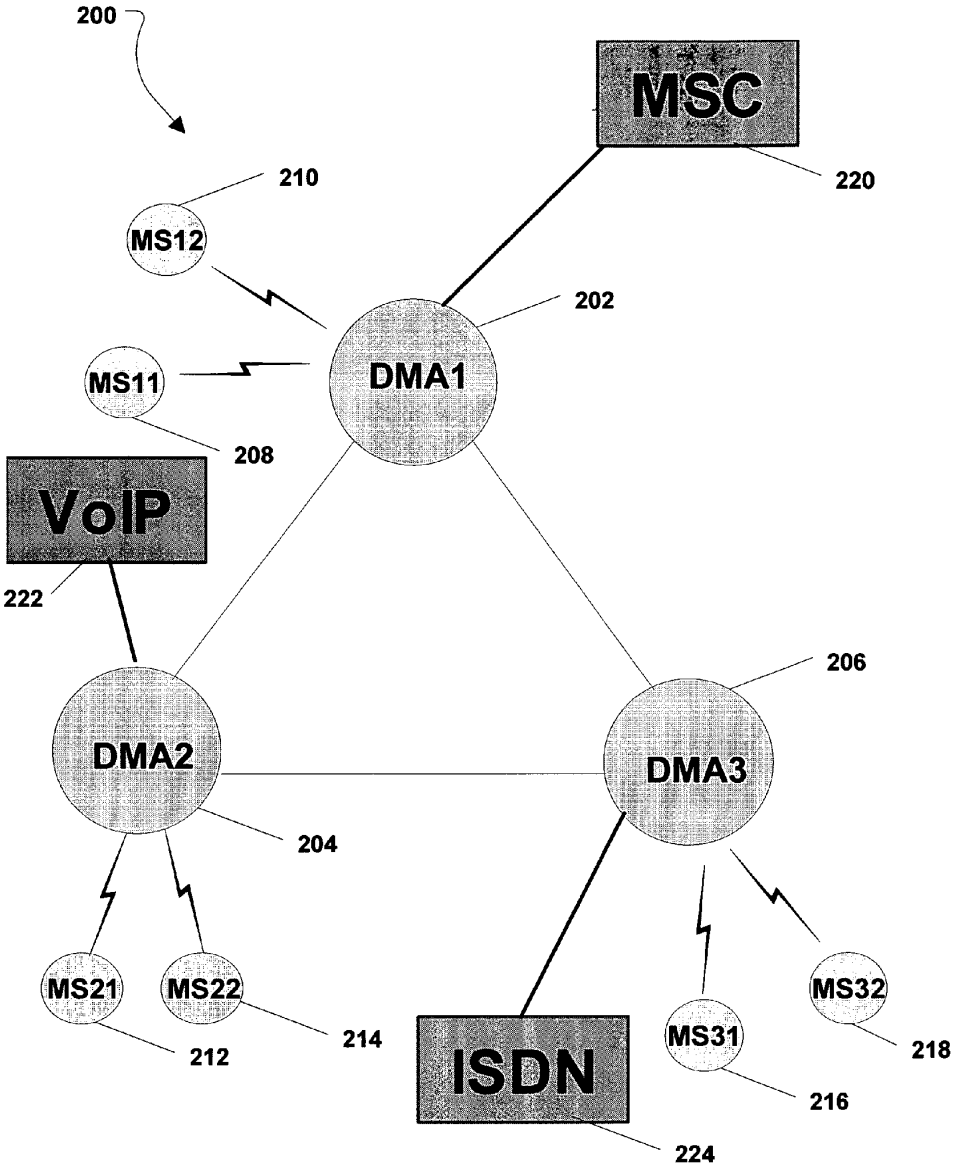

200
MSC
220
210
MS12
202
DMA1
MS11
208
VoIP
222
206
DMA2
DMA3
204
MS21
MS22
214
212
ISDN
MS31
MS32
218
216
224

FIG. 2

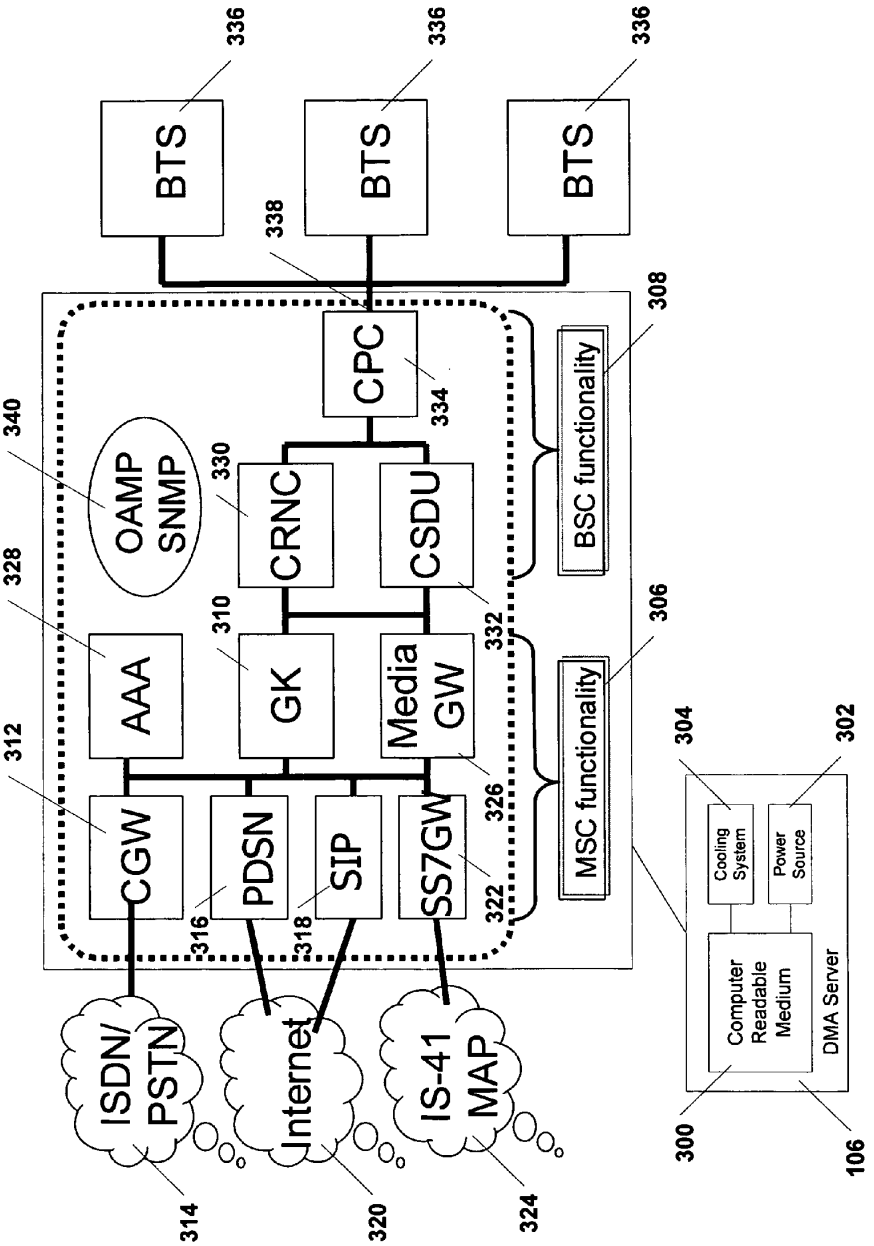

BTS
BTS
BTS
336
336
336
338
CPC
334
308
BSC functionality
340
OAMP
SNMP
330
CRNC
CSDU
328
310
332
306
AAA
GK
Media
GW
MSC functionality
312
CGW
PDSN
SIP
SS7GW
326
322
316
318
304
302
Cooling
System
Power
Source
Computer
Readable
Medium
DMA Server
ISDN/
PSTN
Internet
IS-41
MAP
300
106
314
320
324

FIG. 3

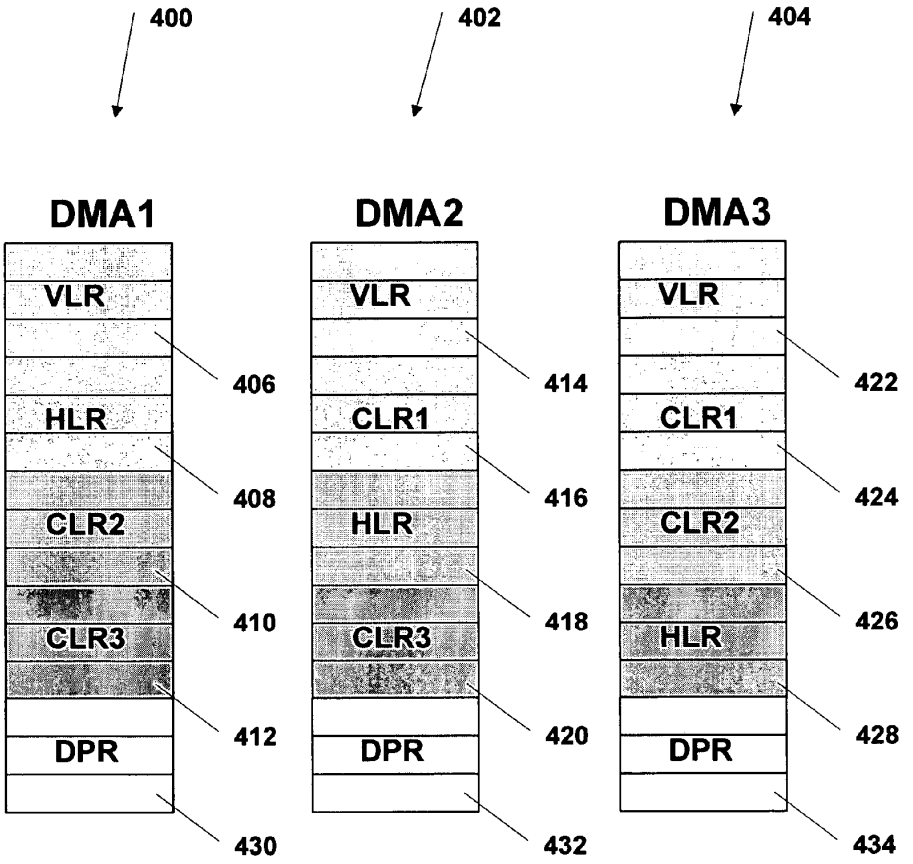

400
402
404
DMA1
DMA2
DMA3
VLR
HLR
CLR2
CLR3
DPR
VLR
CLR1
HLR
CLR3
DPR
VLR
CLR1
CLR2
HLR
DPR
406
408
410
412
430
414
416
418
420
432
422
424
426
428
434

FIG. 4

500

DMA1	IMSI (510)	ESN (512)	MDN (514)	Loc (516)	TLDN (518)	Req? (520)	Timer (522)	MSC1 Prefer (524)	ISDN Prefer (526)	VoIP Prefer (528)
HLR	IMSI11	ESN11	MDN11	@IP		y	4hr			
IP Addr	IMSI12	ESN12	MDN12	@IP		y	4hr			
GPS Loc	IMSI13	ESN13	MDN13		TLDN	y	4hr	@PC		
	IMSI14	ESN14	MDN14			n				
CLR2	IMSI21	ESN21	MDN21	NA	NA					
IP Addr	IMSI22	ESN22	MDN22	NA	NA					
GPS Loc	IMSI23	ESN23	MDN23	NA	NA					
NB List	IMSI24	ESN24	MDN24	NA	NA					
CLR3	IMSI31	ESN31	MDN31	NA	NA					
IP Addr	IMSI32	ESN32	MDN32	NA	NA					
GPS Loc	IMSI33	ESN33	MDN33	NA	NA					
NB List	IMSI34	ESN34	MDN34	NA	NA					
VLR	IMSIa	ESNa	NA	NA	TLDNa	y	4hr	@PC		
	IMSIb	ESNb	NA	NA	TLDNb	y	4hr	@PC		
	IMSIc	ESNc	NA	NA	TLDNc	y	4hr	@PC		
	Partial	Prefer	Prefer	Prefer						
	MDN	1	2	3						
DPR	P1-MDN	MSC	ISDN	VoIP						
	P2-MDN	ISDN	MSC	VoIP						
	P3-MDN	VoIP	ISDN	MSC						

502 504 506 508 530 532 534 536 538

FIG. 5

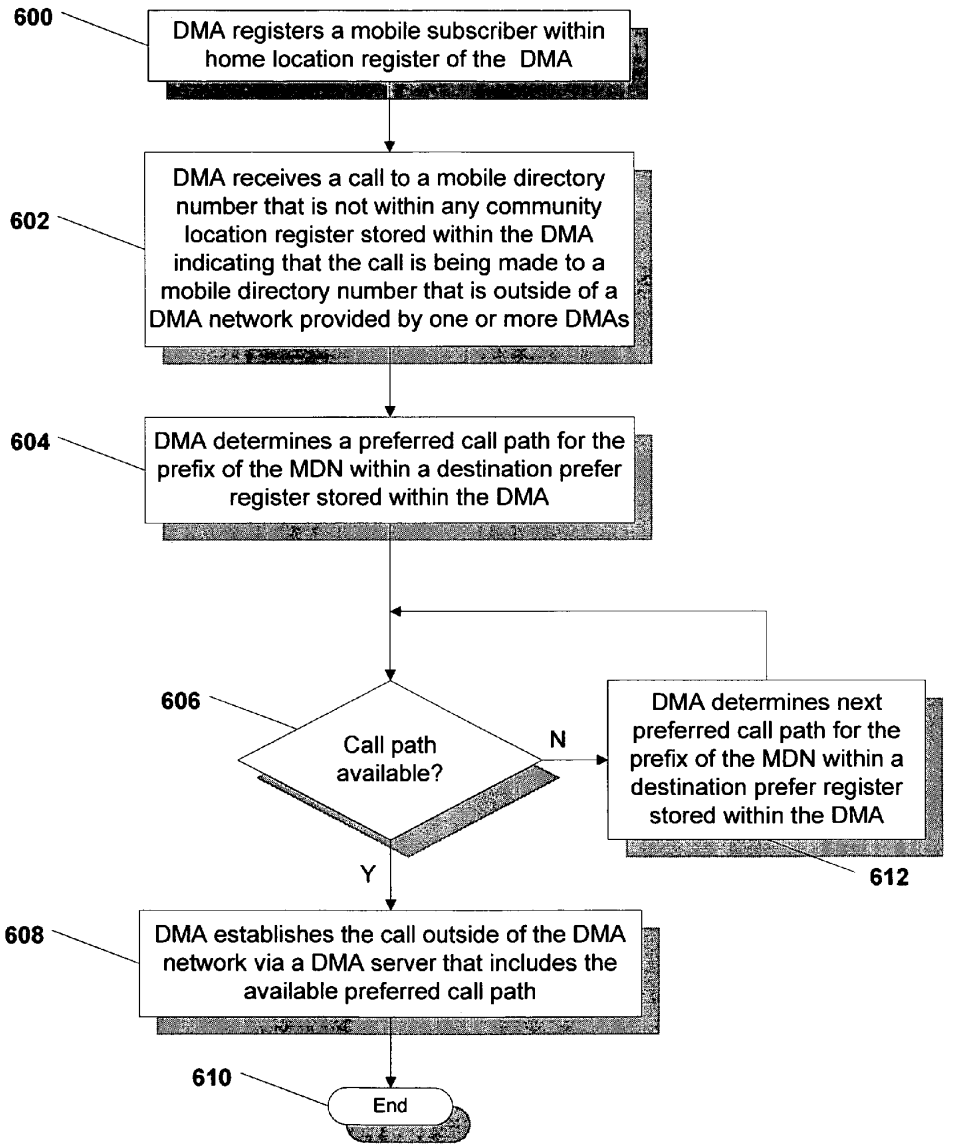

600
DMA registers a mobile subscriber within home location register of the DMA
602
DMA receives a call to a mobile directory number that is not within any community location register stored within the DMA indicating that the call is being made to a mobile directory number that is outside of a DMA network provided by one or more DMAs
604
DMA determines a preferred call path for the prefix of the MDN within a destination prefer register stored within the DMA
606
Call path available?
N
DMA determines next preferred call path for the prefix of the MDN within a destination prefer register stored within the DMA
612
Y
608
DMA establishes the call outside of the DMA network via a DMA server that includes the available preferred call path
610
End

FIG. 6

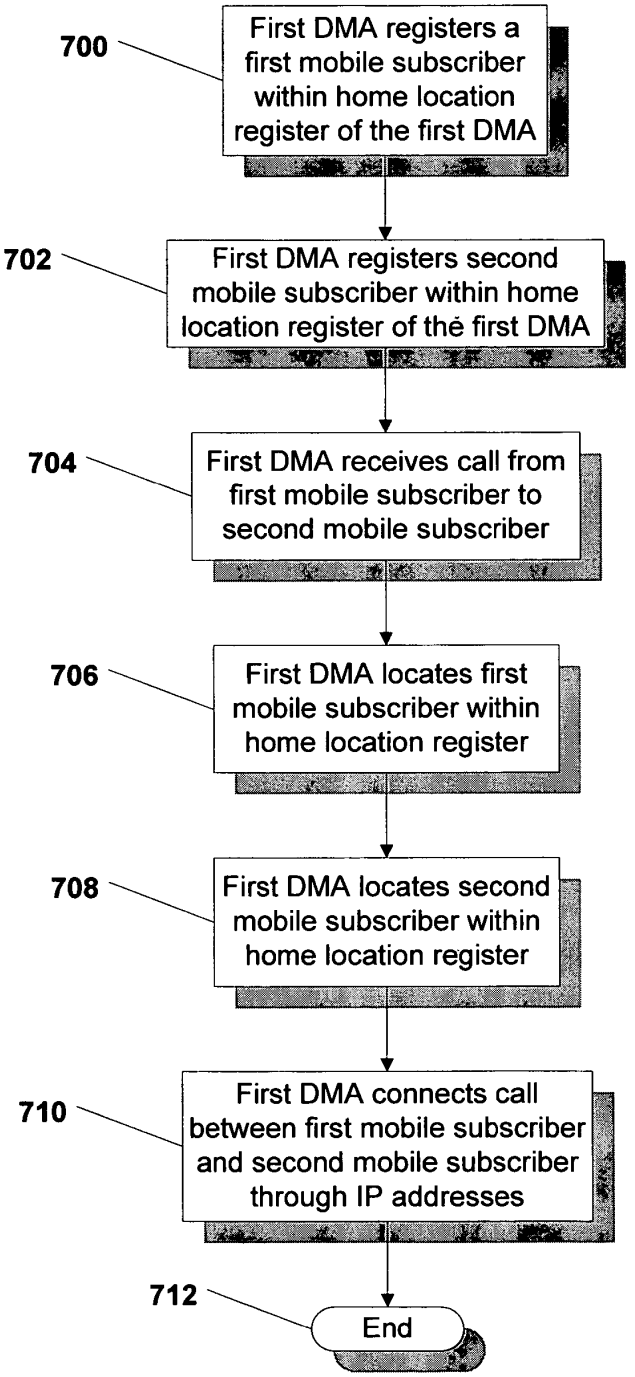

700
First DMA registers a first mobile subscriber within home location register of the first DMA
702
First DMA registers second mobile subscriber within home location register of the first DMA
704
First DMA receives call from first mobile subscriber to second mobile subscriber
706
First DMA locates first mobile subscriber within home location register
708
First DMA locates second mobile subscriber within home location register
710
First DMA connects call between first mobile subscriber and second mobile subscriber through IP addresses
712
End

FIG. 7

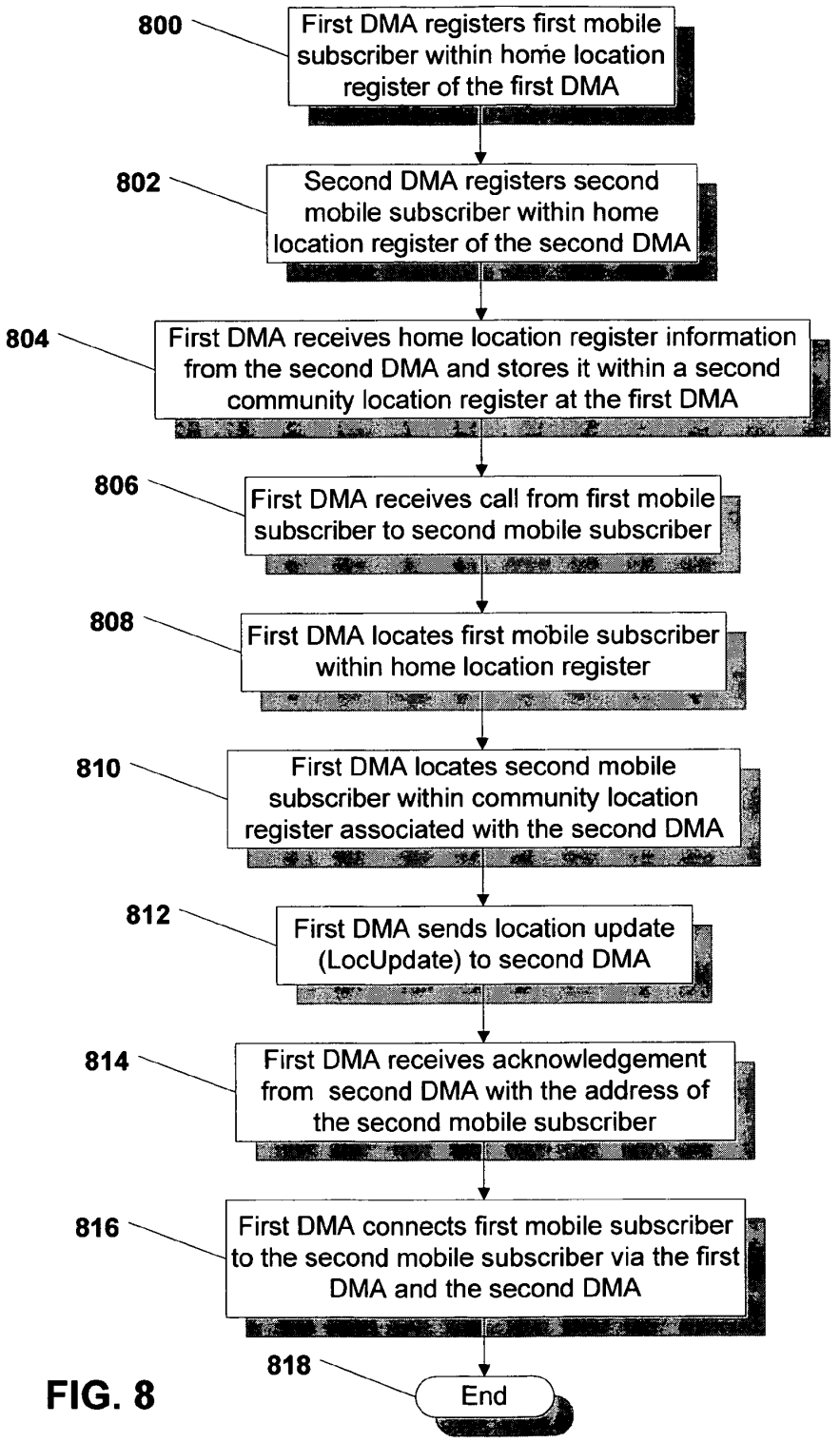

800
First DMA registers first mobile subscriber within home location register of the first DMA
802
Second DMA registers second mobile subscriber within home location register of the second DMA
804
First DMA receives home location register information from the second DMA and stores it within a second community location register at the first DMA
806
First DMA receives call from first mobile subscriber to second mobile subscriber
808
First DMA locates first mobile subscriber within home location register
810
First DMA locates second mobile subscriber within community location register associated with the second DMA
812
First DMA sends location update (LocUpdate) to second DMA
814
First DMA receives acknowledgement from second DMA with the address of the second mobile subscriber
816
First DMA connects first mobile subscriber to the second mobile subscriber via the first DMA and the second DMA
818
End

FIG. 8

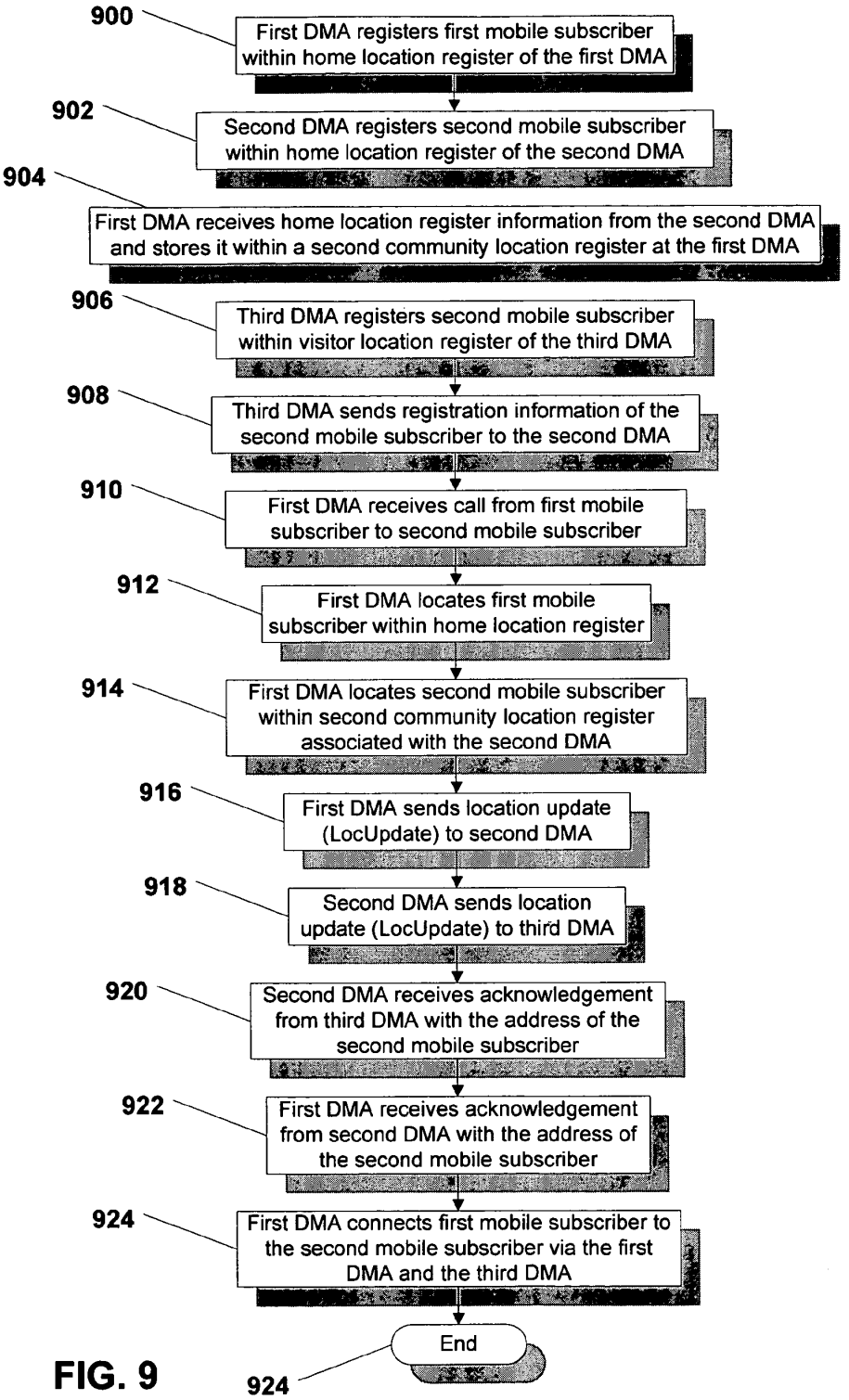

900
First DMA registers first mobile subscriber within home location register of the first DMA
902
Second DMA registers second mobile subscriber within home location register of the second DMA
904
First DMA receives home location register information from the second DMA and stores it within a second community location register at the first DMA
906
Third DMA registers second mobile subscriber within visitor location register of the third DMA
908
Third DMA sends registration information of the second mobile subscriber to the second DMA
910
First DMA receives call from first mobile subscriber to second mobile subscriber
912
First DMA locates first mobile subscriber within home location register
914
First DMA locates second mobile subscriber within second community location register associated with the second DMA
916
First DMA sends location update (LocUpdate) to second DMA
918
Second DMA sends location update (LocUpdate) to third DMA
920
Second DMA receives acknowledgement from third DMA with the address of the second mobile subscriber
922
First DMA receives acknowledgement from second DMA with the address of the second mobile subscriber
924
First DMA connects first mobile subscriber to the second mobile subscriber via the first DMA and the third DMA
End
924

FIG. 9

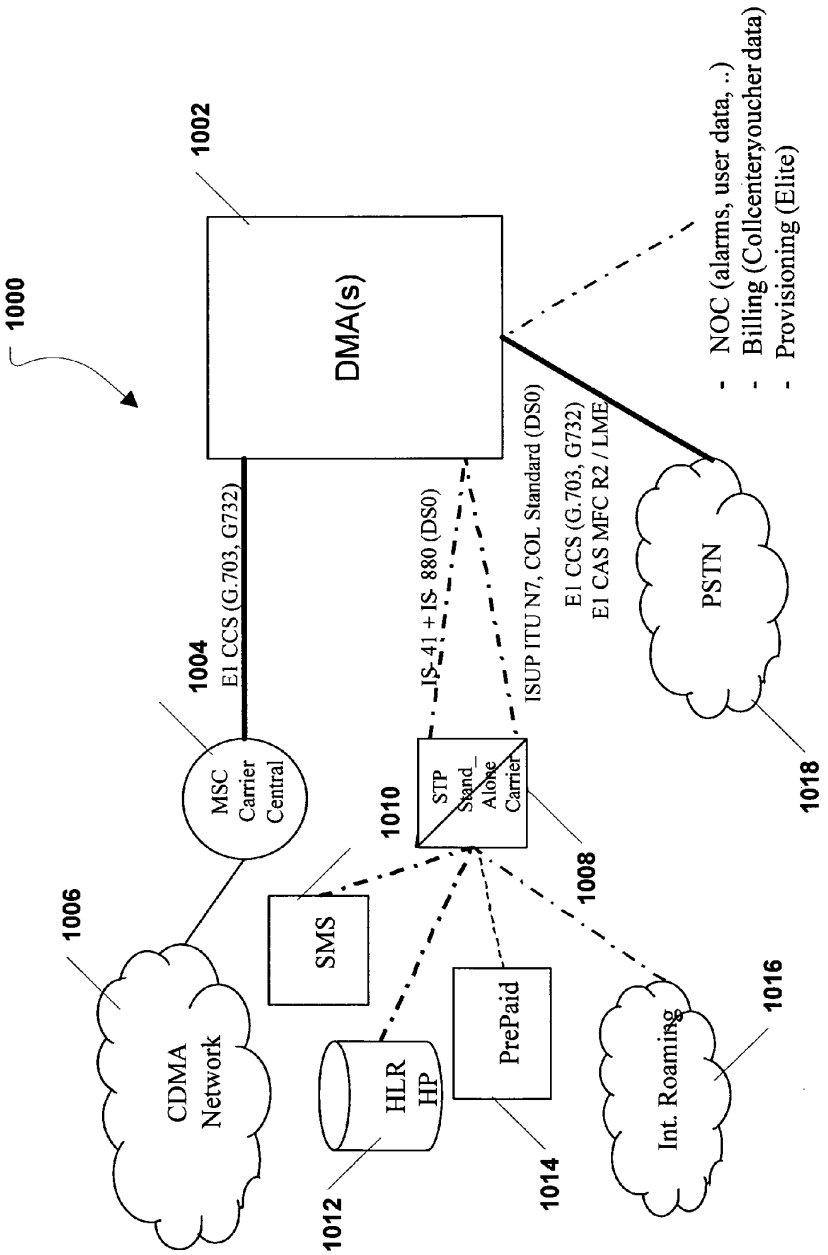

1000
1002
DMA(s)
1004
E1 CCS (G.703, G732)
MSC
Carrier
Central
1006
CDMA
Network
SMS
1010
STP
Stand_
Alone
Carrier
1008
IS-41 + IS-880 (DS0)
ISUP ITU N7, COL Standard (DS0)
E1 CCS (G.703, G732)
E1 CAS MFC R2 / LME
HLR
HP
1012
PrePaid
1014
Int. Roaming
1016
PSTN
1018
- NOC (alarms, user data, ..)
- Billing (Collcenteryoucher data)
- Provisioning (Elite)

FIG. 10

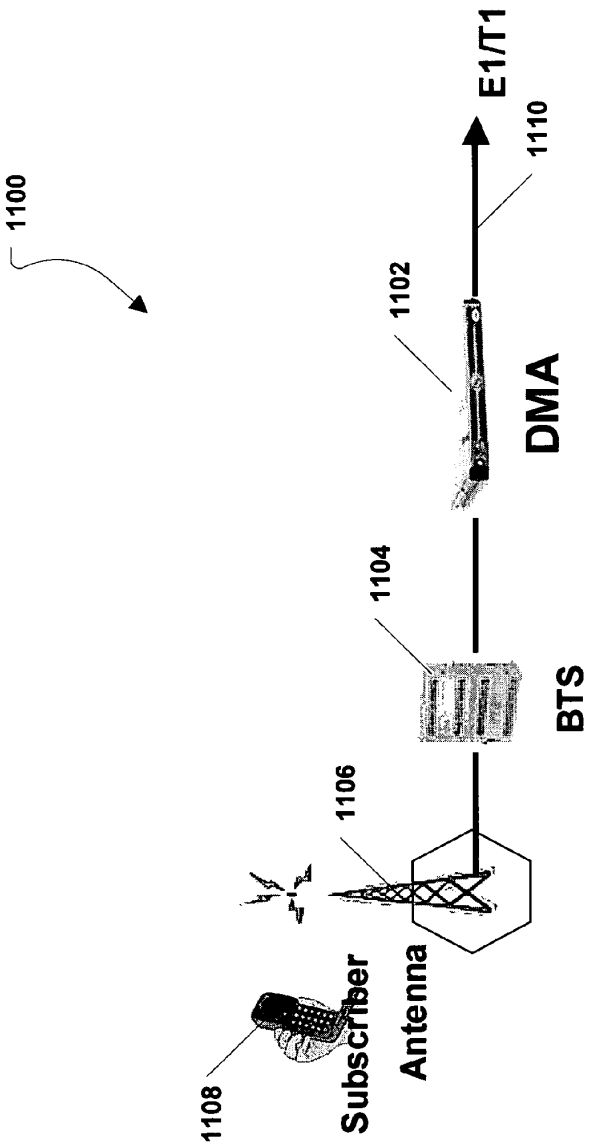

1100
1108
Subscriber
1106
Antenna
1104
BTS
1102
DMA
1110
E1/T1

FIG. 11

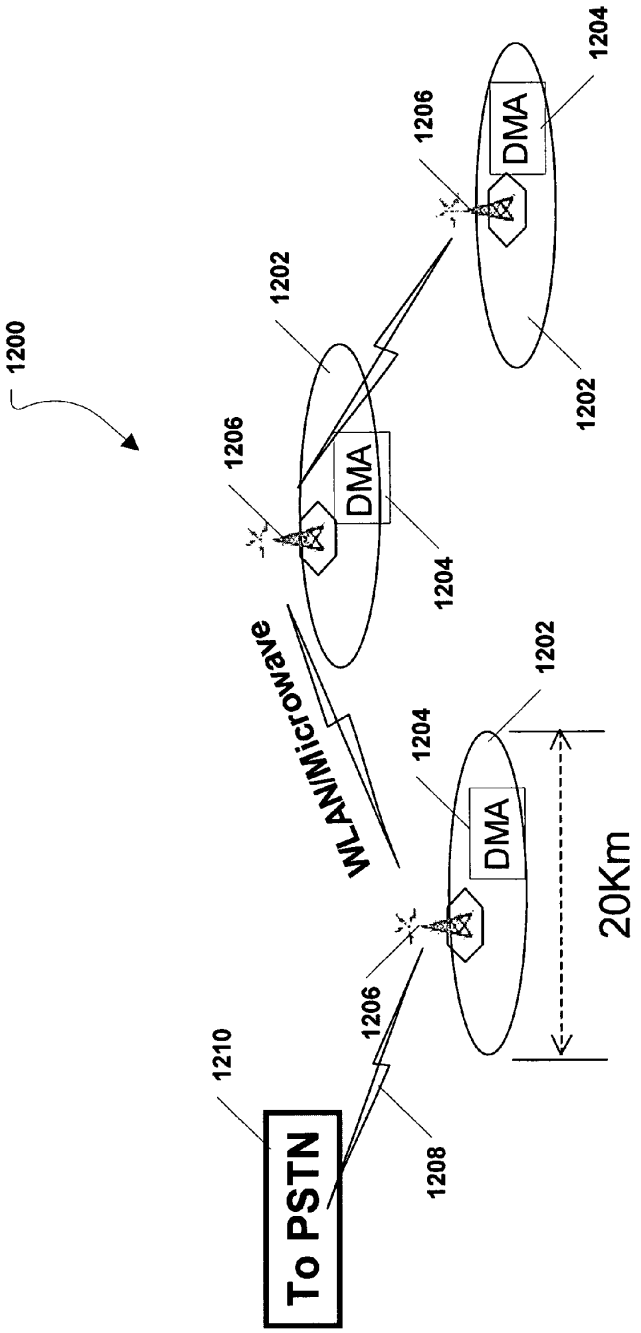

1200
1202
1204
1206
DMA
WLAN/Microwave
20Km
1208
1210
To PSTN

FIG. 12

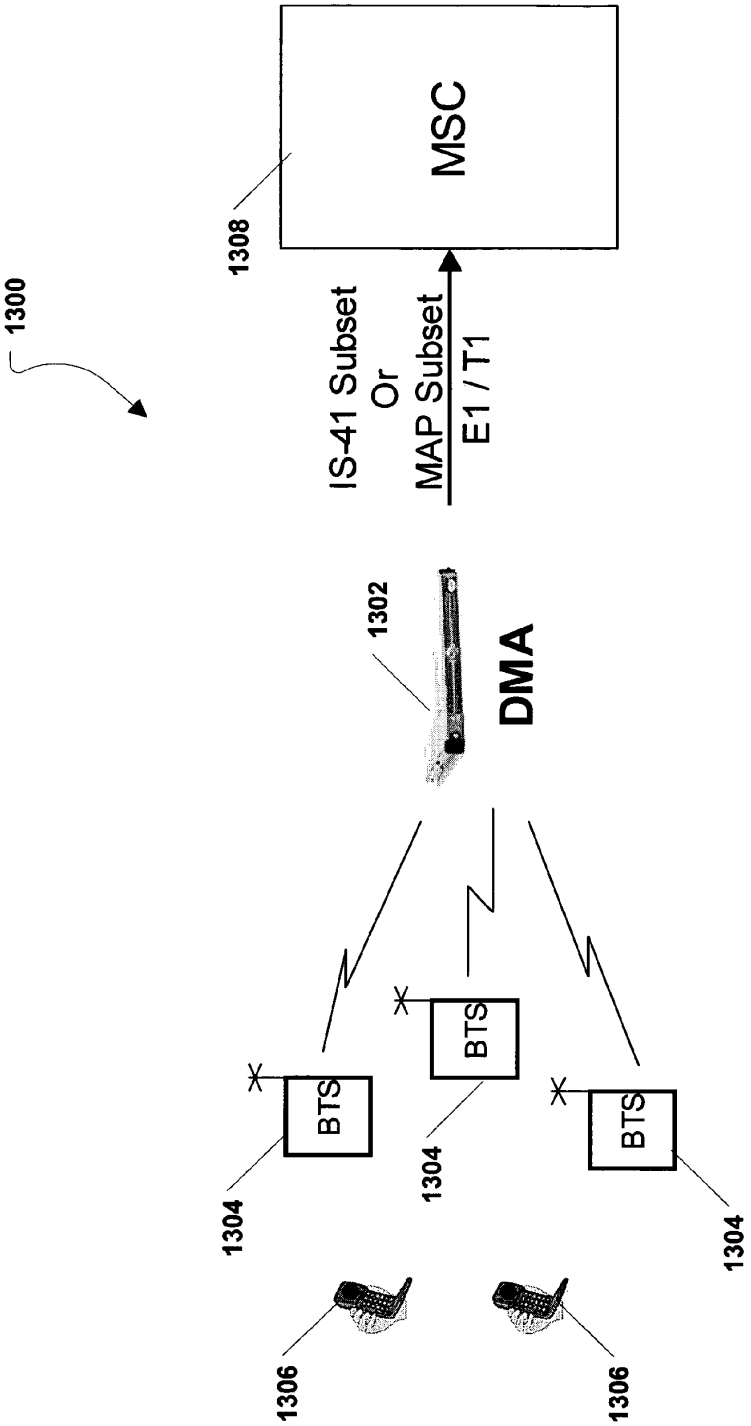

1300
1308
MSC
IS-41 Subset
Or
MAP Subset
E1 / T1
1302
DMA
BTS
BTS
BTS
1304
1304
1304
1306
1306

FIG. 13

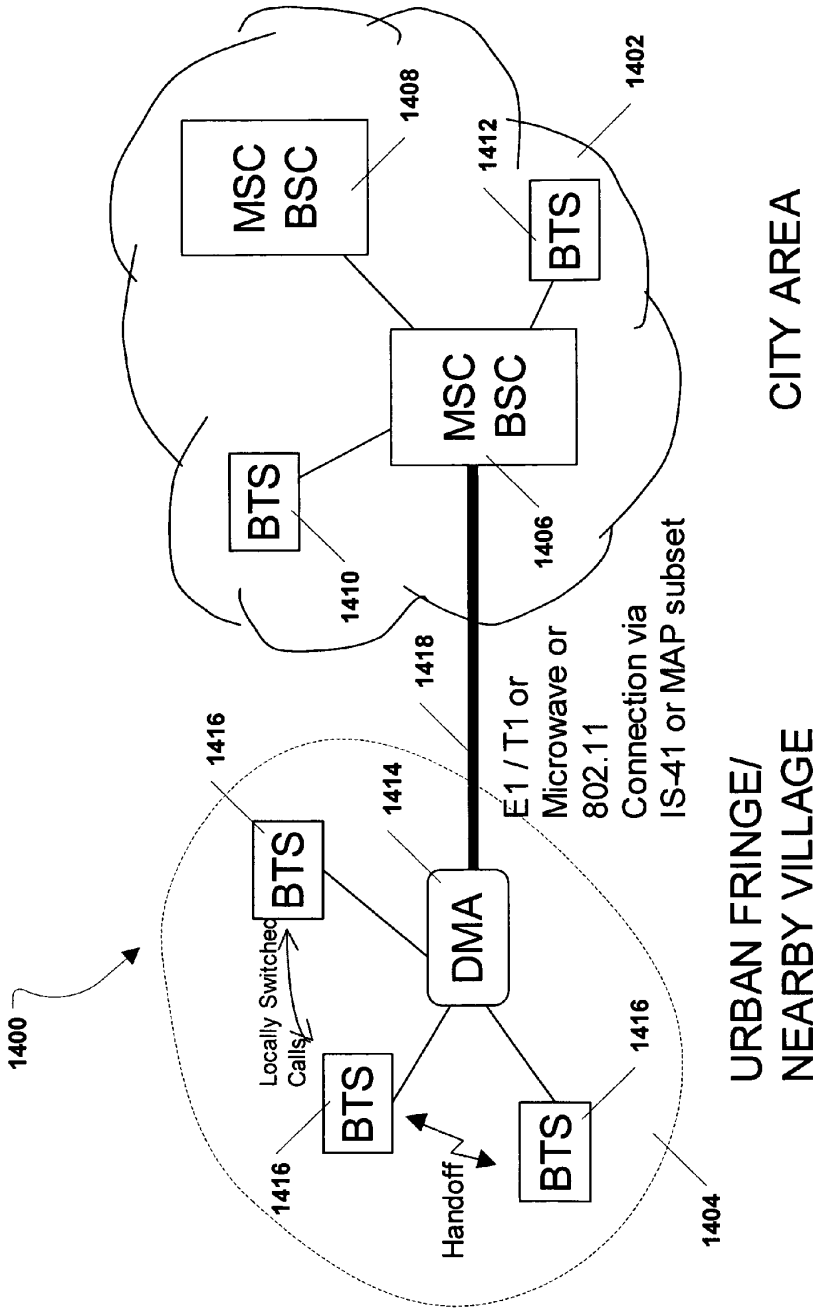

1400
MSC
BSC
1408
BTS
1412
1402
MSC
BSC
BTS
1410
1406
CITY AREA
1418
E1 / T1 or
Microwave or
802.11
Connection via
IS-41 or MAP subset
1416
BTS
1414
DMA
Locally Switched
Calls
BTS
1416
Handoff
BTS
1416
1404
URBAN FRINGE/
NEARBY VILLAGE

FIG. 14

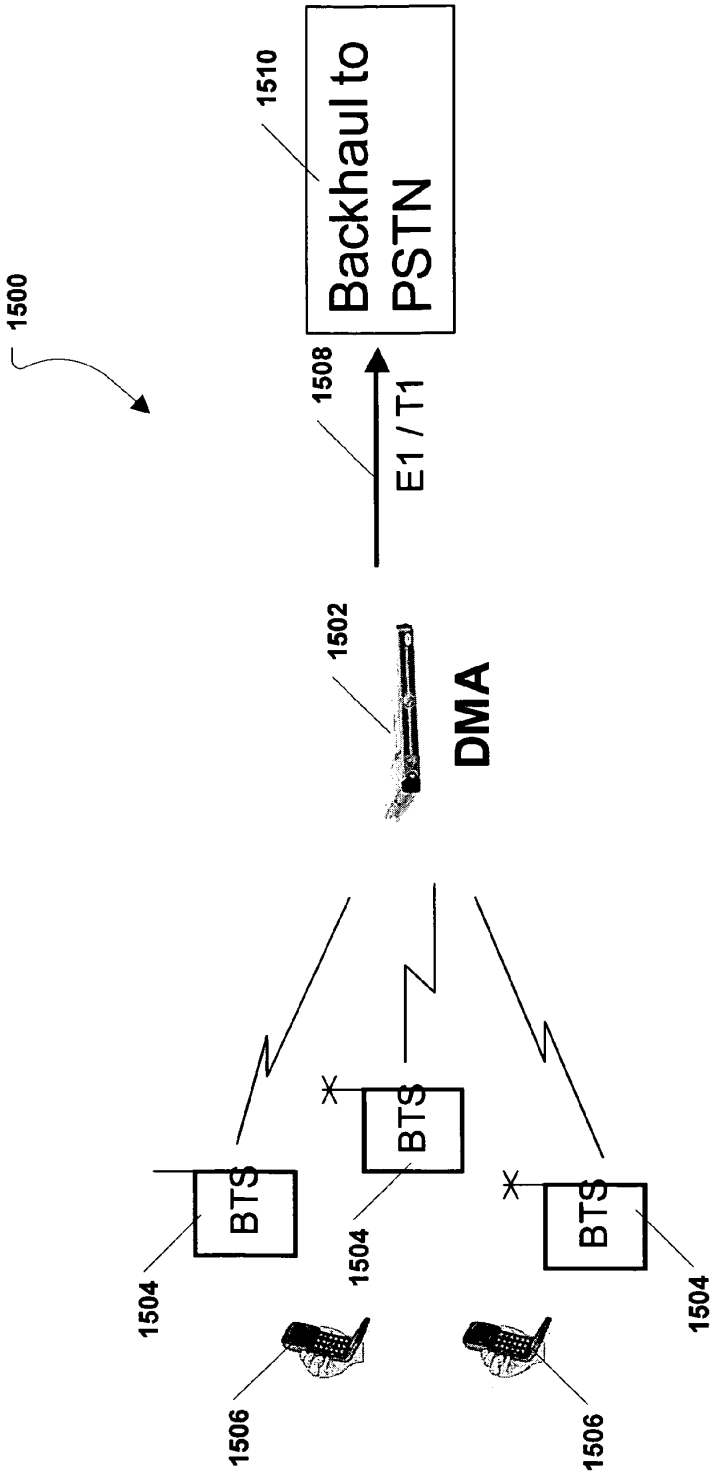

1500
1510
Backhaul to PSTN
1508
E1 / T1
1502
DMA
BTS
BTS
BTS
1504
1504
1504
1506
1506

FIG. 15

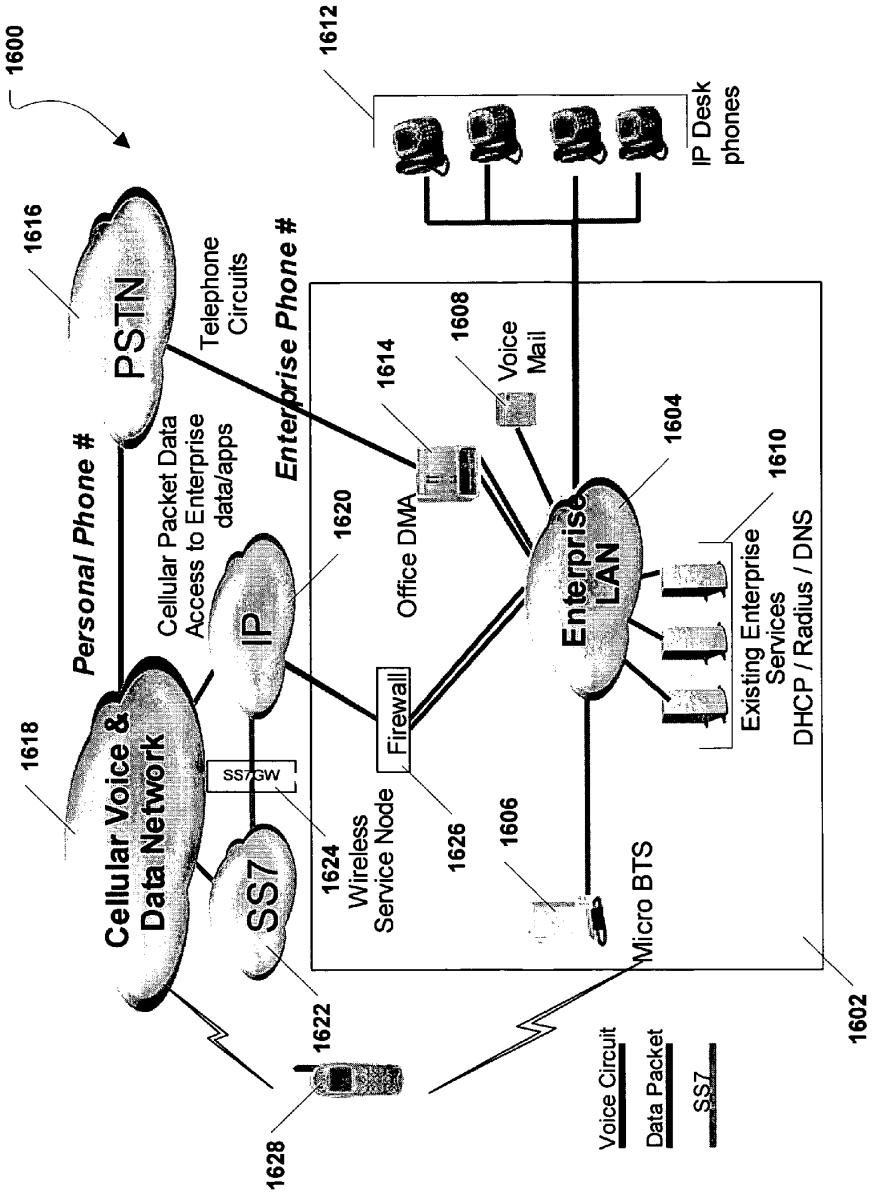

1600
1612
IP Desk phones
1616
PSTN
Telephone Circuits
Enterprise Phone #
1608
Voice Mail
1614
1604
1610
Personal Phone #
Cellular Packet Data Access to Enterprise data/apps
1620
IP
Office DMA
Enterprise LAN
Existing Enterprise Services
DHCP / Radius / DNS
1618
Cellular Voice & Data Network
SS7GW
Firewall
1624
Wireless Service Node
1626
1606
SS7
Micro BTS
1622
1628
1602
Voice Circuit
Data Packet
SS7

FIG. 16

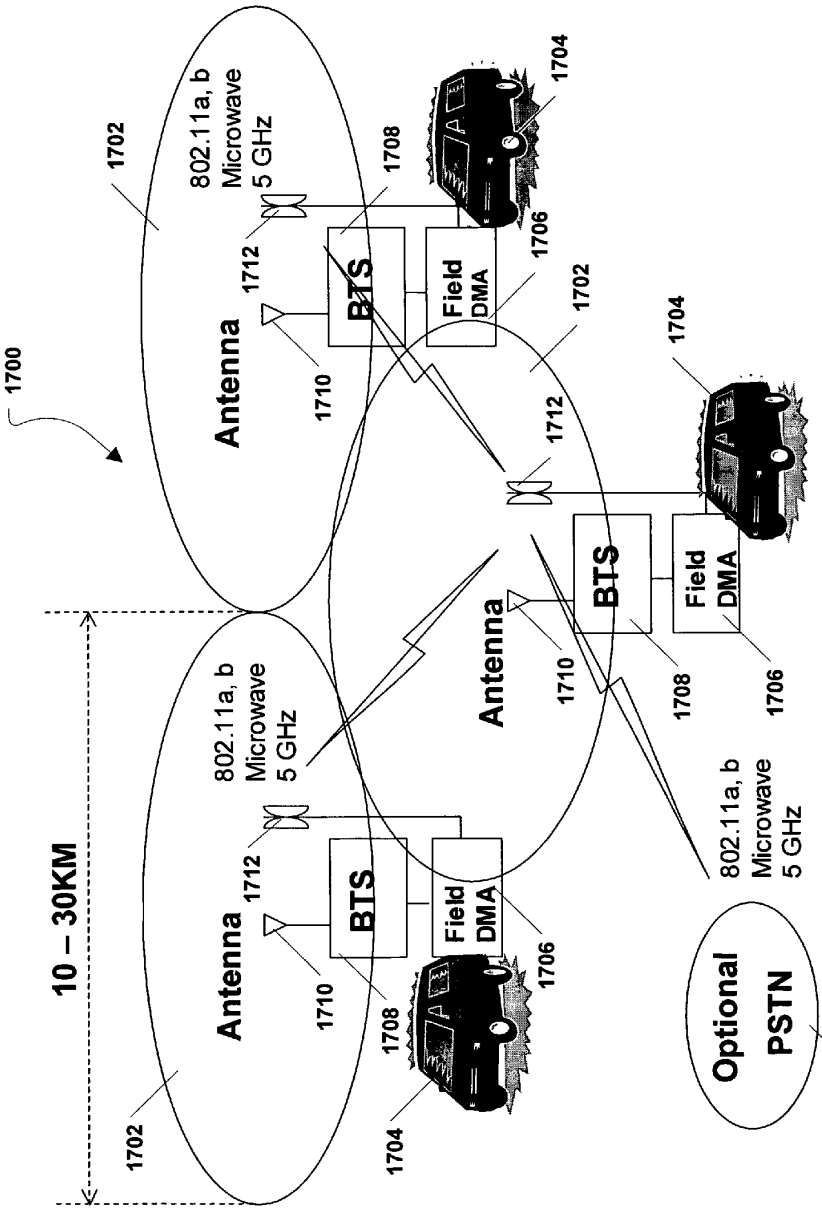

1700
1702
802.11a, b
Microwave
5 GHz
1712
Antenna
1710
BTS
1708
Field
DMA
1706
1704
10 – 30KM
Optional
PSTN
1714

FIG. 17

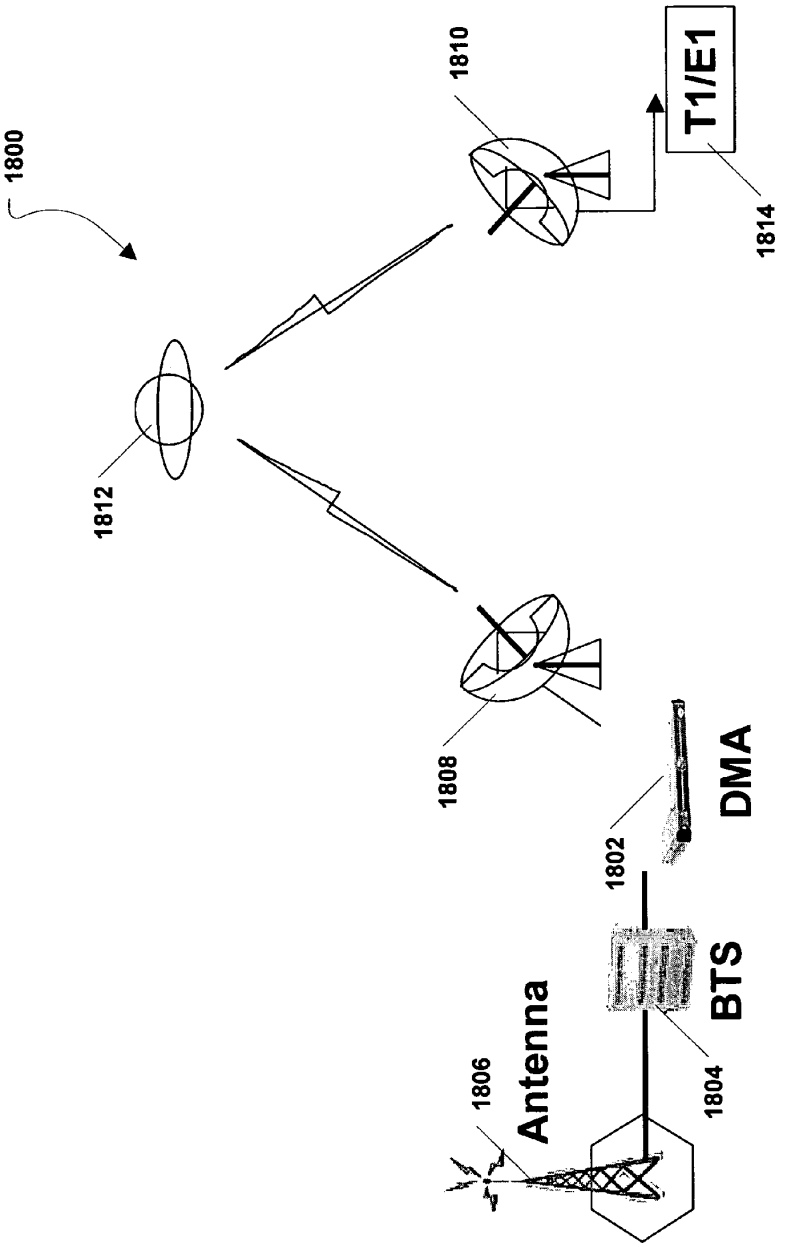


FIG. 18

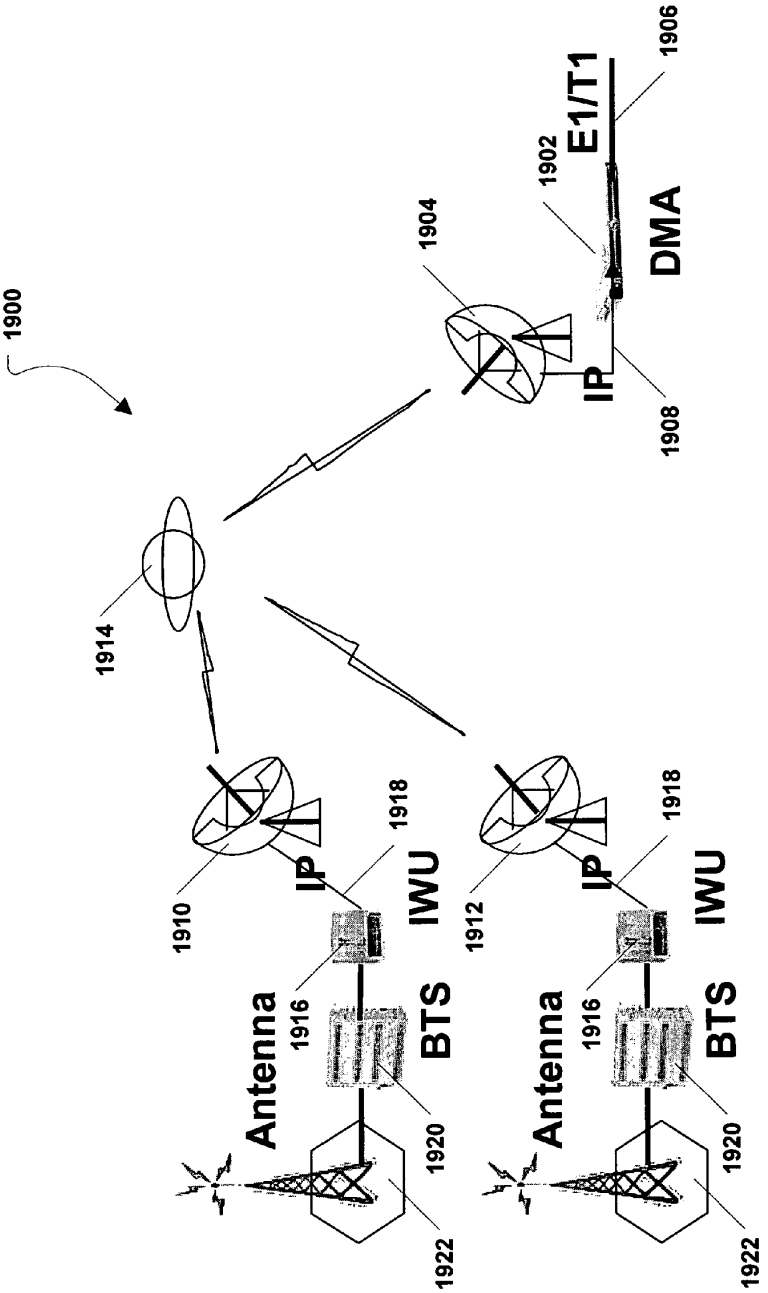

1900
1904
1902
E1/T1
1906
DMA
IP
1908
1914
1910
IP
1918
IWU
1916
Antenna
BTS
1920
1922
1912
IP
1918
IWU
1916
Antenna
BTS
1920
1922

FIG. 19

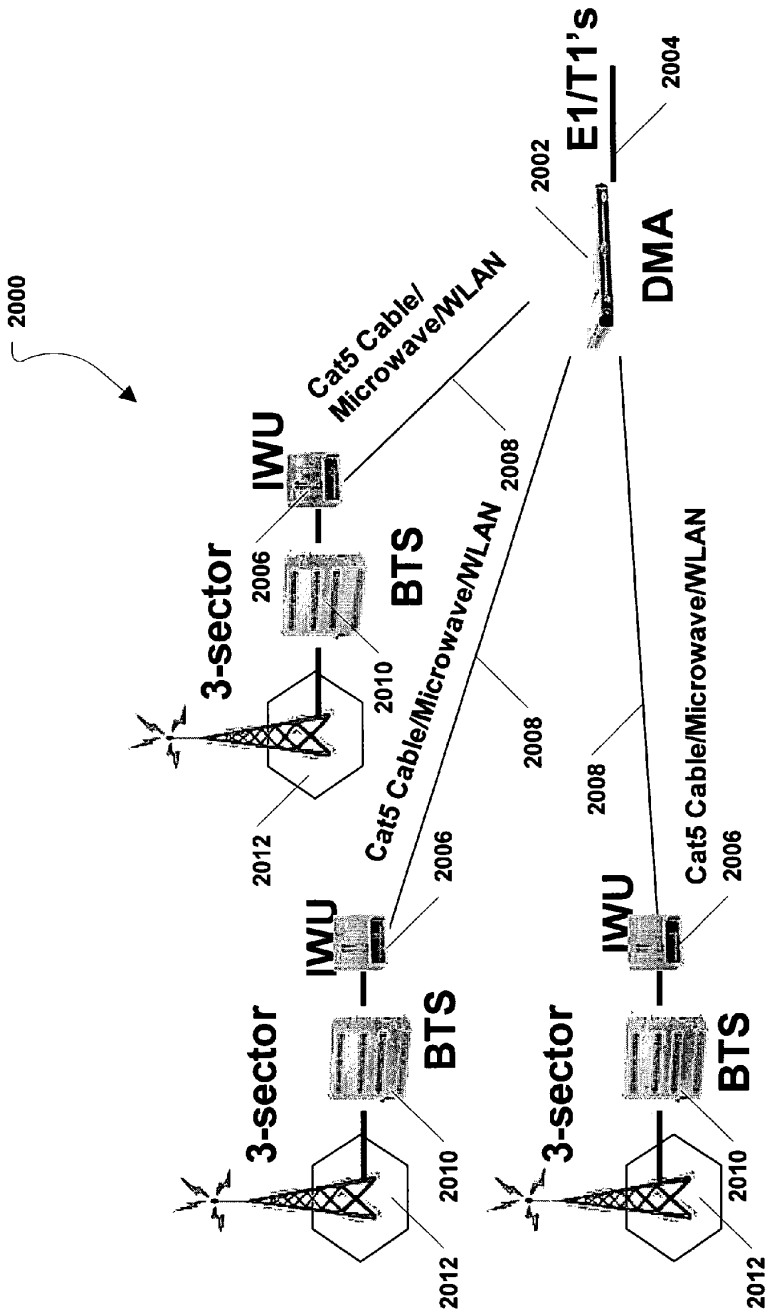

2000
E1/T1's
2004
2002
DMA
Cat5 Cable/
Microwave/WLAN
2008
IWU
2006
BTS
3-sector
2010
2012
Cat5 Cable/Microwave/WLAN
2008
2008
Cat5 Cable/Microwave/WLAN
2006
IWU
3-sector
BTS
2010
2012
IWU
2006
3-sector
BTS
2010
2012

FIG. 20

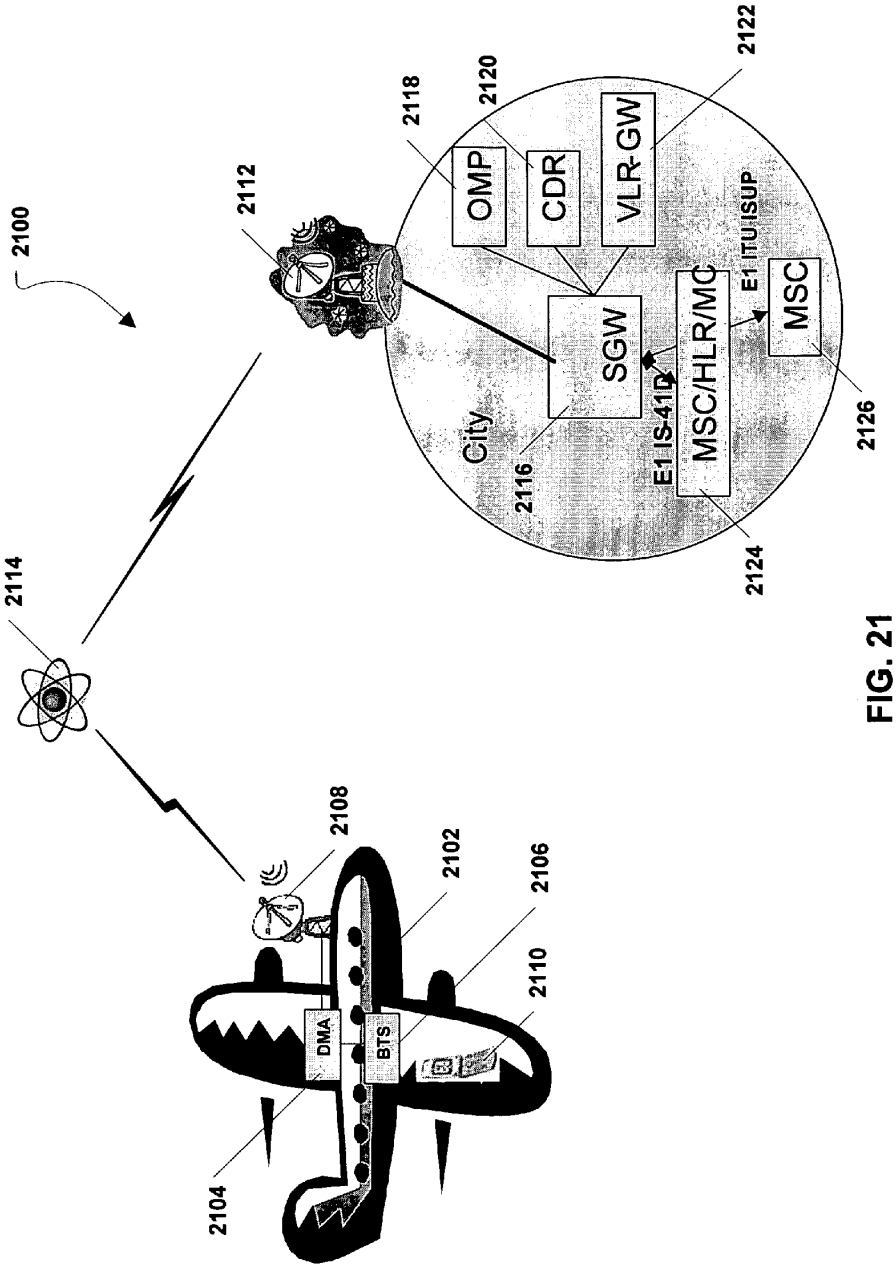

2100
2104
DMA
BTS
2108
2102
2106
2110
2114
2112
City
2116
SGW
OMP
2118
CDR
2120
VLR-GW
2122
E1 IS-41D
MSC/HLR/MC
2124
E1 ITU ISUP
MSC
2126

FIG. 21

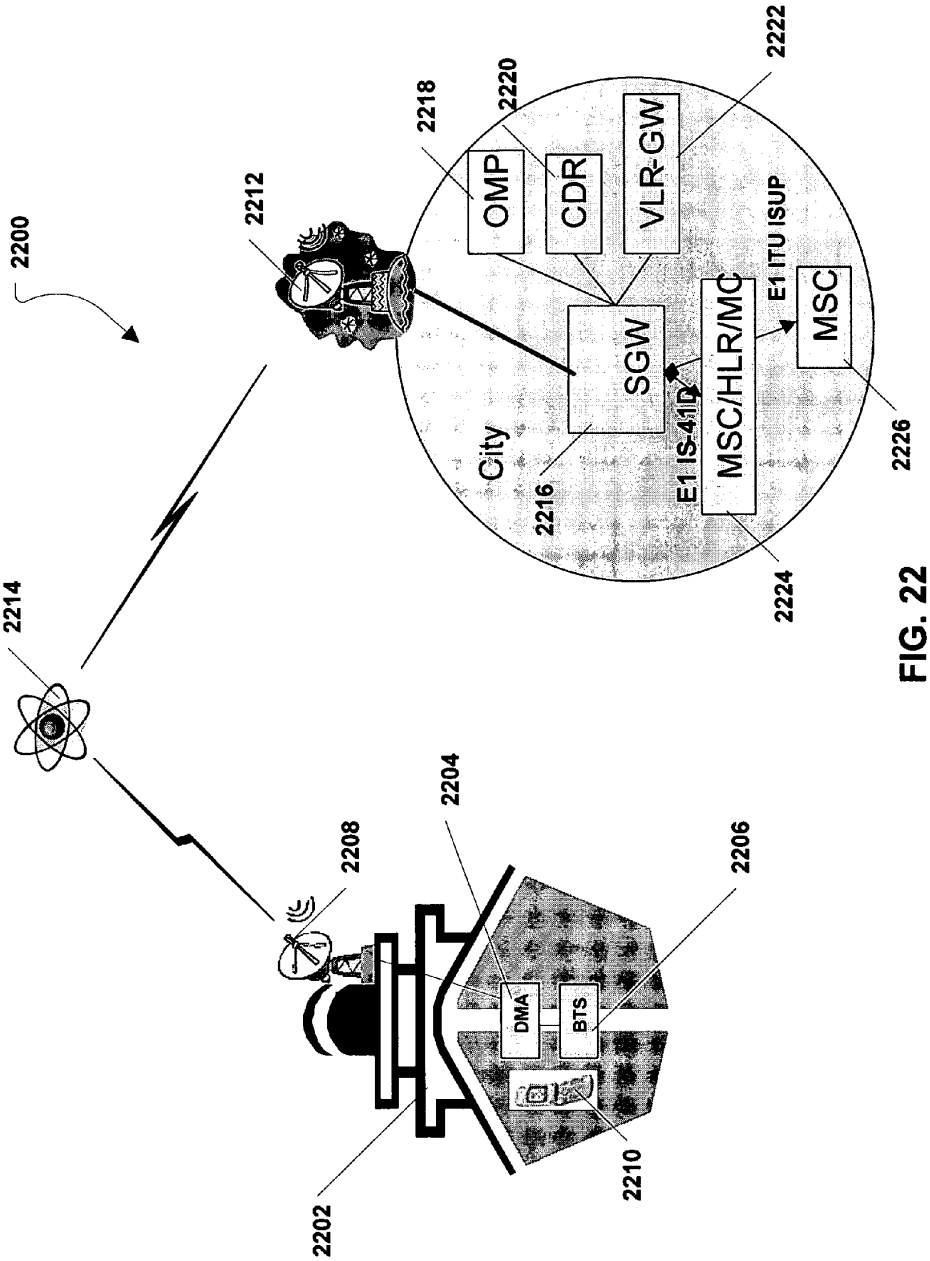

2200
2212
2218
2220
2222
OMP
CDR
VLR-GW
City
SGW
MSC/HLR/MC
E1 IS-41D
E1 ITU ISUP
MSC
2216
2224
2226
2214
2208
2204
2206
DMA
BTS
2210
2202

FIG. 22

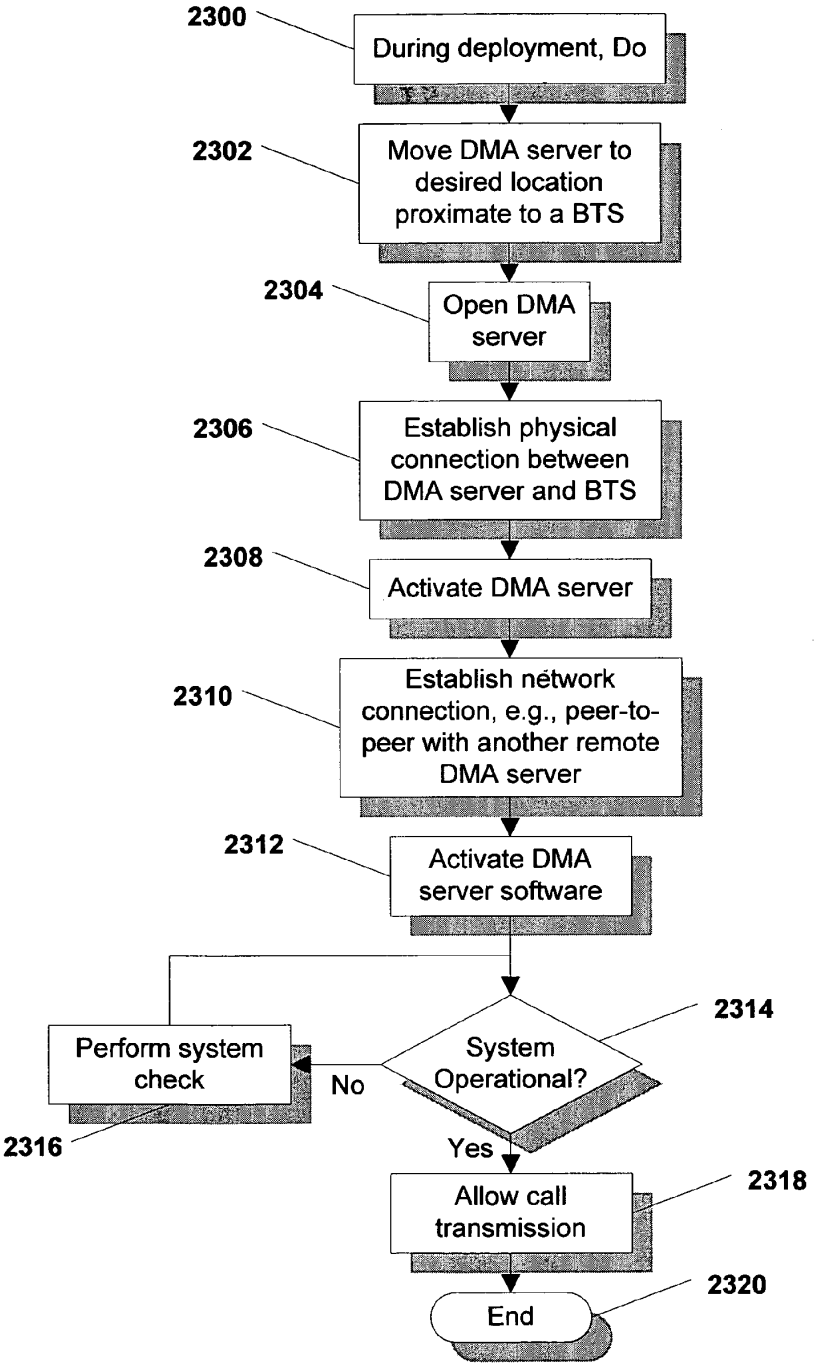

2300
During deployment, Do
2302
Move DMA server to desired location proximate to a BTS
2304
Open DMA server
2306
Establish physical connection between DMA server and BTS
2308
Activate DMA server
2310
Establish network connection, e.g., peer-to-peer with another remote DMA server
2312
Activate DMA server software
2314
System Operational?
No
Perform system check
2316
Yes
2318
Allow call transmission
2320
End

FIG. 23

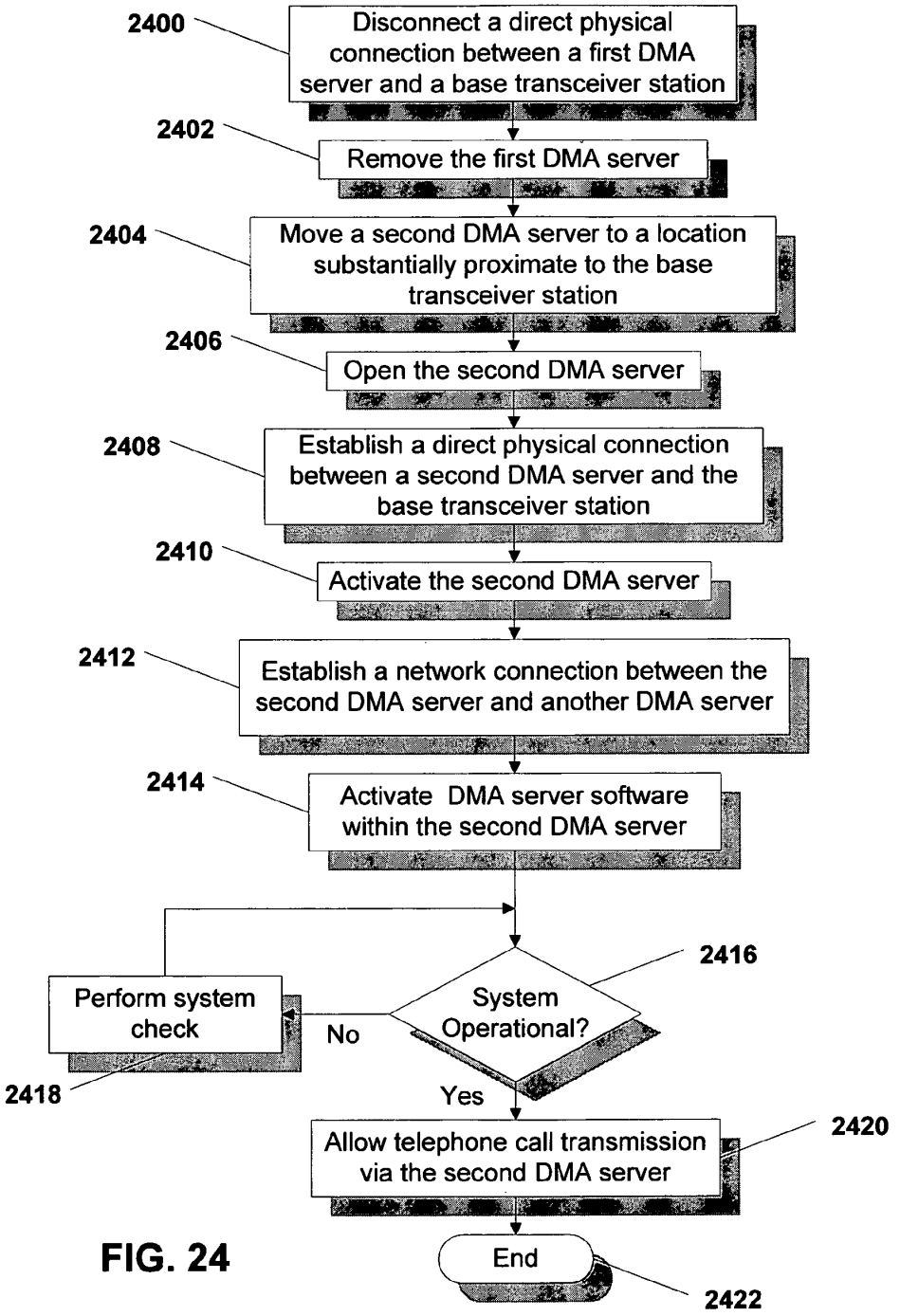

2400
Disconnect a direct physical connection between a first DMA server and a base transceiver station
2402
Remove the first DMA server
2404
Move a second DMA server to a location substantially proximate to the base transceiver station
2406
Open the second DMA server
2408
Establish a direct physical connection between a second DMA server and the base transceiver station
2410
Activate the second DMA server
2412
Establish a network connection between the second DMA server and another DMA server
2414
Activate DMA server software within the second DMA server
2416
System Operational?
No
Perform system check
2418
Yes
Allow telephone call transmission via the second DMA server
2420
End
2422

FIG. 24

SYSTEM, METHOD, AND DEVICE FOR PROVIDING COMMUNICATIONS USING A DISTRIBUTED MOBILE ARCHITECTURE

FIELD OF THE DISCLOSURE

The present disclosure relates generally to the distributed mobile communication systems.

BACKGROUND

Access to basic telephony service is particularly important for rural and isolated communities. Telephony access allows small-scale enterprises, cooperatives, and farmers to obtain accurate information on fair prices for their products and to access regional and national markets. Access also reduces the cost of transportation and supports the local tourist industry. By bringing markets to people via telecommunications, rather than forcing people to leave in search of markets, urban migration is reduced and greater income and employment potential are generated in rural areas.

Unfortunately, the last decade of the telecommunications boom has not alleviated the disparities between urban and rural communities. The average imbalance, in terms of telephone penetration, in Asia, for example, is over ten to one and is often as high as twenty to 1.2. This means that a country whose urban markets have a penetration of four (4) telephone lines per one-hundred (100) inhabitants, e.g., India and Pakistan, has a rural penetration of less than 0.2 per one-hundred (100). The situation is more acute in most African countries and in some parts of Latin America. By comparison, the disparity in average income level between urban and rural residents in the developing world is usually less than 4 to 1.

Current telephone systems are expensive to deploy. For example, a typical cellular system that includes a mobile switching center (MSC), a base station controller (BSC), and a home location register/visitor location register (HLR/VLR) can cost over $2.0 million. Moreover, such a system may require a minimum of ten thousand users in order to be economically viable. In many rural areas, the population is not large enough to support the installation of such a system. Further, in many cases, the conditions in which the equipment, e.g., the MSC, BSC, and HLR/VLR, are to be operated are extremely harsh and environmentally challenging. An alternative to such a cellular system can include a wired system, but the costs associated with deploying and maintaining land lines are too high for certain rural areas.

Accordingly, there exists a need for an improved communications system that is relatively inexpensive to deploy and relatively inexpensive to operate.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is pointed out with particularity in the appended claims. However, other features are described in the following detailed description in conjunction with the accompanying drawings in which:

FIG. **1** is a diagram of a distributed and associative communication system;

FIG. **2** is a diagram of a network including a plurality of distributed mobile architectures;

FIG. **3** is a block diagram of a distributed management architecture server;

FIG. **4** is a diagram of a plurality of distributed mobile architectures;

FIG. **5** is a diagram of an exemplary data structure for use by an authentication, authorization, and accounting module of a distributed mobile architecture;

FIG. **6** is a flow chart to illustrate a method of determining a preferred call path for calls to be routed outside of a DMA network;

FIG. **7** is a flow chart to illustrate a method of providing a call between a first mobile subscriber and a second mobile subscriber via a single distributed mobile architecture;

FIG. **8** is a flow chart to illustrate a method of providing a call between a first mobile subscriber and a second mobile subscriber via a first distributed mobile architecture and a second distributed mobile architecture;

FIG. **9** is a flow chart to illustrate a method of providing a call between a first mobile subscriber and a roaming second mobile subscriber via a first distributed mobile architecture and a third distributed mobile architecture;

FIG. **10** is a diagram of an exemplary communication system in which a distributed management architecture server can be incorporated;

FIG. **11** is a diagram of a wireless local loop communication system in which a distributed management architecture server can be incorporated;

FIG. **12** is a diagram of plural wireless local loop communication systems connected to the public switched telephone network via a single back-haul connection;

FIG. **13** is a diagram of a communication system in which a distributed management architecture server can be deployed to extend an existing cellular network;

FIG. **14** is a diagram of a communication system in which a distributed management architecture server can be deployed to cover urban fringe around an existing network;

FIG. **15** is a diagram of a communication system in which a single distributed management architecture server can be connected to plural base transceiver stations and can provide a single backhaul to the public switched telephone network;

FIG. **16** is a diagram of an in-building communication system in which a distributed management architecture server can be deployed;

FIG. **17** is a diagram of a mobile in-field communication system in which multiple distributed management architecture servers can be deployed via multiple vehicles;

FIG. **18** is a diagram of a communication system in which a distributed management architecture server can utilize a satellite connection as a backhaul connection;

FIG. **19** is a diagram of a communication system in which a distributed management architecture server can receive multiple backhaul signals via multiple satellite signals;

FIG. **20** is a diagram of a communication system in which a single distributed management architecture server can be connected to multiple base transceiver stations;

FIG. **21** is a diagram of a mobile communication system in which a distributed management architecture server can be deployed via an airplanes;

FIG. **22** is a diagram of a mobile communication system in which a distributed management architecture server can be deployed via a ship;

FIG. **23** is a flow chart to illustrate a method of deploying a distributed management architecture server; and

FIG. **24** is a flow chart to illustrate a method of replacing a distributed management architecture server.

DETAILED DESCRIPTION OF THE DRAWINGS

An authentication, authorization, and accounting module of a first distributed mobile architecture system is disclosed and includes a destination preference register. The destination

preference register includes a preferred call path for calls to be routed outside of a distributed mobile architecture network that is accessible to the first distributed mobile architecture system.

In a particular embodiment, the preferred call path is selected from a group comprising a voice over Internet protocol (VoIP) call path, a mobile switching center (MSC) call path, and an integrated services digital network (ISDN) call path. Further, in a particular embodiment, calls that are placed outside of the distributed mobile architecture network from the first distributed mobile architecture system are established via the preferred call path. Additionally, in another particular embodiment, calls that are routed outside of the distributed mobile architecture network from a mobile subscriber in communication with the first distributed mobile architecture system are established via the preferred call path.

In a particular embodiment, the destination preference register includes a first preferred call path, a second preferred call path, and a third preferred call path. Some calls that are routed outside of the distributed mobile architecture network are made via a first available preferred call path. In a particular embodiment, the module also includes a home location register that includes information associated with one or more mobile subscribers registered with the first distributed mobile architecture system, and wherein the home location register provides information related to a first community location register at a second distributed mobile architecture system.

In a particular embodiment, the module also includes a second community location register that includes information associated with one or more mobile subscribers registered with the second distributed mobile architecture system. Also, the module can includes a third community location register that includes information associated with one or more mobile subscribers registered with a third distributed mobile architecture system.

In another particular embodiment, the module includes a visitor location register that includes information associated with one or more roaming mobile subscribers that are temporarily registered with the first distributed mobile architecture system.

In another embodiment, a method of communication is disclosed and includes receiving a call directed to a destination mobile directory number that is not available within a community location register within a distribute mobile architecture and matching a prefix of the mobile directory number to a mobile directory number prefix within a destination preference register.

In yet another embodiment, a distributed mobile architecture device is provided and includes a processor and a computer readable medium that is accessible to the processor. An authentication, authorization, and accounting module is embedded within the computer readable medium and includes a destination preference register. The destination preference register includes at least one preferred call path associated with calls to be placed outside a distributed mobile architecture network that is accessible from one or more distributed mobile architecture devices.

In still another embodiment, a system is disclosed and includes a distributed mobile architecture network that includes a first distributed mobile architecture device, a second distributed mobile architecture that is coupled to the first distributed mobile architecture, and a third distributed mobile architecture that is coupled to the first distributed mobile architecture and to the second distributed mobile architecture. Further, a voice over Internet protocol (VoIP) interface can be coupled to the first distributed mobile architecture, the second distributed mobile architecture, or the third distributed mobile architecture. An integrated services digital network (ISDN) interface can be coupled to the first distributed mobile architecture, the second distributed mobile architecture, or the third distributed mobile architecture. Also, a mobile switching center (MSC) interface can be coupled to the first distributed mobile architecture, the second distributed mobile architecture, or the third distributed mobile architecture. In this embodiment, the first distributed mobile architecture, the second distributed mobile architecture, and the third distributed mobile architecture can each include a destination preference register that includes at least one preferred interface supporting calls to be placed outside the distributed mobile architecture network.

Referring to FIG. **1**, a non-limiting, exemplary embodiment of a distributed and associative telecommunications system is illustrated and is generally designated **100**. As depicted in FIG. **1**, the system **100** includes four cellular coverage sites **102**. Each coverage site **102** includes an antenna **104**. In one embodiment, the antenna **104** is connected to a transceiver belonging to a base transceiver station (BTS) and the BTS is a 3-sector BTS. FIG. **1** also indicates that a distributed mobile architecture (DMA) **106** can be connected to each antenna **104**. In one embodiment, each DMA **106** is physically and directly connected to its respective antenna **104**, e.g., by a wire or cable **108**. Further, in an illustrative embodiment, each DMA **106** can include the components described herein in conjunction with FIG. **3**.

As illustrated in FIG. **1**, each DMA **106** is interconnected with the other DMAs **106** via an Internet protocol network **110**. As such, there exists a peer-to-peer connection **112** between each DMA **106** in the system **100**. The DMAs **106** can handle telephony traffic that is communicated at each antenna **104**. For example, the DMAs **106** can switch and route calls received via each antenna **104**. Additionally, the DMAs **106** can hand-off calls to each other as mobile communication devices move around and between the cellular coverage sites **102**. The DMAs **106** can communicate with each other via the IP network **110** and can further transmit calls to each other via the IP network **110**. It should be understood that more than four cellular coverage sites **102** can be included in the system and that the inclusion of only four cellular coverage sites **102** in FIG. **1** is merely for clarity and explanation purposes.

Within the distributed and associative communications system **100**, the controlling logic can be distributed and decentralized. Moreover, the wireless coverage provided by the disclosed system **100** is self-healing and redundant. In other words, due to the interconnectivity via the IP network **110**, if one or more of the DMAs **106** loses power, fails, or is otherwise inoperable, telephony traffic handled by the inoperable DMA **106** can re-routed to one of the remaining operable DMAs **106**. Additionally, user data stored in a database, e.g., a home locator resource (HLR) or a visitor locator resource (VLR), can be distributed equally and fully among all of the DMAs **106**. It can also be appreciated that new cellular coverage sites can be easily added to the system **100** as the demand for users increases. Specifically, a DMA can be deployed, connected to an antenna, connected to the IP network, and activated to provide cellular coverage in a new area.

FIG. **2** shows an exemplary, non-limiting embodiment of a network system, generally designated **200**, that includes a plurality of DMAs. As illustrated in FIG. **2**, the system **200** can include an Internet protocol (IP) peer-to-peer network that includes a first distributed mobile architecture **202** that is coupled to a second distributed mobile architecture **204** and to a third distributed mobile architecture **206**. Further, the sec-

ond distributed mobile architecture **204** is coupled to the third distributed mobile architecture **206**.

As shown in FIG. **2**, a first mobile subscriber **208** and a second mobile subscriber **210** are wirelessly coupled to the first distributed mobile architecture **202**. A first mobile subscriber **212** and a second mobile subscriber **214** are wirelessly coupled to the second distributed mobile architecture **204**. Additionally, a first mobile subscriber **216** and a second mobile subscriber **218** are wirelessly coupled to the third distributed mobile architecture **206**. FIG. **3** further indicates that a mobile switching center (MSC) interface **220** can be coupled to the first distributed mobile architecture **202** to provide access to a mobile telephone network, such as a cellular telephone network. Further, a voice over Internet protocol (VoIP) interface **222** is coupled to the second distributed mobile architecture **204** to provide access to a VoIP network. FIG. **3** also shows that an integrated services digital network (ISDN) interface **224** can be coupled to the third distributed mobile architecture **206** to provide connectivity to an ISDN.

In a particular embodiment, as described in detail herein, a mobile subscriber can communicate with another mobile subscriber via the first distributed mobile architecture **202**, the second distributed mobile architecture **204**, or the third distributed mobile architecture **206**. Further, in a particular embodiment, a mobile subscriber can communicate with another mobile subscriber via the first distributed mobile architecture **202** and the second distributed mobile architecture **204**, the first distributed mobile architecture **202** and the third distributed mobile architecture **206**, and the second distributed mobile architecture **204** and the third distributed mobile architecture **206**. Additionally, in a particular embodiment, a mobile subscriber can communicate with another mobile subscriber via the first distributed mobile architecture **202**, the second distributed mobile architecture **204**, or the third distributed mobile architecture **206**.

Further, in a particular embodiment, the first mobile subscriber **210** of the first DMA **202** can be connected locally to the second mobile subscriber **210** of the first DMA **202** after locating the second mobile subscriber **210** within the a home location register (HLR) within the first DMA **202**. Additionally, the first or second mobile subscriber **210**, **212** of the first DMA **202** can be connected to the first or second mobile subscriber **212**, **214** of the second DMA **204** after locating the first or second mobile subscriber **212**, **214** of the second DMA **204** within a second community location register (CLR) associated with the second DMA **202** that is stored within the first DMA **202**. Moreover, the first or second mobile subscriber **210**, **212** of the first DMA **202** can be connected to the first or second mobile subscriber **216**, **218** of the third DMA **206** after locating the first or second mobile subscriber **216**, **218** of the third DMA **206** within a third community location register (CLR) associated with the third DMA **206** that is stored within the first DMA **202**.

As a mobile subscriber roams into a coverage area that is not provided by the DMA to which the mobile subscriber is registered, the mobile subscriber can be temporarily registered with a new DMA while the mobile subscriber is roaming. CLR information concerning the roaming mobile subscriber can be obtained from the new DMA in order to complete a call to the roaming mobile subscriber.

In another particular embodiment, calls can be made from a mobile subscriber to an external destination, i.e., external to the DMA network, vie the MSC interface **220**, the VoIP interface **222**, or the ISDN interface **224**. A user can create a preferred hierarchy of interfaces to make calls external to the DMA network. As such, a user can indicate that all calls made from a mobile subscriber to an external device are to be established via the VoIP interface **222**. If the VoIP interface **222** is unavailable, a second preferred interface can be used to establish the external call.

FIG. **3** shows an exemplary, non-limiting, embodiment of a DMA, e.g., one of the DMAs **106** described in conjunction with FIG. **1** or one of the DMAs **202**, **204**, **206** shown in FIG. **2**. In a particular embodiment, the DMA **106** includes a processor, or computer, having a housing and a computer readable medium **300** that is disposed therein. A power supply **302** can also be disposed within the housing of the DMA **106** in order to provide power to the DMA **106**. The power supply **302** can be a rechargeable battery disposed within the DMA **106** or it can be external to the DMA **106**, i.e., a standard power outlet. Moreover, a cooling system **304**, e.g., a fan with a thermostat, can be within the DMA **106** in order to keep the DMA **106** from overheating. In an alternative embodiment, the DMA **106** can be a single board processor that does not require a fan.

As depicted in FIG. **3**, the DMA **106** can include a mobile switching center (MSC) module **306** and a base station controller (BSC) module **308** embedded within the computer readable medium **300**. In an exemplary, non-limiting embodiment, the MSC module **306** can include a gatekeeper (GK) **310** that is connected to several gateways. For example, a circuit gateway (CGW) **312** can be connected to the GK **310** and can provide connectivity to an integrated services digital network/public switched telephone network (ISDN/PSTN) interface **314**. The CGW **312** can provide a circuit switched to packet data conversion. In an exemplary, non-limiting embodiment, the PSTN portion of the ISDN/PSTN interface **314** can be an inter-office interface that uses the Bellcore industry standard ISDN user part (ISUP) signaling on a signaling system seven (SS7) link set. Moreover, the voice trunks on this interface can be timeslots on a T1 connection. Inbound and outbound voice calls can be supported on the ISDN portion of the ISDN/PSTN interface **314**.

As further illustrated in FIG. **3**, a packet data service node (PDSN) gateway **316** for CDMA, or a Gateway GPRS Support Node (GGSN) for Global System for Mobile Communication (GSM), and a Session Initiation Protocol (SIP) gateway **318** can also be connected to the GK **310**. The PDSN gateway **316** and the SIP gateway **318** can provide connectivity to an Internet protocol (IP) interface **320**. Further, the PDSN gateway **316** or a GGSN can establish a reverse tunnel with the PDSN or GGSN gateway **316** using generic routing encapsulation (GRE). Moreover, the PDSN gateway **316**, or GGSN, can implement the Pseudo Random Function (PRF)/Foreign Agent (FA) functionality of the DMA **106** which supports mobile IP functions.

FIG. **3** further shows an SS7 gateway **322** that provides connectivity to an ANSI-41 and GSM Mobile Application Part (MAP) interface **324**. In a particular embodiment, the ANSI-41 interface can be an SS7 TCAP/SCCP interface on the same SS7 link set used for ISUP signaling. The same SS7 point code can be used to identify the DMA **106** in the ANSI-41 network. The ANSI-41 interface can be used for roamer registration. Further, in an exemplary, non-limiting embodiment, the GSM MAP interface can be an SS7 TCAP/SCCP interface on the same SS7 link set used for ISUP signaling. It can be appreciated that there are different protocols of MAP from MAP/B to MAP/I, but in the illustrative embodiment, the different MAP/x protocols are not stacked—they are used independently.

As depicted in FIG. **3**, a media gateway **326** can also be coupled to the GK **310**. In an exemplary, non-limiting embodiment, the media gateway **326** can include cellular

transcoders, one or more intranet gateways, conferencing bridges, and group calling functionality. Further, an authentication, authorization, and accounting (AAA) module **328** can be coupled to the GK **310**. In an exemplary, non-limiting embodiment, there are three levels of authentication management. The highest level is for administration, the mid-level is for operations, and the lowest level is for normal users. The functions of the AAA module **328** can be included in the user level.

In an exemplary, non-limiting embodiment, the GK **310** can act as an AAA server and a feather server to support advanced supplementary service, short message service, etc. Moreover, the GK **310** can act as a call manager and can support ISUP and PSTN f unction calls. Additionally, the GK **310** can act as a signal gateway, e.g., IP to SS7 inter-working, ISUP, GSM MAP or ANSI-41 to PSTN and ANSI-42/GSM. The GK **310** can also function as a data call server.

As illustrated in FIG. **3**, the BSC module **308** includes a cellular radio network controller (CRNC) **330** and a cellular selection/distribution unit (CSDU) **332** that are connected to a call protocol controller (CPC) **334**. In turn, the CPC **334** can be connected to a plurality of base transceiver stations (BTSs) **336**. Specifically, the DMA **106** includes a BTS interface **338** at the CPC **334** that can be physically and directly connected to the BTSs **336**. The CRNC **330** can provide cellular radio resource management and cellular call control. The CSDU **332** can provide Fundamental Channel (FCH) soft handoff and distribution, Link Access Control (LAC) processing for inband signaling, multiplexer (MUX) functions, and centralized power control. Further, the CPC **334** can convert a T1 or E1 message or ATM interface to a data packet message. In a particular embodiment, each BTS **336** supports signals and traffic up to the front point of the CPC **334**, e.g., up to the BTS interface **338**. Further, in a particular embodiment, the CRNC **330**, the CPC **334**, the CSDU **332** and the OAMP **340** can perform one or more of the functions of legacy Base Station Controllers (BSC).

In an exemplary, non-limiting embodiment, the BTS interface **338** can be an IS-95A OR IS-2000 interface over E1 or ATM, or the BTS interface **338** can be a GSM BTS interface using Abis or an UMTS Iub interface or customized application for mobile network enhanced logic (CAMEL). In an illustrative embodiment, the CPC **334** can be connected to one or more BTSs **336**. FIG. **3** further shows that the BSC module **308** includes an operations, administration, maintenance, and provisioning (OAMP) module **340**. In an exemplary, non-limiting embodiment, the OAMP module **340** can use simple network management protocol (SNMP) for operations interfaces. Further, the OAMP module **340** can include a JAVA user interface. The OAMP module **340** can also include a software agent that is assigned to each component within the DMA **106**. The agents independently monitor their respective components. Moreover, each agent can provision its respective component.

In a particular embodiment, a DMA can be implemented as a system or a device. For example, a DMA system or a DMA device can include a DMA server or an DMA on board processor.

FIG. **4** depicts a plurality of DMAs. Particularly, FIG. **4** depicts a first DMA **400**, a second DMA **402**, and a third DMA **404**. FIG. **4** indicates that, in general, each DMA **400** includes a visitor location register (VLR), a home location register (HLR), and at least one community location register (CLR). In a particular embodiment, the VLR, HLR, and the CLR within each DMA **400**, **402**, **404** are part of an AAA module within each DMA **400**, **402**, **404**. For example, the HLR, VLR, and CLR may be within the AAA module **328** of the exemplary DMA of FIG. **3**.

In a particular embodiment, as indicated in FIG. **4**, the first DMA **400** includes a VLR **406**, an HLR **408**, a second CLR **410**, and a third CLR **412**. Further, the second DMA **402** includes a VLR **414**, a first CLR **416**, an HLR **418**, and a third CLR **420**. Additionally, the third DMA **404** includes a VLR **422**, a first CLR **424**, a second CLR **426**, and an HLR **428**.

In an exemplary, non-limiting embodiment, the first CLR **416** within the second DMA **402** and the first CLR **424** within the third DMA **404** correspond to the HLR **408** of the first DMA **400**. More particularly, the first CLR **416** within the second DMA **402** and the first CLR **424** within the third DMA **404** include information that is stored within the HLR **408** of the first DMA server **400**.

Additionally, in an exemplary, non-limiting embodiment, the second CLR **410** within the first DMA **400** and the second CLR **426** within the third DMA **404** correspond to the HLR **418** of the second DMA **402**. More particularly, the second CLR **410** within the first DMA **400** and the second CLR **426** within the third DMA **404** include the information that is stored within the HLR **418** of the second DMA server **402**.

Also, in an exemplary, non-limiting embodiment, the third CLR **412** within the first DMA **400** and the third CLR **420** within the second DMA **402** correspond to the HLR **428** of the third DMA **404**. More particularly, the third CLR **412** within the first DMA **400** and the third CLR **420** within the second DMA **402** include the information that is stored within the HLR **428** of the third DMA server **404**.

FIG. **4** further indicates that the first DMA **400** can include a destination preference register (DPR) **430**. Also, the second DMA **402** can include a DPR **432**. Moreover, the third DMA **404** can also include a DPR **434**. In a particular embodiment, each DPR **430**, **432**, **434** includes a preference for a call path to be used to place calls outside of a DMA network provided by the DMAs **400**, **402**, **404**. In a particular embodiment, the preference is established for each mobile subscriber registered with the DMA network. In another embodiment, the preference is established for each DMA within the DMA network.

Referring to FIG. **5**, an exemplary, non-limiting embodiment of an authentication, authorization, and accounting (AAA) module is shown and is generally designated **500**. The AAA module depicted in FIG. **5** can be embedded within any of the DMAs that are described herein. As indicated in FIG. **5**, the AAA module **500** includes data associated with an HLR **502**, a second CLR **504**, a third CLR **506**, and a VLR **508**. As shown, the HLR **502** data includes a plurality of IP addresses that can be used to establish one or more telephone calls within a first DMA in which the AAA module **500** is embedded. The HLR **502** data further includes a GPS location of the first DMA in which the AAA **500** is embedded.

As illustrated in FIG. **5**, the second CLR **504** and the third CLR **506** include one or more IP addresses that can be used to establish one or more telephone calls via a second and third DMA that are coupled to the first DMA in which the AAA module **500** is embedded. The second CLR **504** and the third CLR **506** also include a GPS location for the second and third DMA that are coupled to the first DMA in which the AAA module **500** is embedded. Further, the second CLR **502** and the third CLR **504** include a neighborhood (NB) list to identify neighboring DMS that are located proximately to the DMA in which the AAA module **500** is embedded.

FIG. **5** further indicates the data associated with the HLR **502**, the second CLR **504**, the third CLR **506**, and the VLR **508** include at least one international mobile subscriber identification (IMSI) **512** and at least one electronic series number

(ESN) **514**. Moreover, the HLR **502**, the second CLR **504**, and the third CLR **506** records also include at least one mobile directory number (MDN) **516**. In a particular embodiment, the HLR **502** includes a location **518** for at least one mobile subscriber that is registered with the HLR **502**.

As shown in FIG. **5**, the HLR **502** and the VLR **508** further include at least one temporary location directory number (TLDN) **520**, a registration indicator **522**, a timer **524**, a mobile switching center (MSC) preference indicator **526**, an integrated services digital network (ISDN) preference indicator **528**, and a voice over Internet protocol (VoIP) preference indicator **530** and a timer interval given to the visited mobile to be registered.

As shown in FIG. **5**, the AAA module **500** can also include a DPR **530**. As shown the DPR **530** includes at least one MDN prefix **532**. Further, the DPR **530** includes a first preferred destination indicator **534**, a second preferred destination indicator **536**, and a third preferred destination indicator **538**. In a particular embodiment, the preferred destination indicators **534**, **536**, **638** indicate a hierarchy of call paths that may be used to place calls outside a DMA network provided by one or more DMAs. For example, the first preferred destination indicator **534** can be a VoIP call path, the second preferred destination indicator **536** can be an ISDN call path, and the third destination indicator can be an MSC call path.

As such, in an illustrative embodiment, when a mobile subscriber attempts to call a particular MDN that is not within the HLR **502**, the second CLR **504**, or the third CLR **506**, the AAA module **500** can match the prefix of the MDN to the at least one MDN prefix in order to determine a preferred call path destination for establishing a call outside of the DMA network provided by the DMA in which the AAA module **500** is embedded. Accordingly, if a user wishes to save money, the user can choose to make calls outside of the DMA network via a VoIP interface. In another example, if a user wishes to have a higher call quality, the user can choose to make calls outside of the DMA network via an ISDN interface.

Referring to FIG. **6**, a method of determining a preferred call path for calls to be routed outside of a DMA network is shown and commences at block **600**. At block **600**, a DMA registers a mobile subscriber within a home location register (HLR) of the DMA. At block **602**, the DMA receives a call directed to a destination mobile directory number (MDN) that is not within any community location register (CLR) stored within the DMA. In a particular embodiment, this is an indication that the call is being made to a mobile directory number that is outside of a DMA network provided by one or more DMAs. Moving to block **604**, the DMA determines a preferred call path based on the prefix of the MDN. In a particular embodiment, the DMA can match the prefix of the MDN with an MDN prefix within a destination preference register (DPR) stored within the DMA in order to determine a hierarchy of preferred call paths for routing the call to the MDN. In a particular embodiment, the MDN is a ten digit telephone number, e.g., 222-333-4444, and the prefix of the MDN can be the first three digits of the number, e.g., 222. Further, in a particular embodiment, the preferred call path can be placed over a VoIP interface, an ISDN interface, or an MSC interface.

Proceeding to block **606**, the DMA determines whether an interface associated with a selected first preferred the call path is available. If so, the method continues to block **608** and the DMA establishes the call to the MDN outside of the DMA network via a DMA server that routes the call over the preferred call path. The method then ends at state **610**. For example, with reference to FIG. **2**, if the first subscriber **208** of the first DMA **202** includes a first preferred call path that is set to ISDN and the ISDN interface at the third DMA **206** is available, a call from the first subscriber **208** of the first DMA **202** to an external device can be routed to the third DMA **206**. In turn, the third DMA **206** can route the external device via the ISDN interface **224**.

Returning to decision step **606**, if the first preferred call path is not available, the DMA determines the next preferred call path for the matching MDN prefix within the DPR. The method then returns to decision step **606** and continues as described herein. Again, with reference to FIG. **2**, if the ISDN interface **224** is unavailable, a call to an external device can be routed to the first DMA **202**, which can route the call to the external device via the MSC interface **220**. Additionally, if the ISDN interface **224** and the MSC interface **220** is unavailable, a call to an external device can be routed to the second DMA **204**, which can route the call to the external device via the VoIP interface. In a particular embodiment, if none of the preferred call paths are available, the DMA can indicate that the call cannot be connected.

Referring to FIG. **7**, a method of establishing communication via a distributed mobile architecture (DMA) is shown and commences at block **700**. At block **700**, the DMA registers a first mobile subscriber within the home location register (HLR) of the DMA. Next, at block **702**, the DMA registers a second mobile subscriber within the home location register (HLR) of the DMA. Moving to block **704**, the DMA receives a call from the first mobile subscriber to the second mobile subscriber. At block **706**, the DMA locates the first mobile subscriber within the home location register of the DMA. Next, at block **708**, the DMA locates the second mobile subscriber within the home location register of the DMA. Proceeding to block **710**, the DMA connects the call between the first mobile subscriber and the second mobile subscriber via one or more local IP addresses within the DMA. The method then ends at state **712**.

FIG. **8** depicts a method of establishing communication via a first distributed mobile architecture (DMA) and a second DMA. Beginning at block **800**, the first DMA registers a first mobile subscriber within a home location register (HLR) of the first DMA. At block **802**, the second DMA registers a second mobile subscriber within the home location register (HLR) of the second DMA. Thereafter, at block **804**, the first DMA pre-fetches the home location register (HLR) information from the second DMA and stores it within a second community location register (CLR) at the first DMA. In a particular embodiment, the first DMA and the second DMA can be linked to each other via an IP network.

Moving to block **806**, the first DMA receives a call from the first mobile subscriber to be routed to the second mobile subscriber. At block **808**, the first DMA locates the first mobile subscriber within the home location register (HLR) of the first DMA. Proceeding to block **810**, the first DMA locates the second mobile subscriber within the second community location register (CLR) associated with the second DMA. At block **812**, the first DMA sends a location update request (LocUpdate) to the second DMA. Next, at block **814**, the first DMA receives an acknowledgement from the second DMA. In an illustrative embodiment, the acknowledgement includes the current address of the second mobile subscriber within the second DMA. Continuing to block **816**, the first DMA connects the first mobile subscriber to the second mobile subscriber via the first DMA and the second DMA by assigning an IP address at both the first DMA and the second DMA. The method then ends at state **818**.

Referring to FIG. **9**, a method of establishing communication between a first mobile subscriber and a second mobile subscriber that is roaming is shown and commences at block **900**. At block **900**, a first distributed mobile architecture

(DMA) registers a first mobile subscriber within a home location register (HLR) of the first DMA. At block **902**, a second DMA registers a second mobile subscriber within a home location register (HLR) of the second DMA. Moving to block **904**, the first DMA receives the home location register (HLR) information from the second DMA and stores it within a second community location register (CLR) at the first DMA.

Proceeding to block **906**, a third DMA registers the second mobile subscriber within a visitor location register (VLR) of the third DMA. In a particular embodiment, this indicates that the second mobile subscriber has roamed into a coverage area controlled by the third DMA. At block **908**, the third DMA sends the registration information of the second mobile subscriber to the second DMA.

Moving to block **910**, the first DMA receives a call from the first mobile subscriber to be routed to the second mobile subscriber. Thereafter, at block **912**, the first DMA locates the first mobile subscriber within the home location register (HLR) of the first DMA. At block **914**, the first DMA locates the second mobile subscriber within the second community location register (CLR) that is associated with the second DMA.

Proceeding to block **916**, the first DMA sends a location update request (LocUpdate) to the second DMA. At block **918**, the second DMA sends the location update (LocUpdate) to the third DMA. Then, at block **920**, the second DMA receives an acknowledgement from the third DMA. In a particular embodiment, the acknowledgement includes a current address of the second mobile subscriber within the third DMA. For example, the third DMA can retrieve the current address of the second mobile subscriber from the VLR within the third DMA. Continuing to block **922**, the first DMA receives the acknowledgement from the second DMA with the address of the second mobile subscriber. Next, at block **924**, the first DMA connects the first mobile subscriber to the second mobile subscriber via the first DMA and the third DMA. For example, an IP address at the third DMA is assigned to the call and is used to route the call over an IP network between the first DMA and the third DMA. The method then ends at state **926**.

Referring to FIG. **10**, an exemplary, non-limiting embodiment of a telecommunications system is shown and is generally designated **1000**. As shown, the system includes one or more DMAs **1002** that are connected to a wireless carrier's central MSC **1004**. The DMA(s) **1002** can be connected to the MSC **1004** via an E1 CCS (G.703, G732) connection, or any other applicable connection. The MSC **1004**, in turn, is connected to a code division multiple access (CDMA) network **1006**. FIG. **10** further shows that the DMA(s) **1002** can be connected to a switching transfer point (STP) **1008** of a standalone carrier. As shown, the DMA **1002** can be connected to the STP **1008** via an IS-41+IS-880 (DS0) connection, or an ISUP ITU N7 connection.

As further depicted in FIG. **10**, the STP **1008** can be connected to a short messaging service (SMS) server **1010** in order to provide text-messaging capabilities for the mobile communication devices using the system **1000** shown in FIG. **10**. Additionally, the STP **1008** can be connected to a home location register (HLR) **1012**, a pre-paid wireless server **1014** and an international roaming network **1016** in order to provide pre-paid services and roaming between multiple countries. FIG. **10** shows that the DMA(s) **1002** can be connected to the PTSN **1018** via an E1 CCS (G.703, G732) connection, or any other appropriate connection.

Referring to FIG. **11**, a wireless local loop (WLL) system is portrayed and is generally designated **1100**. As illustrated in FIG. **11**, the system **1100** includes a DMA **1102** that is connected to a BTS **1104**. The BTS **1104**, in turn, is connected to an antenna **1106**. The antenna **1106** provides cellular coverage for one or more subscribers **1108** within transmission distance of the antenna **1106**. FIG. **11** indicates that the system **1100** can further include a data network connection **1110** from the DMA **1102**. The data network connection **1110** can connect the DMA **1102** to the PSTN via an ISUP/ISDN signaling connection on an SS7 link set or a T1/E1 wireless connection. Further, the data network connection **1110** can be an IEEE 802.11 connection between the DMA **1102** depicted in FIG. **11** and other DMAs not shown. The DMA **1102** can beneficially utilize existing infrastructure used for cellular and SMS data services.

FIG. **12** shows a multi-WLL system, generally designated **1200**. As shown, the system **1200** includes a plurality of WLLs **1202**. Each WLL **1202** can include a DMA **1204** and an antenna **1206** connected thereto to provide a cellular coverage site around the antenna **1206**. As illustrated in FIG. **12**, the WLLs **1202** can be interconnected via a wireless local area network (WLAN), or a wide area network, such as a microwave connection. Moreover, a DMA **1204** within one of the WLLs **1202** can provide a back-haul connection **1208** to the PSTN **1210**. This type of deployment scenario can greatly reduce the costs associated with a wireless system. Since the DMAs **1204** are connected to each other via the WLAN or microwave connections, the relatively expensive inter-site back-haul component is removed. Further, using the hand-off logic, the DMAs **1204** can enable roaming between the WLLs **1202** and can further provide roaming to an external wireless or other network.

Referring to FIG. **13**, a telecommunications system is depicted and is designated **1300**. As illustrated in FIG. **13**, the system **1300** includes a DMA **1302** that can be connected to a plurality of BTSs **1304**. Each BTS **1304** can provide cellular coverage for one or more mobile communication devices **1306**, e.g., one or more mobile handsets configured to communicate via the DMA **1302**. FIG. **13** further shows that the DMA **1302** can be connected to an MSC **1308**, such as an MSC of an existing cellular system. The DMA **1302** can be connected to the MSC via an IS-**41** subset or a MAP subset over a wireless E1/T1 connection. With this implementation, the DMA **1302** can extend an existing cellular network when connected to an existing cellular system MSC **1308**.

FIG. **14** shows an additional telecommunications system, generally designated **1400**. As shown, the system **1400** includes a city area coverage site **1402** and an urban fringe/nearby village coverage site **1404**. In an exemplary, non-limiting embodiment, the city area coverage site **1402** includes a first MSC/BSC center **1406** connected to a second MSC/BSC center **1408**. Also, a first representative BTS **1410** and a second representative BTS **1412** are connected to the first MSC/BSC center **1406**. The particular deployment of equipment is configured to provide adequate cellular coverage for mobile communication devices within the city area coverage site **1402**.

As illustrated in FIG. **14**, the urban fringe/nearby village coverage site **1404** includes a DMA **1414** having a plurality of BTSs **1416** connected thereto. The DMA **1414** can provide hand-off of calls between the BTSs **1416** and can switch calls made between the BTSs **1416** locally. However, the DMA **1414** within the urban fringe/nearby village coverage site **1404** can also connect telephony traffic to the first MSC/BSC center **1406** within the city area coverage site **1402** via a data network connection **1418**. In one embodiment, the data network connection can be an E1 connection, a T1 connection, a microwave connection, or an 802.11 connection established

via an IS-41 subset or MAP subset. The deployment of a DMA **1414** in a location such as that described above, i.e., in urban fringe or in a nearby village, and the connection of the DMA **1414** to an MSC/BSC center **1406** in a city area, can provide service to potential wireless customers that typically would not receive cellular coverage from the city area cellular coverage site **1402**. Thus, new subscribers receive access to wireless communication service and can further communicate with wireless customers within the city area cellular coverage site **1402**.

Referring now to FIG. **15**, another telecommunications system is depicted and is designated **1500**. As illustrated in FIG. **15**, the system **1500** includes a DMA **1502** that can be connected to a plurality of BTSs **1504**. Each BTS **1504** can provide cellular coverage for one or more mobile communication devices **1506**. FIG. **15** further shows that the DMA **1502** can include a data network connection **1508** that provides a back-haul connection to the PSTN **1510**. In one embodiment, the data network connection can be an E1 connection, a T1 connection, a cable connection, a microwave connection, or a satellite connection. Moreover, the system **1500** depicted in FIG. **15** can be deployed using CDMA IS-95, CDMA 1X, GSM/GPRS, W-CDMA, or other industry standard technologies.

Using a single back-haul connection greatly minimizes costs associated with the wireless communication network. Further, the system **1500** shown in FIG. **15** can be deployed relatively rapidly and can be maintained remotely. Additionally, with the inclusion of the OAMP module **540** (FIG. **5**) and the AAA module **528** (FIG. **5**), subscriber accounts can be managed locally and billing can be performed locally, i.e., within the DMA **1502**. Moreover, as the number of subscribers increase, the size of the system can be increased modularly, e.g., by adding DMAs, corresponding BTSs, and the appropriate connections.

FIG. **16** illustrates an in-building telecommunications network that is generally designated **1600**. FIG. **16** depicts a structure **1602**, e.g., an office building, a commercial building, a house, etc. An enterprise local area network (LAN) **1604** is installed within the building **1602**. A micro-BTS **1606** is connected to the enterprise LAN **1604**. Moreover, a voice mail server **1608** and plural enterprise services servers **1610** are connected to the enterprise LAN **1604**. In an exemplary, non-limiting embodiment, the enterprise services servers **1610** can include a dynamic host configuration protocol (DHCP) server, a radius server, a domain name server (DNS), etc. As depicted in FIG. **16**, a plurality of phones **1612**, e.g., IP desk phones can be connected to the enterprise LAN **1604**.

FIG. **16** further indicates that an office DMA **1614** can be connected to the enterprise LAN **1604**. The office DMA **1614** can also be connected to the PSTN **1616**, which, in turn, can be connected to a cellular voice and data network **1618**. The enterprise LAN **1604** can also be connected to the cellular voice and data network **1618** via an Internet protocol (IP) network **1620**. A signaling system seven (SS7) network **1622** can be connected to the cellular voice and data network **1618** and the IP network **1620**. FIG. **16** also depicts an SS7 gateway **1624** between the SS7 network **1622** and the IP network **1620** and a firewall **1626** between the enterprise LAN **1604** and the IP network **1620**. FIG. **16** shows a wireless communication device **1628** in communication with the cellular voice and data network **1618** and the micro-BTS **1606**.

Referring to FIG. **17**, a mobile in-field telecommunications system is depicted and is generally designated **1700**. As depicted, the system **1700** includes a plurality of mobile cellular coverage sites **1702**. Each mobile cellular coverage site **1702** includes a vehicle **1704** in which a field DMA **1706** is disposed. Moreover, a BTS **1708** is disposed within each vehicle **1704** and is in direct physical connection with the field DMA **1706**, e.g., by a wire or cable connected there between. The field DMA **1706** and the BTS **1708** can be removably installed within the vehicle **1704** or permanently affixed therein. FIG. **17** further indicates that each BTS **1708** can include an antenna **1710** that is designed to communicate with mobile communication devices. Also, each field DMA **1706** includes an antenna **1712**. In an exemplary, non-limiting embodiment, the field DMAs **1706** can communicate wirelessly with each other via the antennae **1712**, e.g., via 802.11a, 802.11b, microwaves, or other wireless link.

The mobile cellular coverage sites **1702** can be deployed to provide a temporary web of cellular coverage for a plurality of mobile communication devices, e.g., devices carried by soldiers during a battle. The mobile in-field communications system **1700** can be recalled, moved, and re-deployed as necessary. Further, the system can include a wireless connection, e.g., 802.11a, 802.11b, microwaves, to the PSTN **1714**.

Referring to FIG. **18**, still another telecommunications system is illustrated and is generally designated **1800**. As depicted in FIG. **18**, the system **1800** includes a DMA **1802** that is connected to a BTS **1804**. The BTS **1804**, in turn, is connected to an antenna **1806**. FIG. **18** further illustrates that a first satellite transceiver **1808** is also connected to the DMA **1802**. The first satellite transceiver **1808** communicates with a second satellite transceiver **1810** via a satellite **1812**. Additionally, the second satellite transceiver **1810** includes a data network connection **1814**, e.g., a T1 connection, or an E1 connection. The satellite transceivers **1808**, **1810** and the satellite **1812** can provide a backhaul connection for the DMA **1802**. Or, the satellite transceivers **1808**, **1810** and the satellite **1812** can connect the DMA **1802** to an additional DMA (not shown).

FIG. **19** shows yet another telecommunications system that is generally designated **1900**. As illustrated in FIG. **19**, the system includes a DMA **1902** that is connected to a first satellite transceiver **1904**. Moreover, the DMA **1902** includes a primary network connection **1906**, e.g., a T1 connection, or an E1 connection, and a secondary network connection **1908**, e.g., an IP connection. FIG. **19** shows that the first satellite transceiver **1904** communicates with a second satellite transceiver **1910** and a third satellite transceiver **1912** via a satellite **1914**. Each of the second and third satellite transceivers **1910**, **1912** is connected to an interworking unit (IWU) **1916** via a data network connection **1918**, e.g., an IP connection. Each IWU **1916** is connected to a BTS **1920**, which in turn, is connected to an antenna **1922**. The satellite transceivers **1904**, **1910**, **1912** provide an IP network extension for the DMA **1902**. Moreover, in the deployment illustrated in FIG. **19**, the DMA **1902** can act as a centralized micro-switch for handling calls received at the antennas **1922** and transmitted via the second and third satellite transceivers **1910**, **1912**.

Referring to FIG. **20**, another telecommunications system is depicted and is designated **2000**. As shown, the system **2000** includes a DMA **2002** having a primary network connection **2004**. Moreover, the DMA **2002** can be connected to a plurality of IWUs **2006**. In an exemplary, non-limiting embodiment, the DMA **2002** can be connected to each IWU **2006** via a secondary network connection **2008**, such as a category five (Cat 5) cable connection, a microwave connection, or a WLAN connection. Further, each IWU **2006** is connected to a BTS **2010** and each BTS **2010**, in turn, is connected to an antenna **2012**. Each BTS **2010** can be a 3-sector BTS. In the deployment depicted in FIG. **20**, the

DMA **2002** can act as a centralized micro-switch that can be used to handle telephony traffic received at the antennae **2012**.

FIG. **21** illustrates yet another embodiment of a communications system, designated **2100**. As shown, the system **2100** includes an airplane **2102** in which a DMA **2104** is installed. As shown, the DMA **2104** is coupled to a BTS **2106** and a first satellite transceiver **2108**. FIG. **21** also shows a mobile communication device **2110** within the airplane **2102**. The mobile communication device **2110** can be in wireless communication with the BTS **2106**.

In a particular embodiment, the first satellite transceiver **2108** can communicate with a second satellite transceiver **2112** via a satellite **2114**. As shown, the second satellite transceiver **2112** can be connected to a terrestrial server gateway **2116**, e.g. a DMA gateway, that can provide connectivity to an operations and management platform (OMP) **2118**, a call detail record (CDR) **2120**, and a visitor location register gateway (VLR-GW) **2122**. The OMP **2118**, the CDR **212**, and the VRL-GW **2122** can be separate from or incorporated within the server gateway **2116**. FIG. **21** further shows that the server gateway **2116** can be connected to a first mobile switching center (MSC) **2124** that is coupled to a second MSC **2126**.

Accordingly, the system **2100** shown in FIG. **21** can allow a user in the airplane **2102** to communicate with a ground based telephone. For example, the mobile communication device **2110** can communicate with the BTS **2106**, which, in turn, can communicate with the first satellite transceiver **2108** via the DMA **2104**. Further, the first satellite transceiver **2108** can transmit the call to a ground based communication system via the second satellite transceiver **2112** and the satellite **2114**.

FIG. **21** shows a single airplane, however, multiple airplanes can be configured as described herein to provide communication from multiple airplanes to ground based telephones. Further, airplane-to-airplane communication can be provided. Additionally, the system **2100** can include other airborne vehicles, e.g., blimps.

FIG. **22** illustrates yet another embodiment of a communications system, designated **2200**. As shown, the system **2200** includes a ship **2202** in which a DMA **2204** is installed. As shown, the DMA **2204** is coupled to a BTS **2206** and a first satellite transceiver **2208**. FIG. **22** also shows a mobile communication device **2210** within the ship **2202**. The mobile communication device **2210** can be in wireless communication with the BTS **2206**.

In a particular embodiment, the first satellite transceiver **2208** can communicate with a second satellite transceiver **2212** via a satellite **2214**. As shown, the second satellite transceiver **2212** can be connected to a terrestrial server gateway **2216**, e.g. a DMA gateway, that can provide connectivity to an operations and management platform (OMP) **2218**, a call detail record (CDR) **2220**, and a visitor location register gateway (VLR-GW) **2222**. The OMP **2218**, the CDR **222**, and the VRL-GW **2222** can be separate from or incorporated within the server gateway **2216**. FIG. **22** further shows that the server gateway **2216** can be connected to a first mobile switching center (MSC) **2224** that is coupled to a second MSC **2226**.

Accordingly, the system shown in FIG. **2200** can allow a user within the ship **2202** to communicate with a ground-based telephone. For example, the mobile communication device **2210** can communicate with the BTS **2206**, which, in turn, can communicate with the first satellite transceiver **2208** via the DMA **2204**. Further, the first satellite transceiver **2208** can transmit the call to a ground based communication system via the second satellite transceiver **2212** and the satellite **2214**.

FIG. **22** shows a single ship, however, multiple ships can be configured as described herein to provide communication from multiple ships to ground based telephones. Further, ship-to-ship communication can be provided. Additionally, the system **2200** can include other waterborne vehicles.

Referring to FIG. **23**, a method of deploying a distributed management architecture server is shown and commences at block **2300** wherein during deployment, the succeeding steps are performed. At block **2302**, the DMA is moved to a desired location proximate to a BTS. Moving to block **2304**, the DMA is opened. For example, if the DMA is the DMA shown in FIG. **1**, the latch is unlocked and the lid is rotated about the hinges into the open position. Proceeding to block **2306**, a physical connection is established between the DMA and the BTS, e.g., the BTS is coupled to the DMA via a wire.

Continuing to block **2308**, the DMA is activated, e.g., powered on. At block **2310**, a network connection is established with another remote DMA. In a particular embodiment, the network connection is a peer-to-peer connection between the DMAs. Moving to block **2312**, DMA software within the DMA is activated. Thereafter, at decision step **2314**, it is determined whether the system is operational. That decision can be a performed by the DMA, e.g., by a self-diagnostic routine or module within the DMA. Alternatively, that decision can be determined manually by a technician. If the system is not operational, a system check is performed at block **2316**. In a particular embodiment, the system check performed at block **2316** is performed by a self-diagnostic routine or module within the DMA. On the other hand, a technician can perform the system check. After the system check, the logic then returns to decision step **2314** and continues as described herein. At decision step **2314**, if the system is operational, the method proceeds to block **2318** and call transmission is allowed. The method then ends at state **2320**.

Referring to FIG. **24**, a method of deploying a distributed management architecture server is shown and commences at block **2400** wherein a direct physical connection between a first DMA and a base transceiver station is disconnected. At block **2402**, the first DMA is removed. Proceeding to block **2404**, a second DMA is moved to a location that is substantially proximate to the base transceiver station. At block **2406**, the second DMA is opened. For example, if the DMA is the DMA shown in FIG. **1**, the latch is unlocked and the lid is rotated about the hinges into the open position. Next, at block **2408**, a direct physical connection is established between the second DMA and the base transceiver station.

Continuing to block **2410**, the second DMA is activated. At block **2412**, a network connection is established between the second DMA and another remote DMA. In a particular embodiment, the network connection is a peer-to-peer IP connection between the DMAs. Further, in a particular embodiment, the peer-to-peer connection is established via a private IP network. At block **2414**, DMA software within the second DMA is activated.

Proceeding to decision step **2416**, it is determined whether the system is operational. That decision can be a performed by the second DMA, e.g., by a self-diagnostic routine or module within the second DMA. Alternatively, the decision can be determined manually by a technician. If the system is not operational, a system check is performed at block **2418**. In a particular embodiment, the system check performed at block **2418** is performed by a self-diagnostic routine or module within the second DMA. On the other hand, a technician can

perform the system check. After the system check, the logic then returns to decision step **2416** and continues as described herein. At decision step **2416**, if the system is operational, the method proceeds to block **2420** and call transmission is allowed via the second DMA. The method then ends at state **2422**.

With the configuration of structure described above, the present disclosure provides a flexible telecommunications device, i.e., a DMA, that is distributive and associative, i.e., it can operate stand-alone or seamlessly within an existing cellular or other network. Moreover, the DMA can be integrated with virtually any third party base station. The DMA can operate with multiple air interfaces including CDMA IS-95, CDMA 1X, CDMA EVDO, GSM, GPRS, W-CDMA, 802.11 (Wi-fi), 802.16 (Wi-fi), etc. Further, the DMA can provide integrated prepaid billing, OAMP, network management, and AAA functionality. The DMA can include a Java based user interface and feature configuration system. Also, the DMA can provide real time call metering, call detail record (CDR) generation, and real time call provisioning. The DMA may be implemented in a relatively small footprint and has a relatively low power requirement. Further, the DMA may be implemented using inexpensive and widely available computer equipment.

With one or more of the deployment configurations described above, the present system provides mobile to landline calls from mobile handsets within a DMA cellular coverage area. Also, mobile to landline calls can be made from mobile handsets roaming into DMA coverage areas. Mobile to mobile calls can be made from home/roaming handsets to DMA handsets and vice versa. Further, mobile to IP calls and IP to mobile calls can be made from within a DMA coverage area. IP to IP calls can be made from any DMA handset to any IP phone. Additionally, IP to landline calls and landline to IP calls can be made from a DMA handset to any phone. Further, land-line to mobile calls to DMA handsets can be made.

The systems described above can support call forwarding, call waiting, 3-way calling caller ID, voice mail, and mobile to mobile SMS service, i.e., text messaging. Further, the systems described above can provide broadcast SMS service, mobile to land high-speed IP data (1X or GPRS) service and mobile-to-mobile high speed IP data (1X or GPRS) service. Also, the systems described above can provide IP-PBX capability.

Further, one or more of the illustrated systems can provide IP transport between distributed elements, e.g., DMAs. Packet back-haul from BTS to RAN can be provided. Further, the control logic within the DMAs can be distributed and associated. Associated systems can be redundant, self-healing, self-organizing, and scalable. Distributed systems can be "snap-together," i.e., a DMA can be linked to a previously deployed DMA in order to broaden, or otherwise extend, cellular coverage. Further, distributed systems can be decentralized to avoid single points of failure.

One or more of the systems described above can also provide soft and softer call handoffs on the same frequency interfaces. Also, soft handoffs can be provided on different systems. Further, a DMA based system can operate stand-alone with a billing system provided by a DMA and CDR generation. Or, a system can use the SS7 network to pass CDRs to a central switch for integrated billing and operation with an existing network.

The above-disclosed subject matter is to be considered illustrative, and not restrictive, and the appended claims are intended to cover all such modifications, enhancements, and other embodiments, which fall within the true spirit and scope of the present invention. Thus, to the maximum extent allowed by law, the scope of the present invention is to be determined by the broadest permissible interpretation of the following claims and their equivalents, and shall not be restricted or limited by the foregoing detailed description.

What is claimed is:

1. A method, comprising:

receiving, at a first distributed mobile architecture (DMA) system of a DMA network, a call from a first mobile subscriber to a second mobile subscriber, wherein the DMA network includes at least the first DMA system and a second DMA system;

determining whether the second mobile subscriber is located within a first wireless coverage area of the DMA network that is associated with the first DMA system based on information stored at a home location register (HLR) of the first DMA system and a visitor location register (VLR) of the first DMA system;

when the second mobile subscriber is located within the first wireless coverage area, connecting the call to the second mobile subscriber via the first DMA system;

when the second mobile subscriber is not located within the first wireless coverage area, determining whether the second mobile subscriber is located within a second wireless coverage area of the DMA network that is associated with the second DMA system based on information stored at a community location register (CLR) associated with the second DMA system, wherein the CLR associated with the second DMA system is stored at the first DMA system; and

when the second mobile subscriber is not located within the first wireless coverage area and is not located within the second wireless coverage area, determining a preferred call path to route the call outside of the DMA network based on information stored at a destination preference register (DPR), wherein the DPR is stored at the first DMA system.

2. The method of claim **1**, further comprising:

routing the call outside of the DMA network via the preferred call path when the second mobile subscriber is not located within the first wireless coverage area and is not located within the second wireless coverage area.

3. The method of claim **1**, further comprising:

connecting the call via an Internet Protocol (IP) peer-to-peer connection between the first DMA system and the second DMA system when the second mobile subscriber is located within the second wireless coverage area.

4. The method of claim **1**, wherein the CLR associated with the second DMA system includes information associated with a second HLR that is stored at the second DMA system.

5. The method of claim **1**, wherein the preferred call path includes one of a first preferred Voice over Internet Protocol (VoIP) call path of a plurality of VoIP call paths, a first preferred mobile switching center (MSC) call path of a plurality of MSC call paths, and a first preferred Integrated Services Digital Network (ISDN) call path of a plurality of ISDN call paths.

6. The method of claim **1**, wherein the preferred call path is determined based on information provided by the first mobile subscriber.

7. The method of claim **1**, wherein the first DMA system is associated with a first preferred call path, and wherein the second DMA system is associated with a second preferred call path.

8. A method, comprising:

receiving, at a first distributed mobile architecture (DMA) system of a DMA network, a call from a first mobile subscriber to a second mobile subscriber, wherein the

DMA network includes at least the first DMA system, a second DMA system, and a third DMA system;

determining whether the second mobile subscriber is located within a first wireless coverage area of the DMA network that is associated with the first DMA system based on information stored at a home location register (HLR) of the first DMA system and a visitor location register (VLR) of the first DMA system;

when the second mobile subscriber is located within the first wireless coverage area, connecting the call to the second mobile subscriber via the first DMA system;

when the second mobile subscriber is not located within the first wireless coverage area, determining whether the second mobile subscriber is located within a second wireless coverage area of the DMA network that is associated with the second DMA system based on information stored at a community location register (CLR) associated with the second DMA system, wherein the CLR associated with the second DMA system is stored at the first DMA system;

when the second mobile subscriber is not located within the first wireless coverage area and is not located within the second wireless coverage area, determining whether the second mobile subscriber is located within a third wireless coverage area of the DMA network that is associated with the third DMA system based on information stored at a CLR associated with the third DMA system, wherein the CLR associated with the third DMA system is stored at the first DMA system; and

when the second mobile subscriber is not located within any of the first wireless coverage area, the second wireless coverage area, and the third wireless coverage area, determining a preferred call path to route the call outside of the DMA network based on information stored at a destination preference register (DPR), wherein the DPR is stored at the first DMA system.

9. The method of claim **8**, further comprising:

routing the call outside of the DMA network via the preferred call path when the second mobile subscriber is not located within any of the first wireless coverage area, the second wireless coverage area, and the third wireless coverage area.

10. The method of claim **8**, further comprising:

connecting the call via an Internet Protocol (IP) peer-to-peer connection between the first DMA system and the second DMA system when the second mobile subscriber is located within the second wireless coverage area; and

connecting the call via an IP peer-to-peer connection between the first DMA system and the third DMA system when the second mobile subscriber is located within the third wireless coverage area.

11. A distributed mobile architecture (DMA) system, comprising:

a housing;

a base transceiver station coupled to the housing, the base transceiver station operable to receive a call from a mobile subscriber;

a computer readable storage medium within the housing, the computer readable storage medium comprising:

an authentication, authorization, and accounting (AAA) module embedded within the computer readable storage medium, the AAA module comprising:

a home location register (HLR) that stores information associated with one or more mobile subscriber devices that are registered with the DMA system;

a visitor location register (VLR) that stores information associated with one or more roaming mobile subscriber devices that are temporarily registered with the DMA system;

a community location register (CLR) that stores information associated with a second HLR of a second DMA system, wherein the second HLR stores information associated with one or more mobile subscriber devices that are registered with the second DMA system; and

a destination preference register (DPR) that stores one or more preferred call paths for calls to be routed outside of a DMA network that is accessible to the DMA system, wherein the DMA network includes at least the first DMA system and the second DMA system,

a call routing component embedded within the computer readable storage medium, the call routing component comprising processor executable instructions to route the call via a particular preferred call path of the one or more preferred call paths stored at the DPR when the AAA module determines that the call is directed to a destination device that is outside of the DMA network.

12. The DMA system of claim **11**, wherein the AAA module determines that the destination device is outside of the DMA network based on the information stored at the HLR, the information stored at the VLR, and the information stored at the CLR.

13. The DMA system of claim **11**, further comprising a mobile switching center (MSC) interface that provides communication access to a mobile telephone network.

14. The DMA system of claim **11**, further comprising a Voice over Internet Protocol (VoIP) interface that provides communication access to a VoIP network.

15. The DMA system of claim **11**, further comprising an Integrated Services Digital Network (ISDN) interface that provides communication access to an ISDN network.

16. The DMA system of claim **11**, wherein the particular preferred call path includes one of a Voice over Internet Protocol (VoIP) call path, a mobile switching center (MSC) call path, and an Integrated Services Digital Network (ISDN) call path.

17. The DMA system of claim **16**, wherein the call is directed to a mobile directory number (MDN), and wherein the particular preferred call path is determined based on an MDN prefix.

18. The DMA system of claim **17**, wherein the MDN prefix includes the first three digits of the MDN.

19. The DMA system of claim **17**, wherein a first set of MDN prefixes is associated with the VoIP call path, a second set of MDN prefixes is associated with the MSC call path, and a third set of MDN prefixes is associated with the ISDN call path.

20. The DMA system of claim **11**, wherein the AAA module further comprises:

a second CLR that stores information associated with a third HLR of a third DMA system of the DMA network, wherein the third HLR stores information associated with one or more mobile subscriber devices that are registered with the third DMA system.

21. The DMA system of claim **11**, further comprising:

a mobile switching center (MSC) module embedded within the computer readable storage medium;

a base station controller (BSC) module embedded within the computer readable storage medium; and

a call detail record (CDR) generation program embedded within the computer readable storage medium, the CDR generation program adapted to store a set of call detail records.

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