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(54) **SYSTEM AND METHOD FOR LOCATION BASED EXCHANGES OF DATA FACILITATING DISTRIBUTED LOCATIONAL APPLICATIONS**

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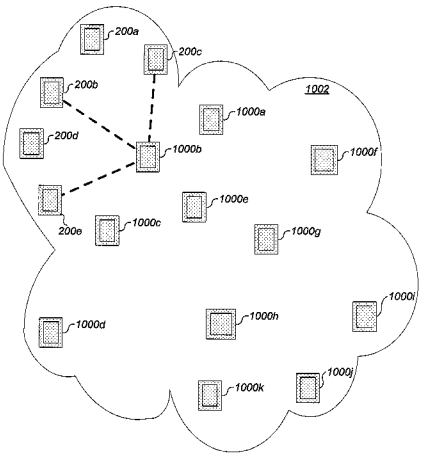
(57) **ABSTRACT**

Provided is a distributed system and method for enabling new and useful location dependent features and functionality to mobile data processing systems. Mobile data processing systems interact with each other as peers in communications and interoperability. Indirectly located mobile data processing systems are located relative other mobile data processing systems, and are automatically located using whereabouts data of directly located mobile data processing systems and/or whereabouts data of other indirectly located mobile data processing systems. A mobile data processing system may dynamically take on roles of being directly located or indirectly located, depending on the environment and capabilities available at a particular time. Reference whereabouts data is appropriately shared between mobile data processing systems to carry out automatic location techniques ensuring mobile data processing systems are kept up to date with their own whereabouts and whereabouts of others, regardless of the freely moving travels of any of the mobile data processing systems involved, and the location technologies that may or may not be available when needed. A confidence is associated to whereabouts data shared for facilitating selection of the best candidate data used in determining new whereabouts information.

46 Claims, 70 Drawing Sheets



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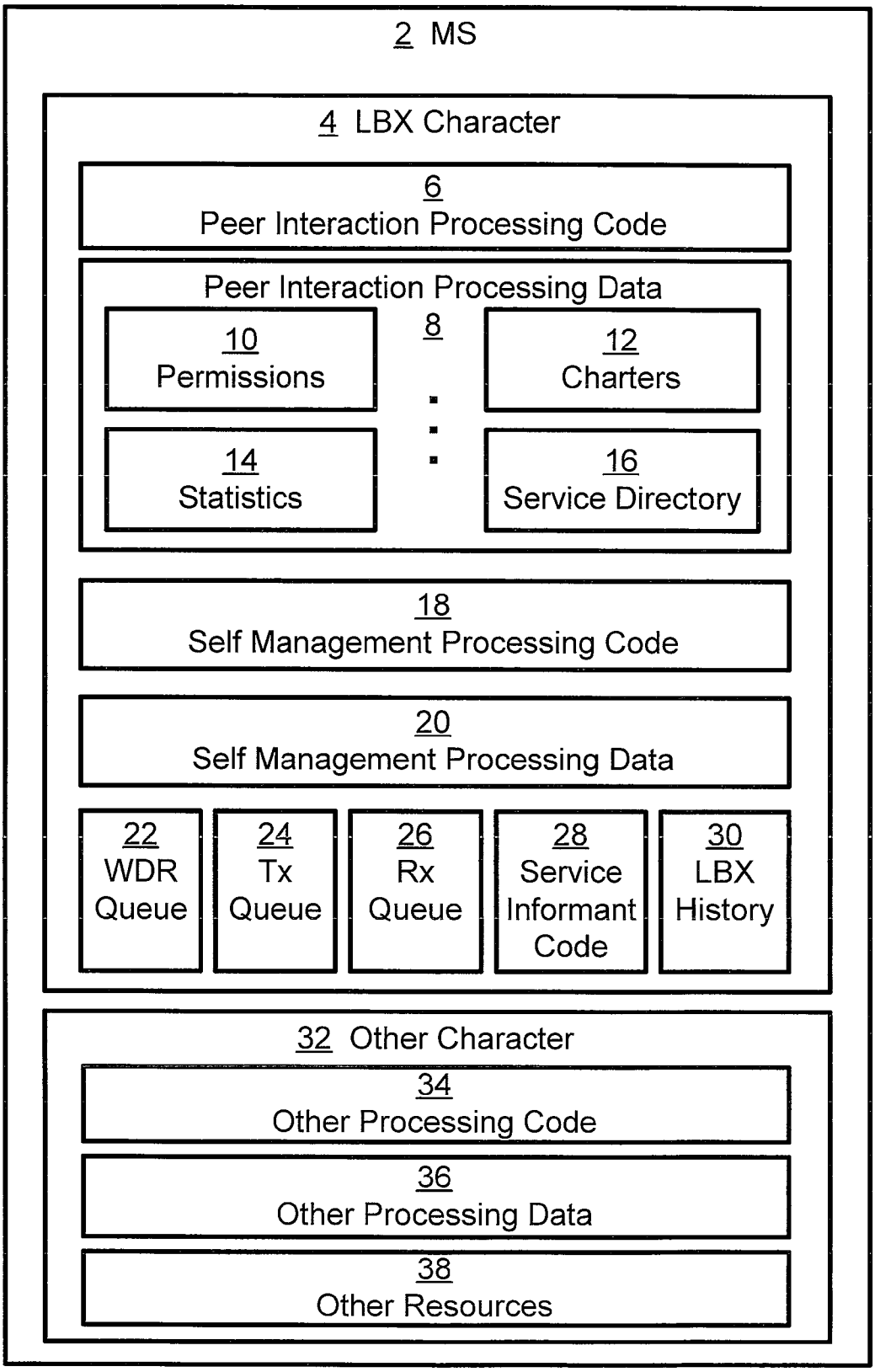

2 MS
4 LBX Character
6
Peer Interaction Processing Code
Peer Interaction Processing Data
10
Permissions
8
12
Charters
14
Statistics
16
Service Directory
18
Self Management Processing Code
20
Self Management Processing Data
22
WDR
Queue
24
Tx
Queue
26
Rx
Queue
28
Service
Informant
Code
30
LBX
History
32 Other Character
34
Other Processing Code
36
Other Processing Data
38
Other Resources

Fig. 1A

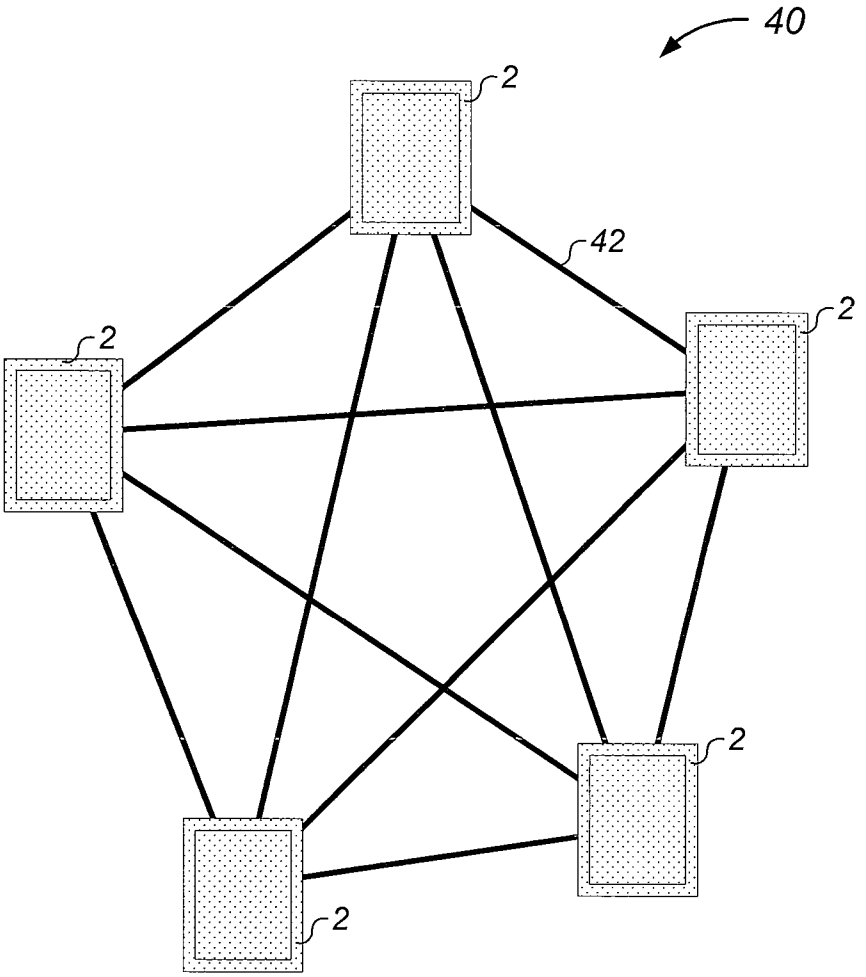


Fig. 1B

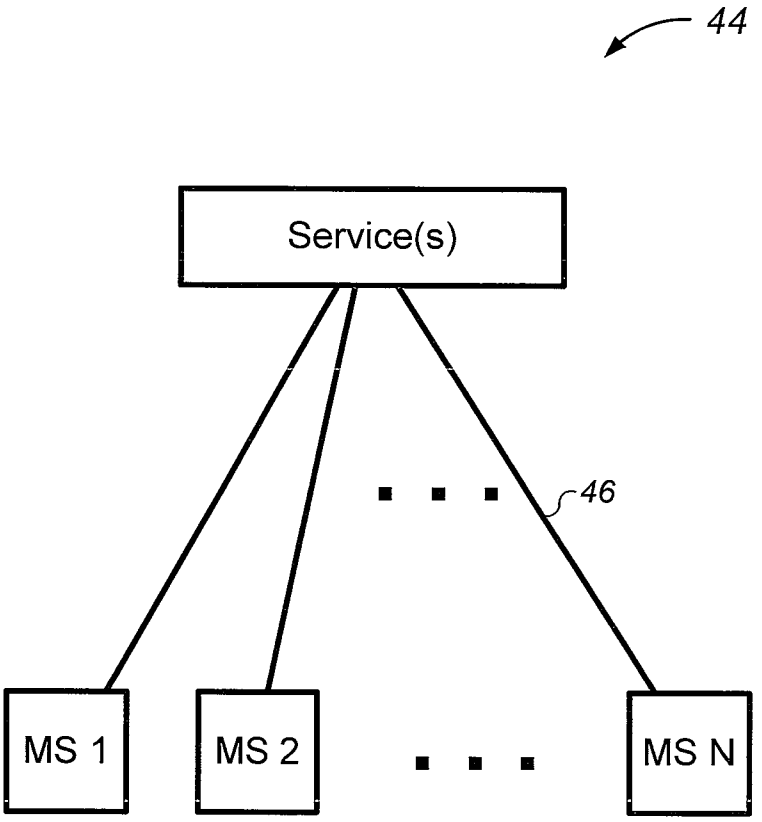


Fig. 1C

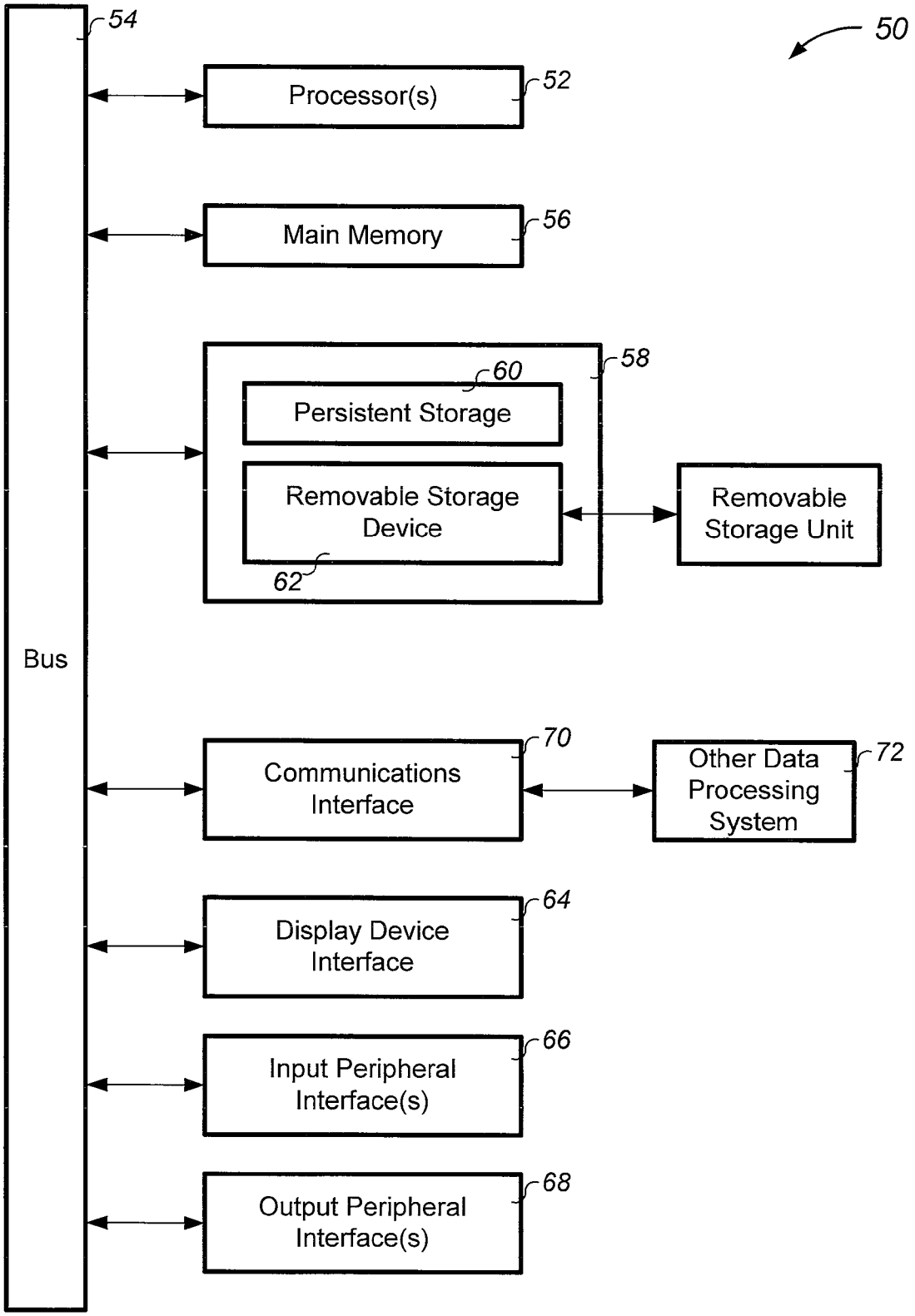
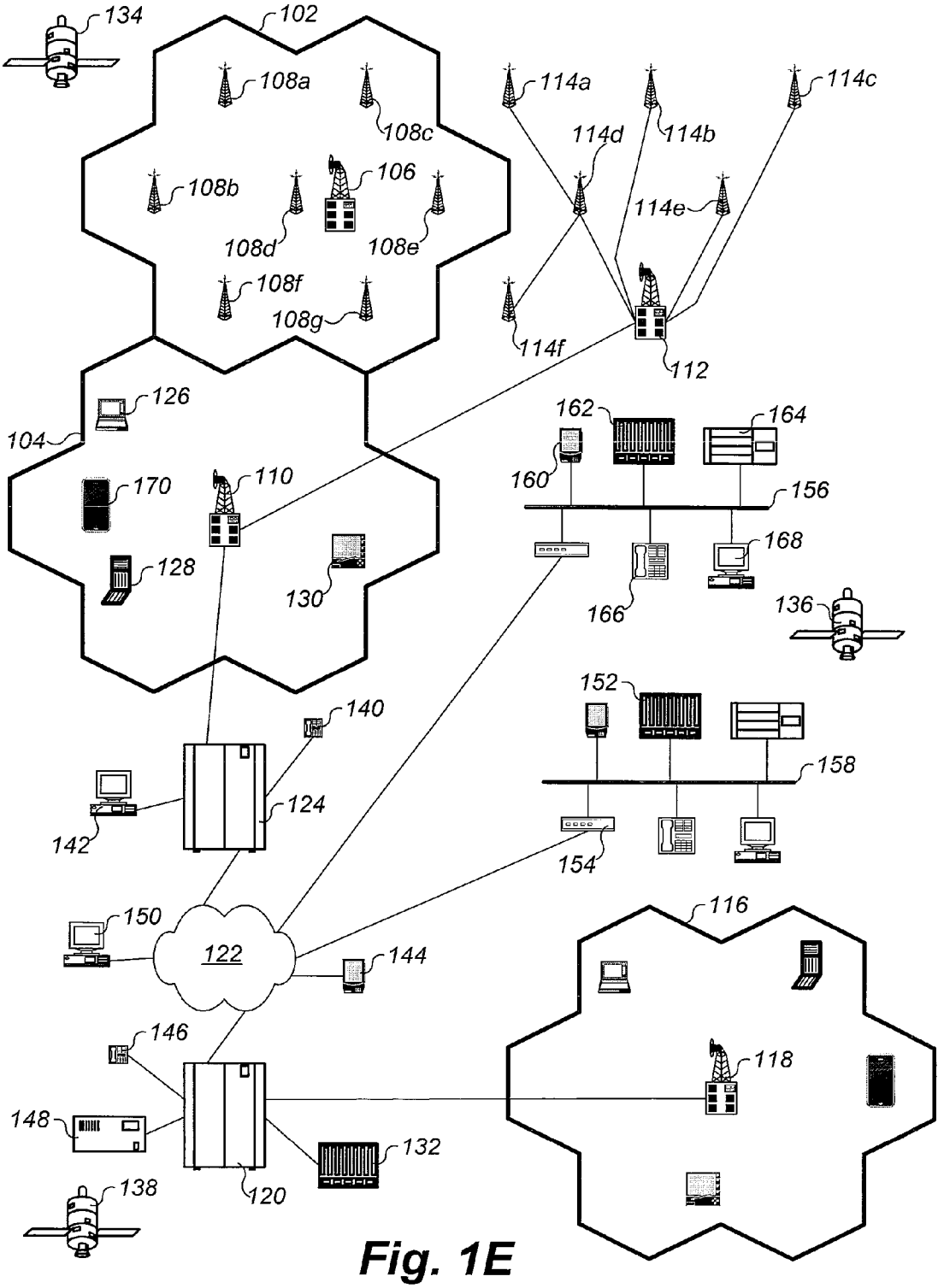

50
54
Processor(s)
52
Main Memory
56
58
60
Persistent Storage
Removable Storage Device
62
Removable Storage Unit
Bus
70
Communications Interface
Other Data Processing System
72
64
Display Device Interface
66
Input Peripheral Interface(s)
68
Output Peripheral Interface(s)

Fig. 1D


134
102
108a
108c
114a
114c
114d
114b
106
108b
114e
108d
108e
108f
108g
114f
112
126
104
162
164
160
156
170
110
168
128
130
166
136
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132
120
138

Fig. 1E

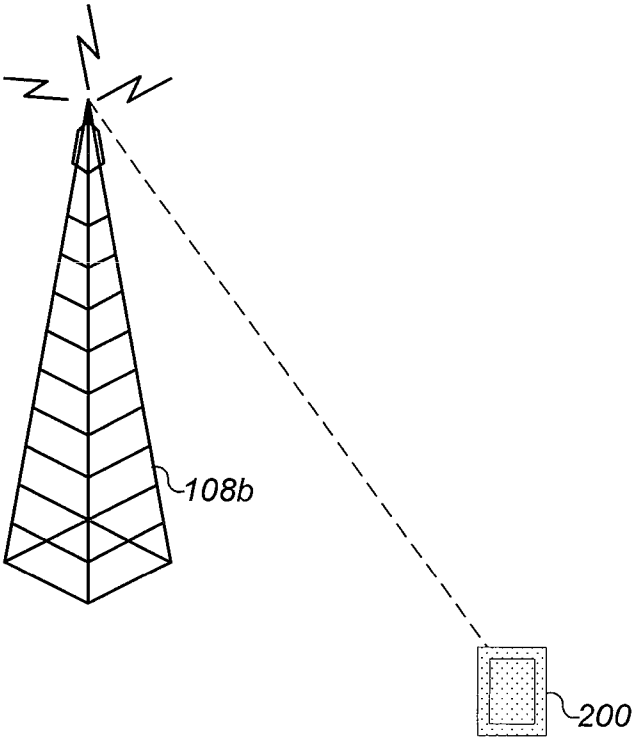

Fig. 2A

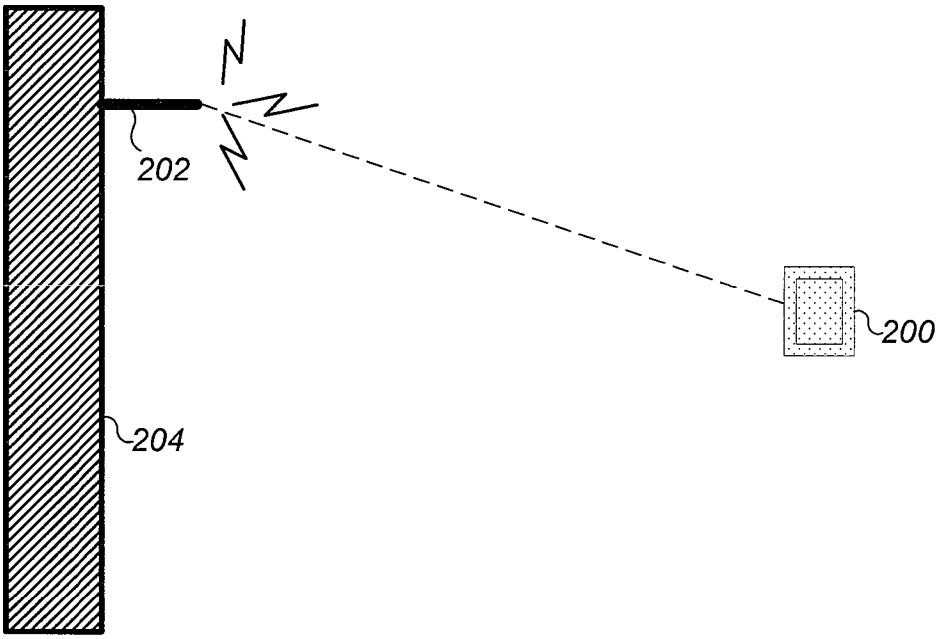

Fig. 2B

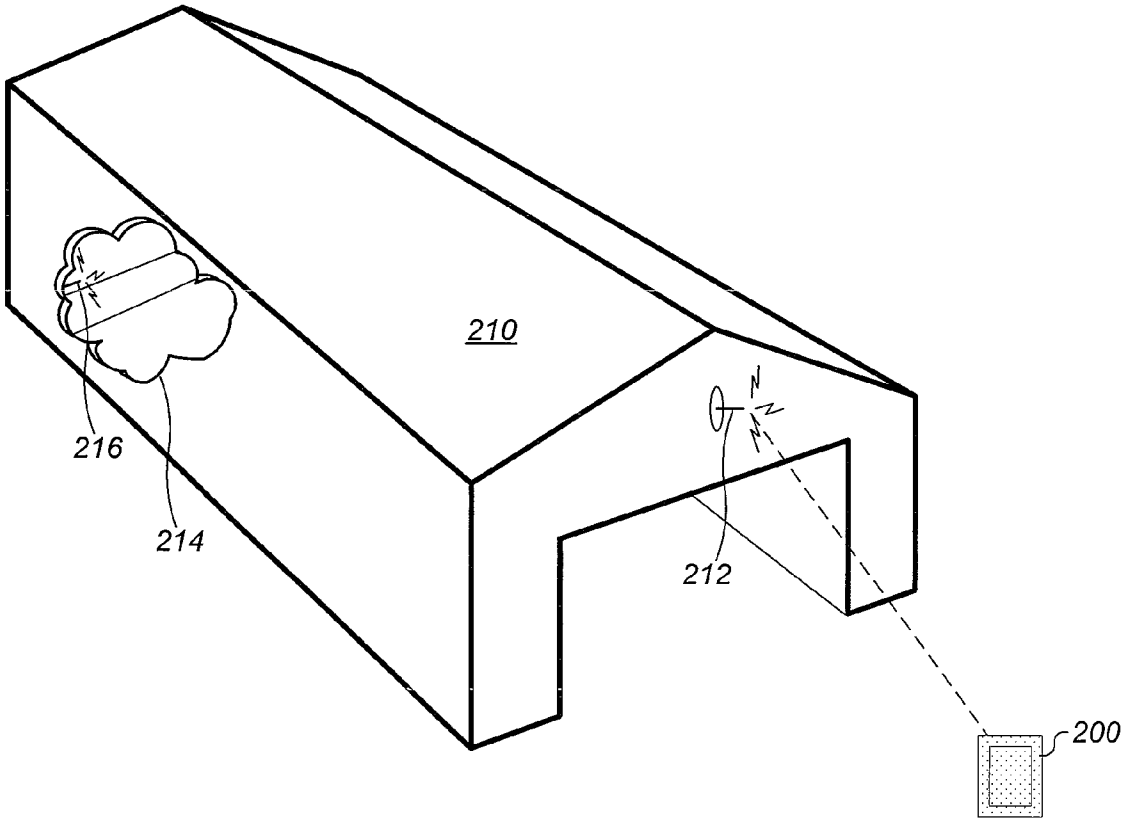

Fig. 2C

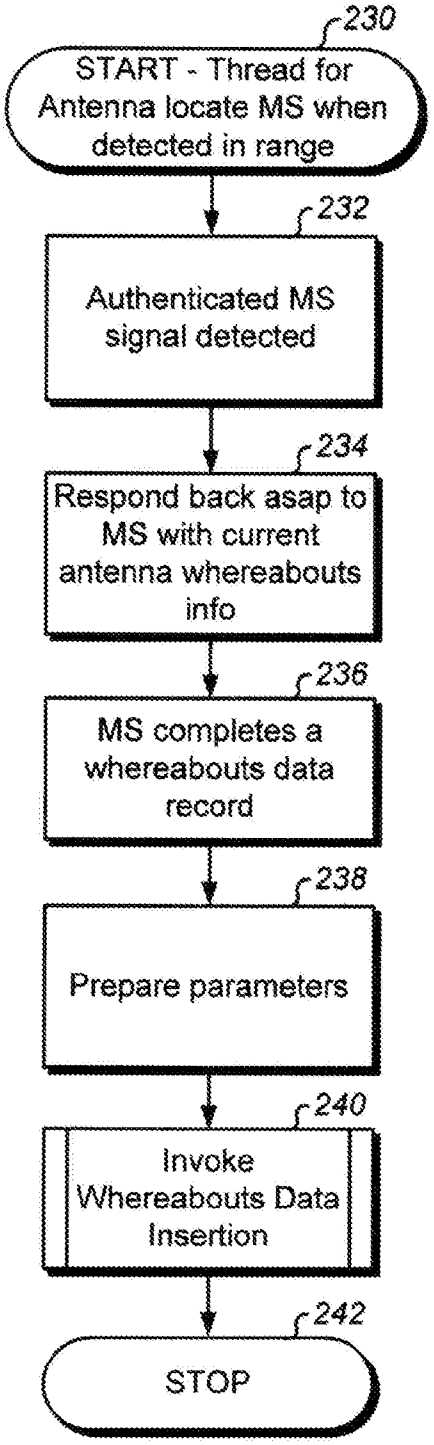
230
START - Thread for Antenna locate MS when detected in range
232
Authenticated MS signal detected
234
Respond back asap to MS with current antenna whereabouts info
236
MS completes a whereabouts data record
238
Prepare parameters
240
Invoke Whereabouts Data Insertion
242
STOP

Fig. 2D

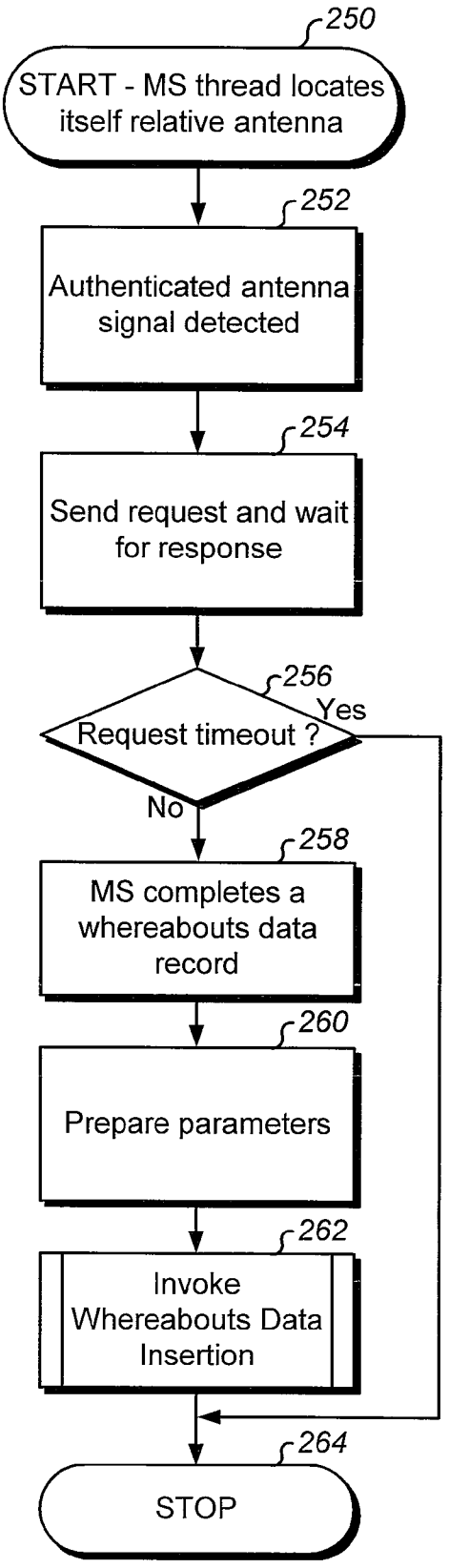
250
START - MS thread locates itself relative antenna
252
Authenticated antenna signal detected
254
Send request and wait for response
256
Request timeout ?
Yes
No
258
MS completes a whereabouts data record
260
Prepare parameters
262
Invoke Whereabouts Data Insertion
264
STOP

Fig. 2E

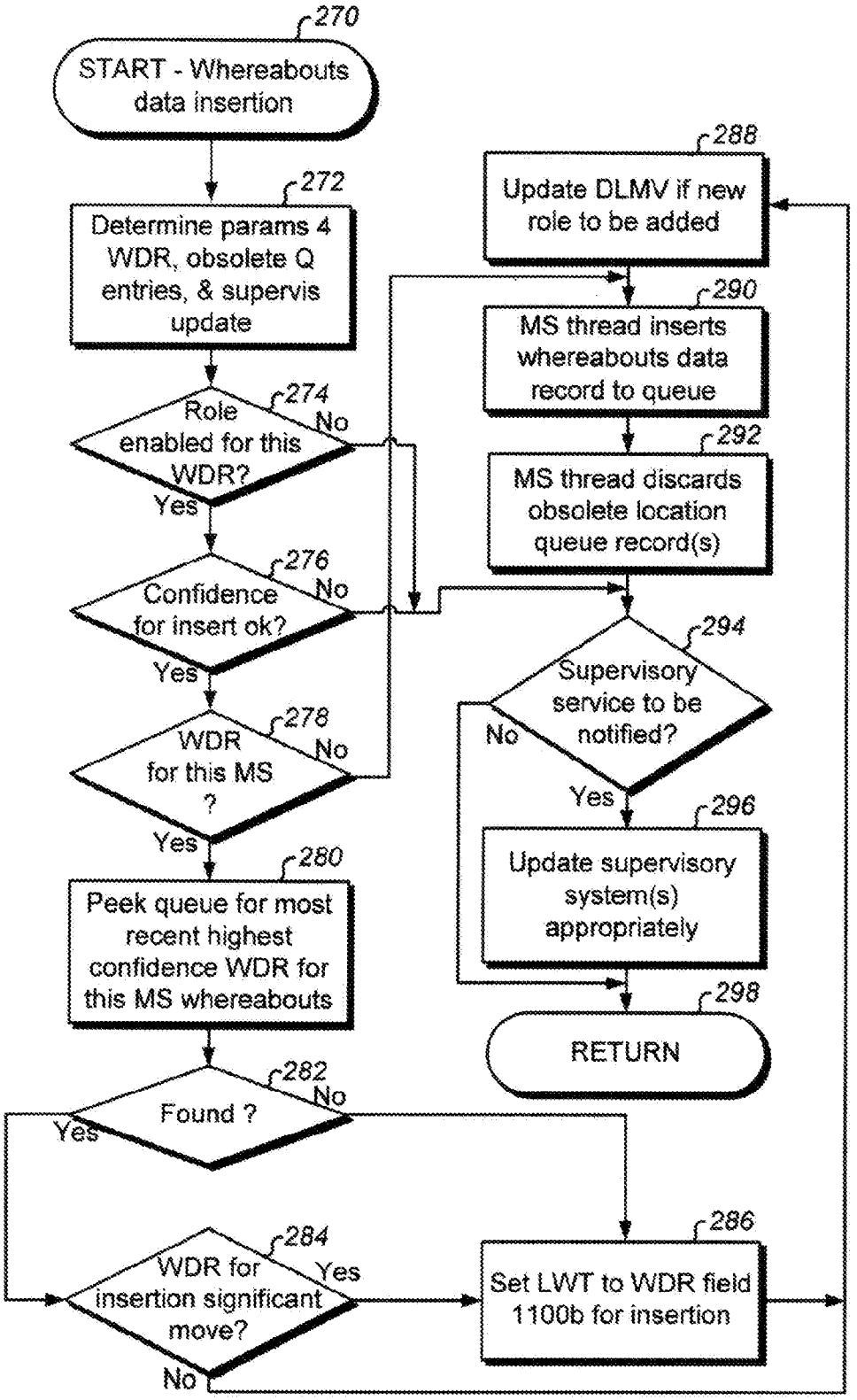
270
START - Whereabouts data insertion
272
Determine params 4 WDR, obsolete Q entries, & supervis update
274
Role enabled for this WDR?
No
Yes
276
Confidence for insert ok?
No
Yes
278
WDR for this MS ?
No
Yes
280
Peek queue for most recent highest confidence WDR for this MS whereabouts
282
Found ?
No
Yes
284
WDR for insertion significant move?
Yes
No
286
Set LWT to WDR field 1100b for insertion
288
Update DLMV if new role to be added
290
MS thread inserts whereabouts data record to queue
292
MS thread discards obsolete location queue record(s)
294
Supervisory service to be notified?
No
Yes
296
Update supervisory system(s) appropriately
298
RETURN

Fig. 2F

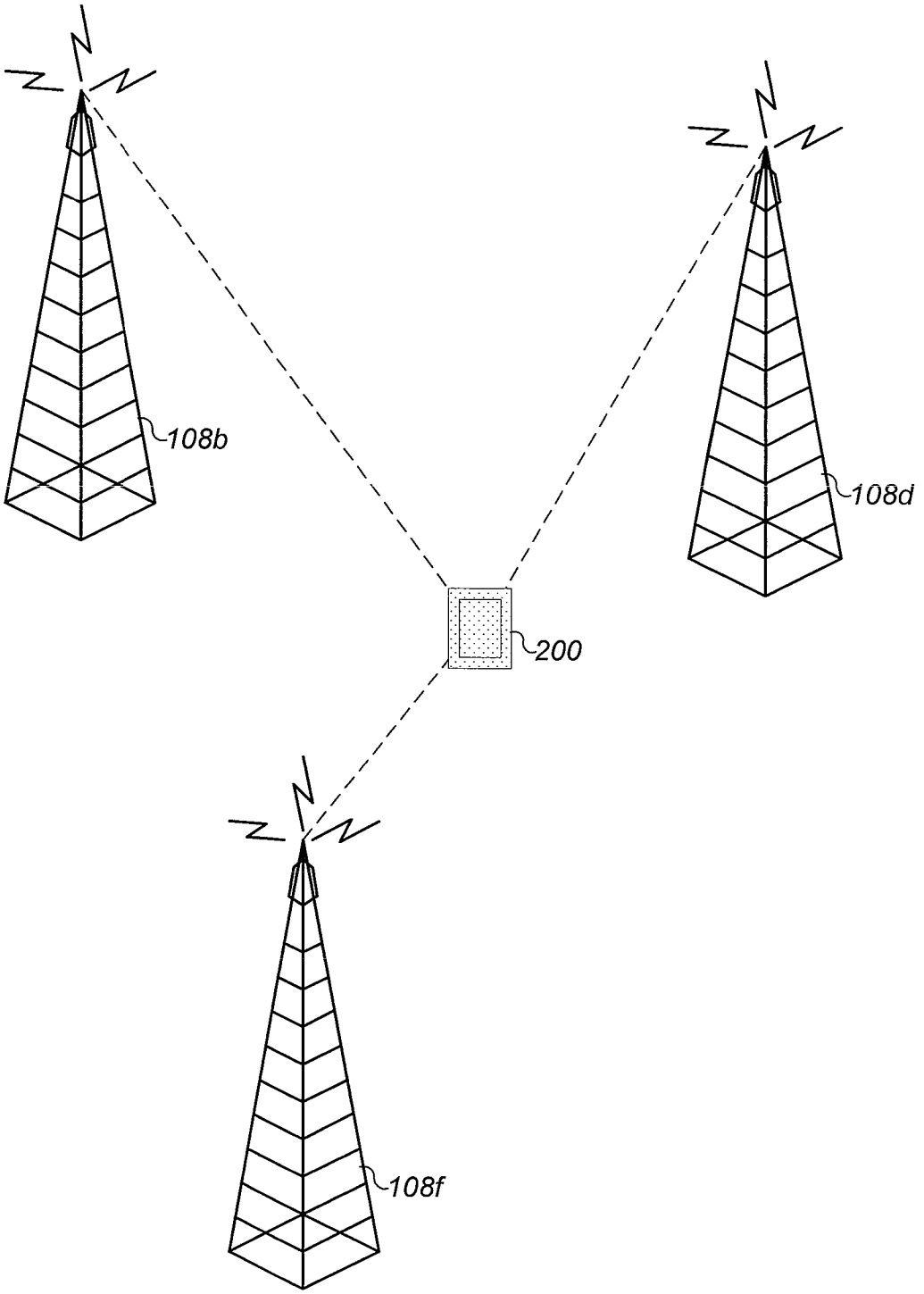

Fig. 3A

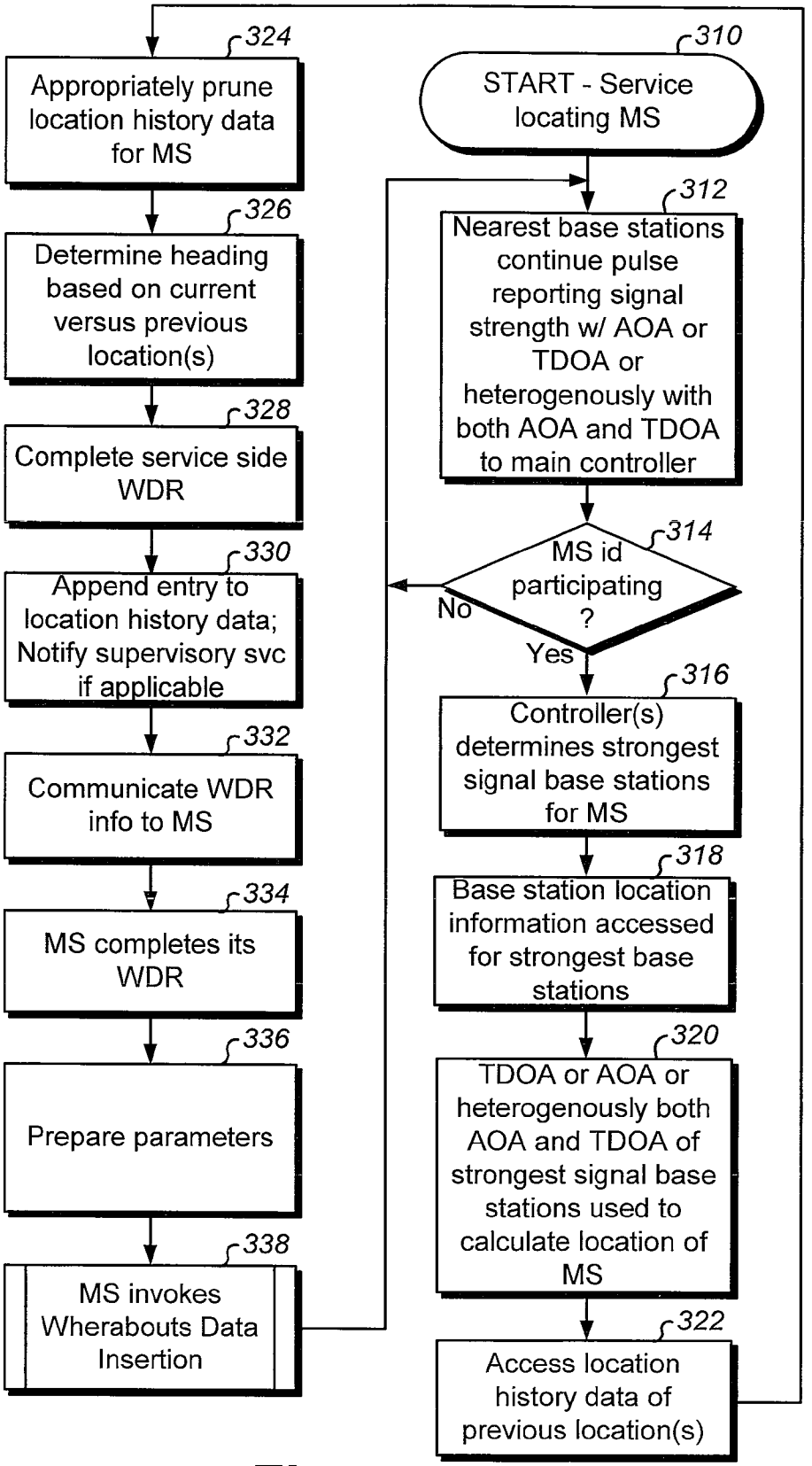
310
START - Service locating MS
312
Nearest base stations continue pulse reporting signal strength w/ AOA or TDOA or heterogenously with both AOA and TDOA to main controller
314
MS id participating ?
No
Yes
316
Controller(s) determines strongest signal base stations for MS
318
Base station location information accessed for strongest base stations
320
TDOA or AOA or heterogenously both AOA and TDOA of strongest signal base stations used to calculate location of MS
322
Access location history data of previous location(s)
324
Appropriately prune location history data for MS
326
Determine heading based on current versus previous location(s)
328
Complete service side WDR
330
Append entry to location history data; Notify supervisory svc if applicable
332
Communicate WDR info to MS
334
MS completes its WDR
336
Prepare parameters
338
MS invokes Wherabouts Data Insertion

Fig. 3B

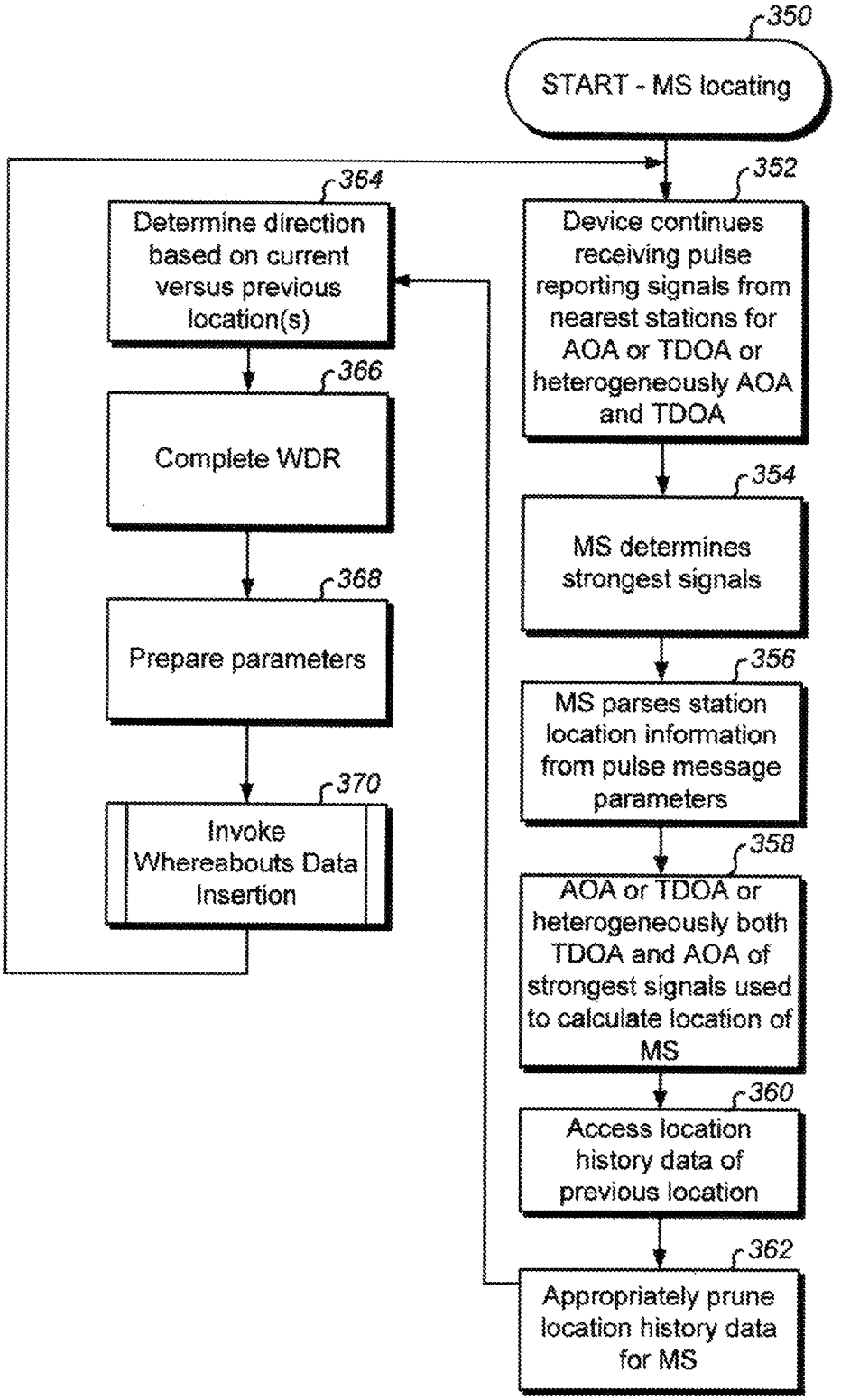
350
START - MS locating
352
Device continues receiving pulse reporting signals from nearest stations for AOA or TDOA or heterogeneously AOA and TDOA
354
MS determines strongest signals
356
MS parses station location information from pulse message parameters
358
AOA or TDOA or heterogeneously both TDOA and AOA of strongest signals used to calculate location of MS
360
Access location history data of previous location
362
Appropriately prune location history data for MS
364
Determine direction based on current versus previous location(s)
366
Complete WDR
368
Prepare parameters
370
Invoke Whereabouts Data Insertion

Fig. 3C

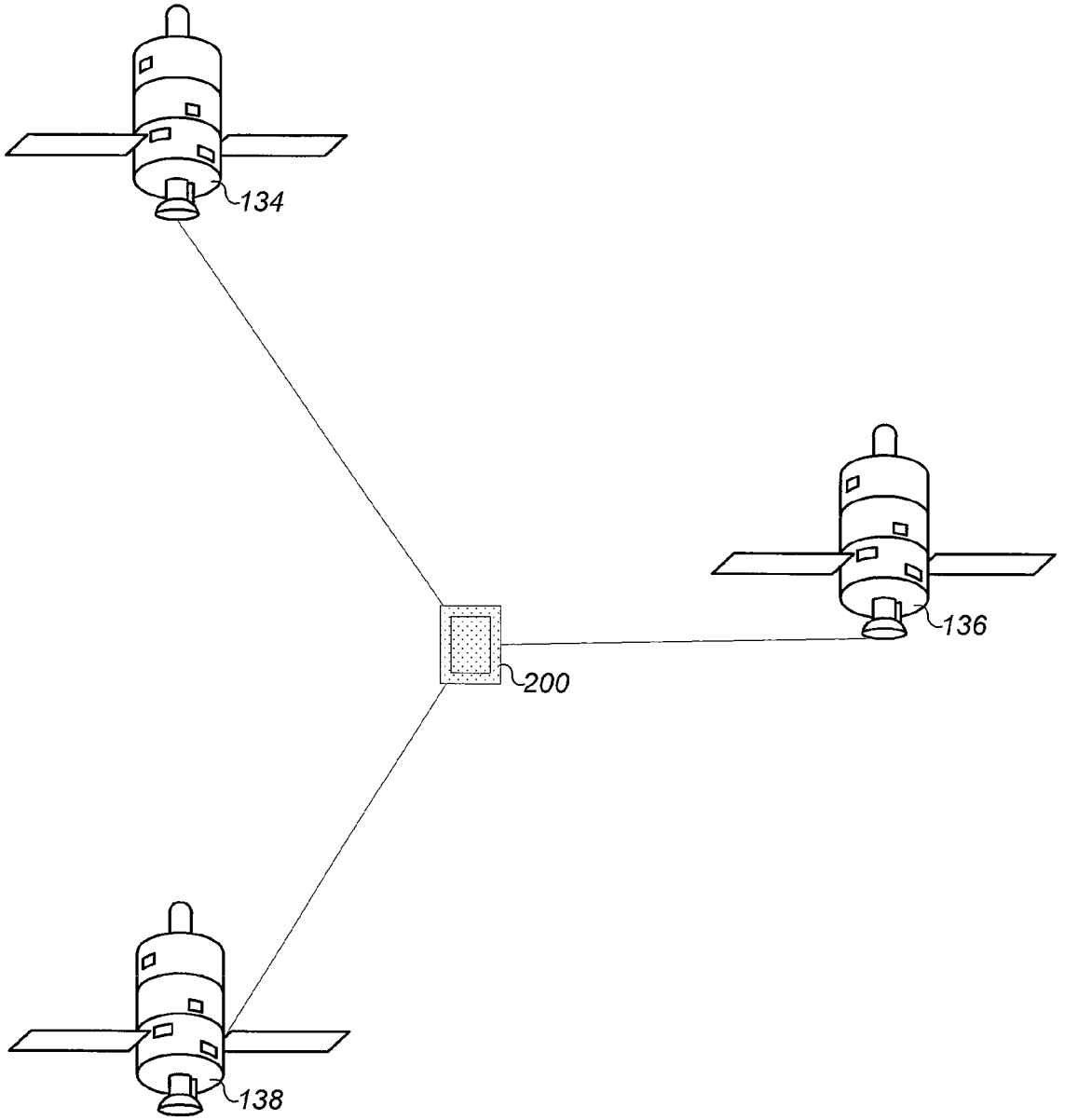

Fig. 4A

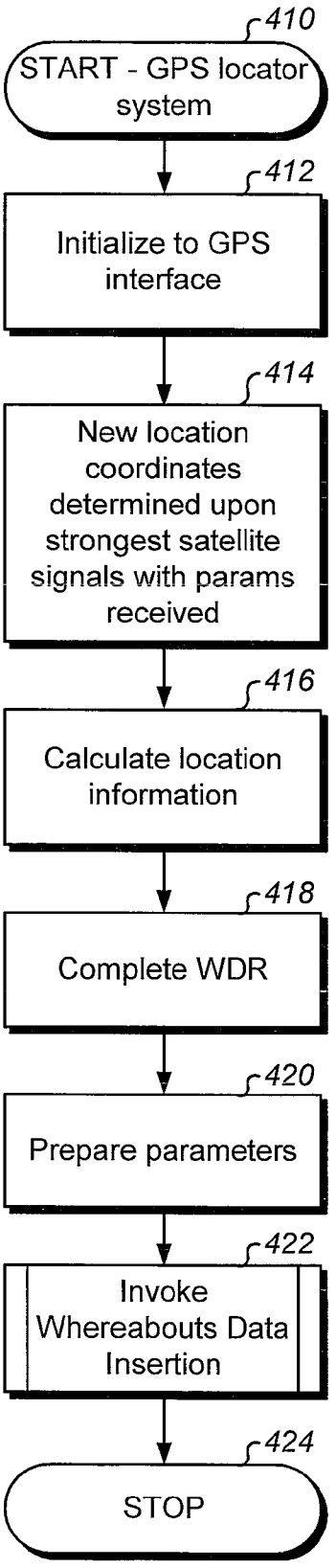
410
START - GPS locator system
412
Initialize to GPS interface
414
New location coordinates determined upon strongest satellite signals with params received
416
Calculate location information
418
Complete WDR
420
Prepare parameters
422
Invoke Whereabouts Data Insertion
424
STOP

Fig. 4B

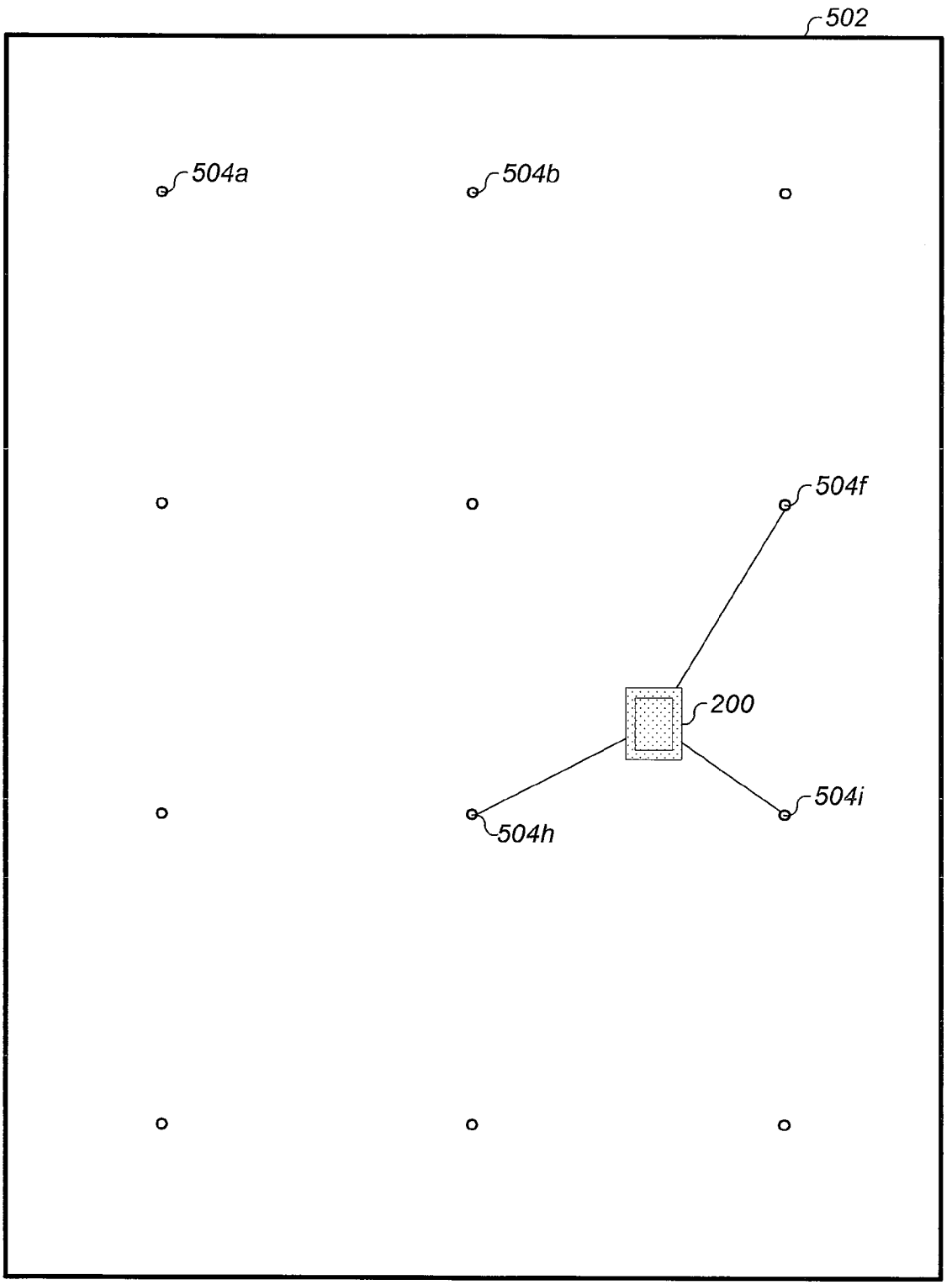

Fig. 5A

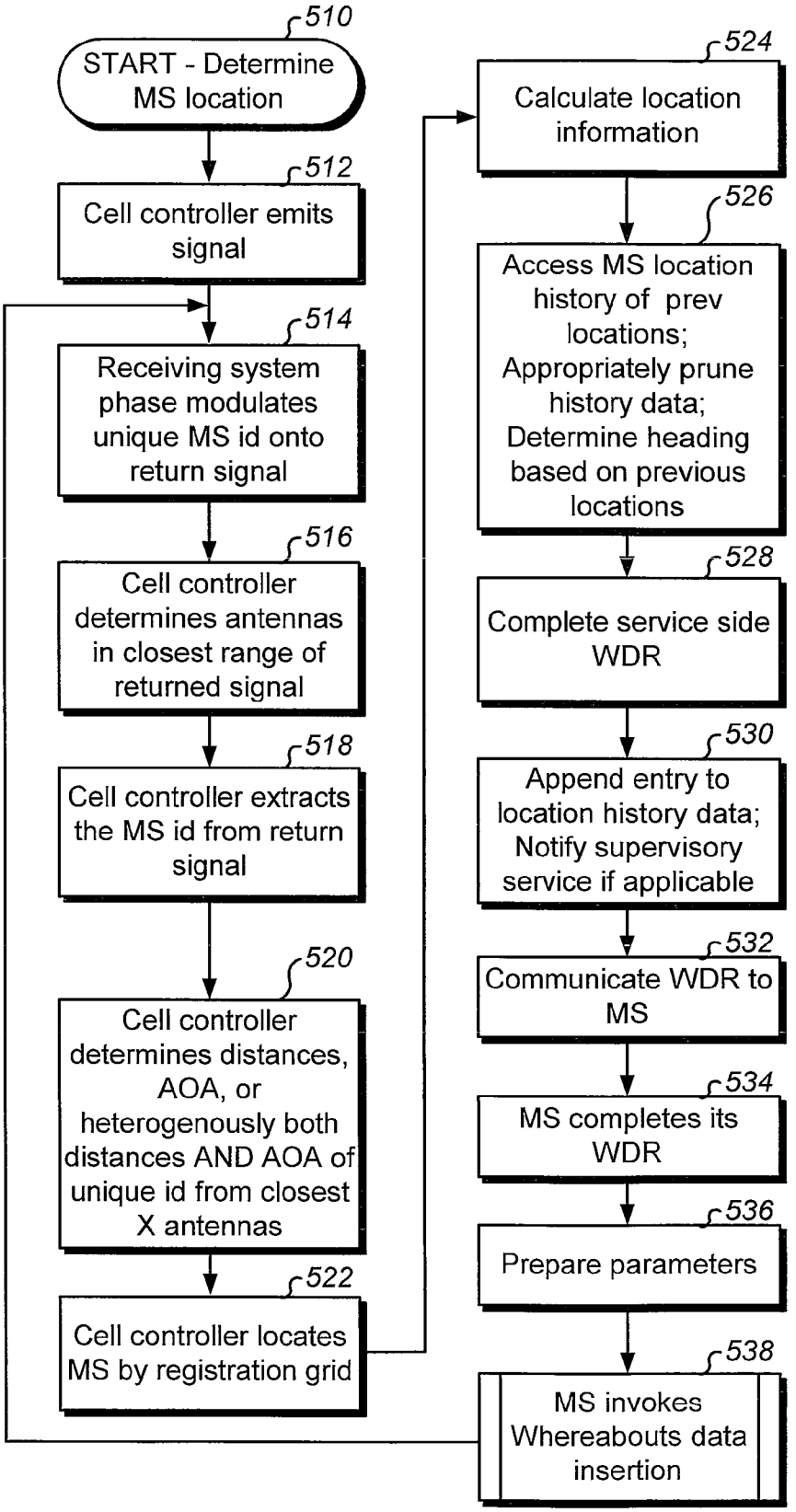
510
START - Determine MS location
512
Cell controller emits signal
514
Receiving system phase modulates unique MS id onto return signal
516
Cell controller determines antennas in closest range of returned signal
518
Cell controller extracts the MS id from return signal
520
Cell controller determines distances, AOA, or heterogenously both distances AND AOA of unique id from closest X antennas
522
Cell controller locates MS by registration grid
524
Calculate location information
526
Access MS location history of prev locations; Appropriately prune history data; Determine heading based on previous locations
528
Complete service side WDR
530
Append entry to location history data; Notify supervisory service if applicable
532
Communicate WDR to MS
534
MS completes its WDR
536
Prepare parameters
538
MS invokes Whereabouts data insertion

Fig. 5B

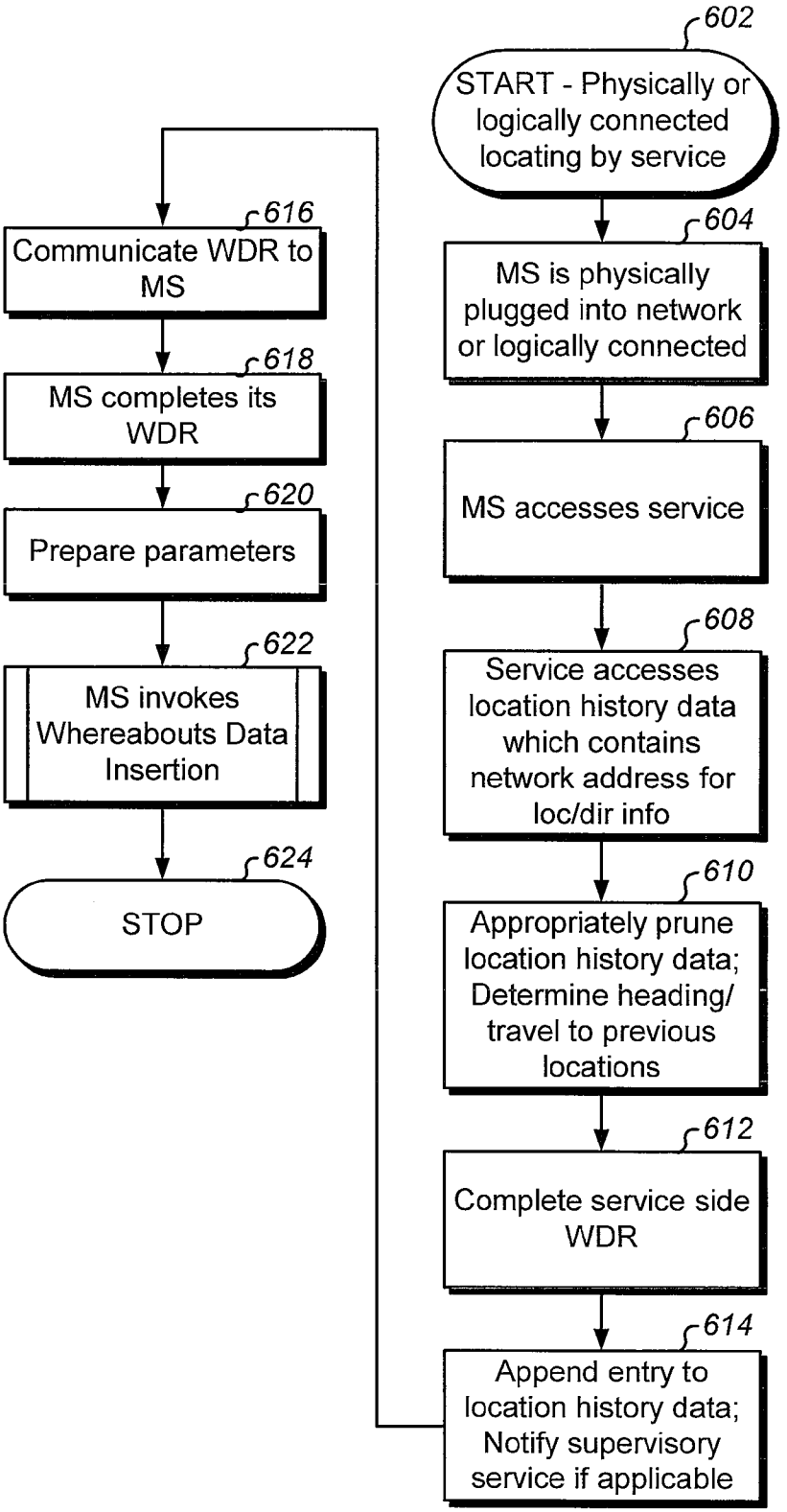
602
START - Physically or logically connected locating by service
604
MS is physically plugged into network or logically connected
606
MS accesses service
608
Service accesses location history data which contains network address for loc/dir info
610
Appropriately prune location history data; Determine heading/ travel to previous locations
612
Complete service side WDR
614
Append entry to location history data; Notify supervisory service if applicable
616
Communicate WDR to MS
618
MS completes its WDR
620
Prepare parameters
622
MS invokes Whereabouts Data Insertion
624
STOP

Fig. 6A

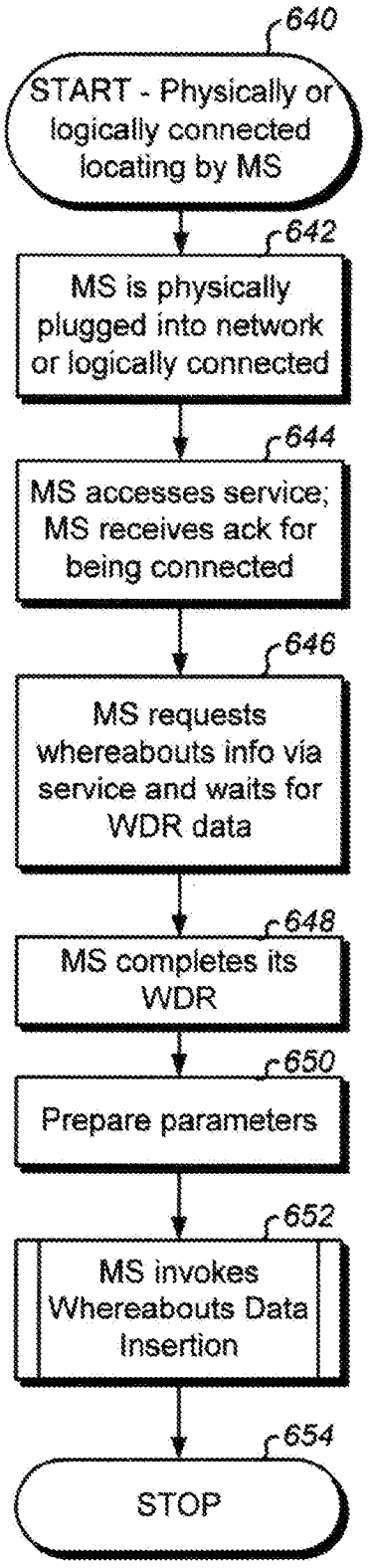
640
START - Physically or logically connected locating by MS
642
MS is physically plugged into network or logically connected
644
MS accesses service; MS receives ack for being connected
646
MS requests whereabouts info via service and waits for WDR data
648
MS completes its WDR
650
Prepare parameters
652
MS invokes Whereabouts Data Insertion
654
STOP

Fig. 6B

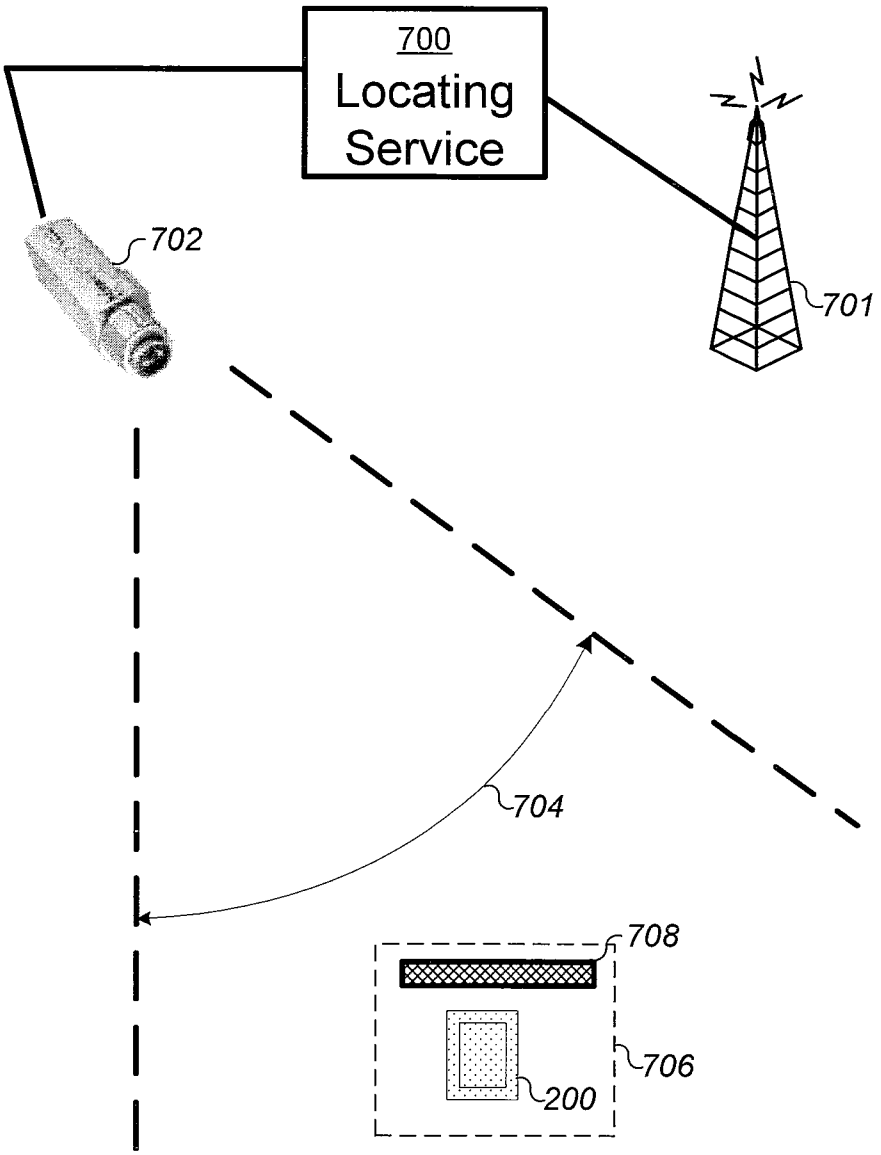

Fig. 7A

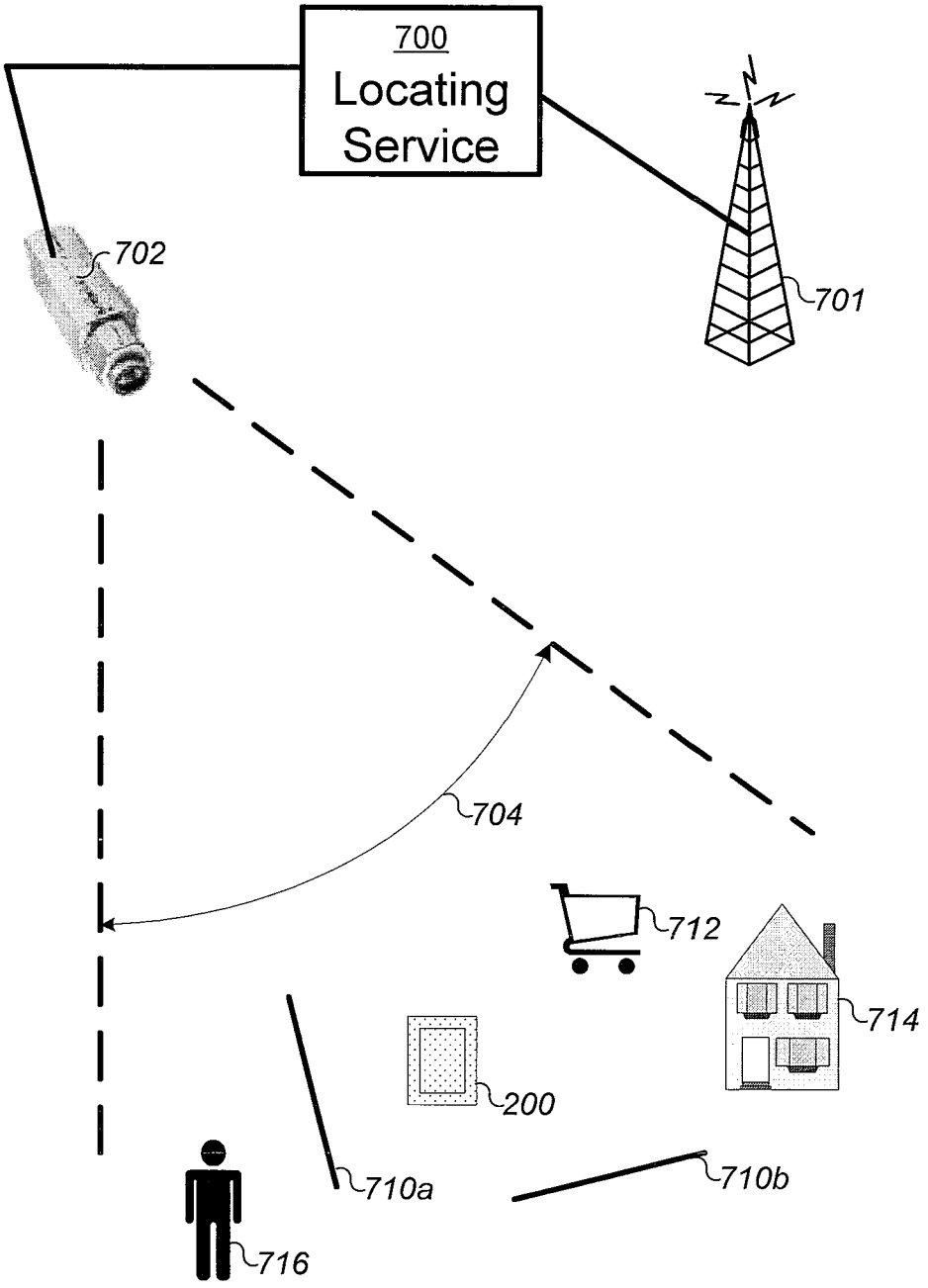

Fig. 7B

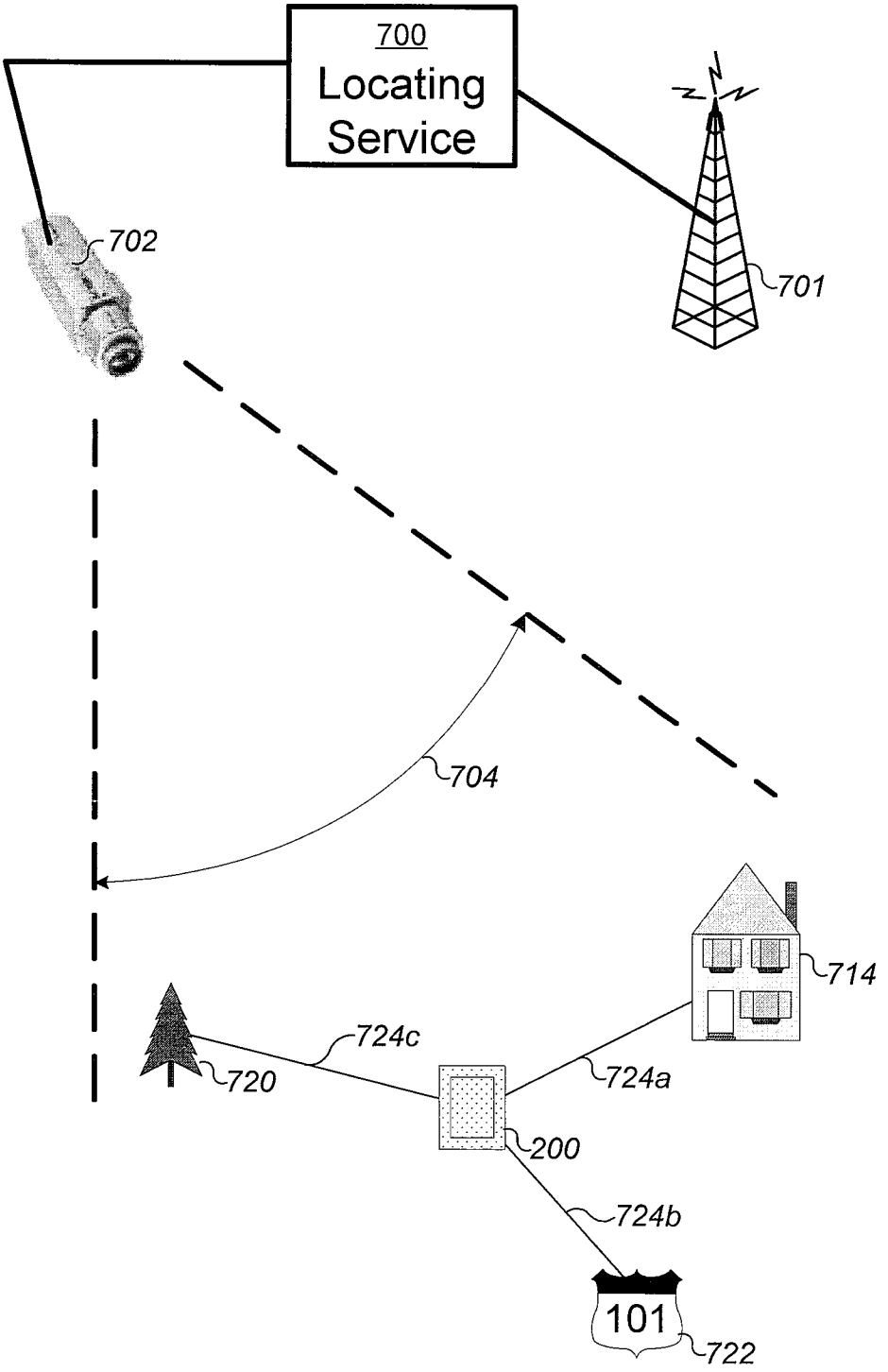
700
Locating Service
702
701
704
714
724c
720
724a
200
724b
101
722

Fig. 7C

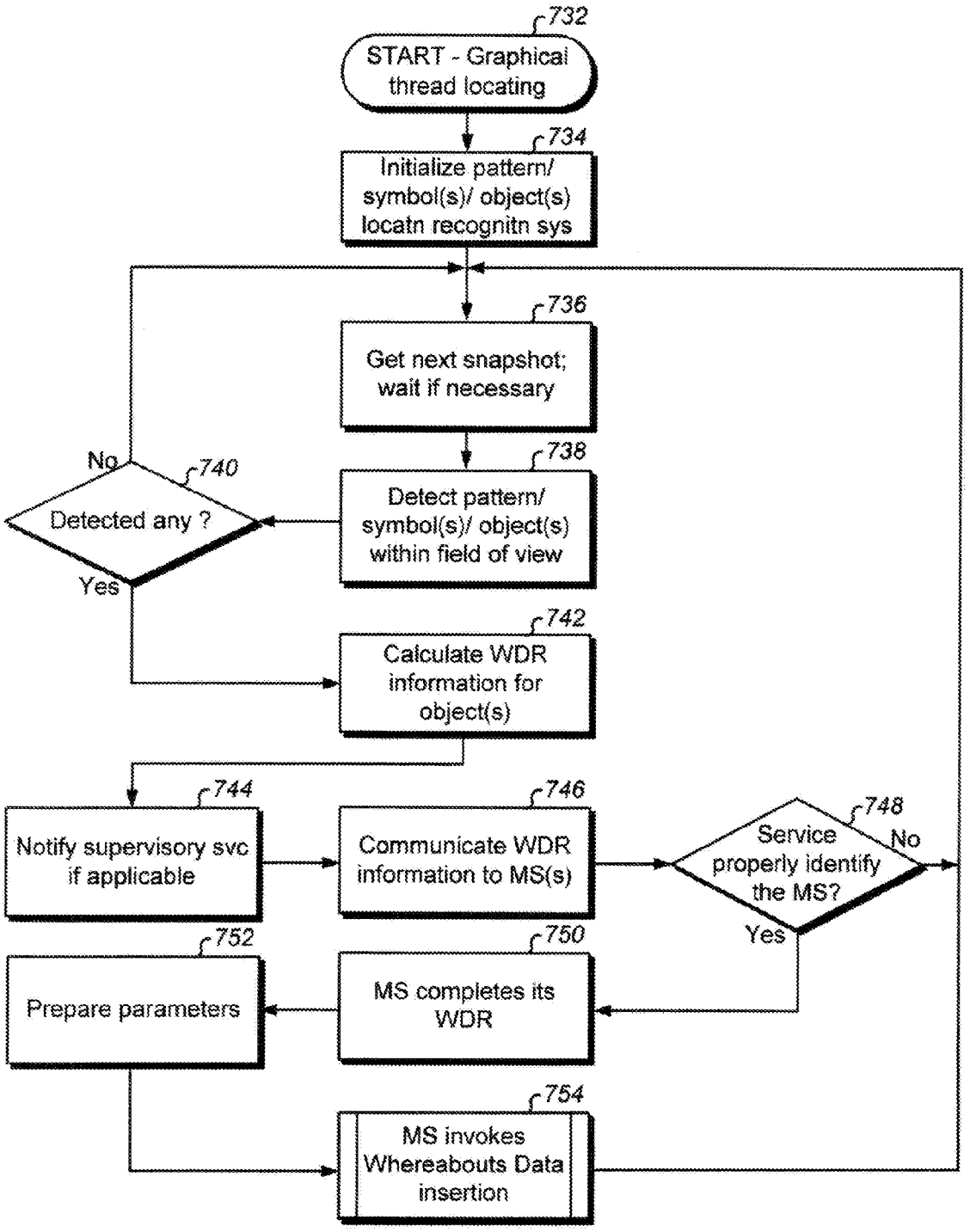
732
START - Graphical thread locating
734
Initialize pattern/ symbol(s)/ object(s) locatn recognitn sys
736
Get next snapshot; wait if necessary
738
Detect pattern/ symbol(s)/ object(s) within field of view
740
Detected any ?
No
Yes
742
Calculate WDR information for object(s)
744
Notify supervisory svc if applicable
746
Communicate WDR information to MS(s)
748
Service properly identify the MS?
No
Yes
750
MS completes its WDR
752
Prepare parameters
754
MS invokes Whereabouts Data insertion

Fig. 7D

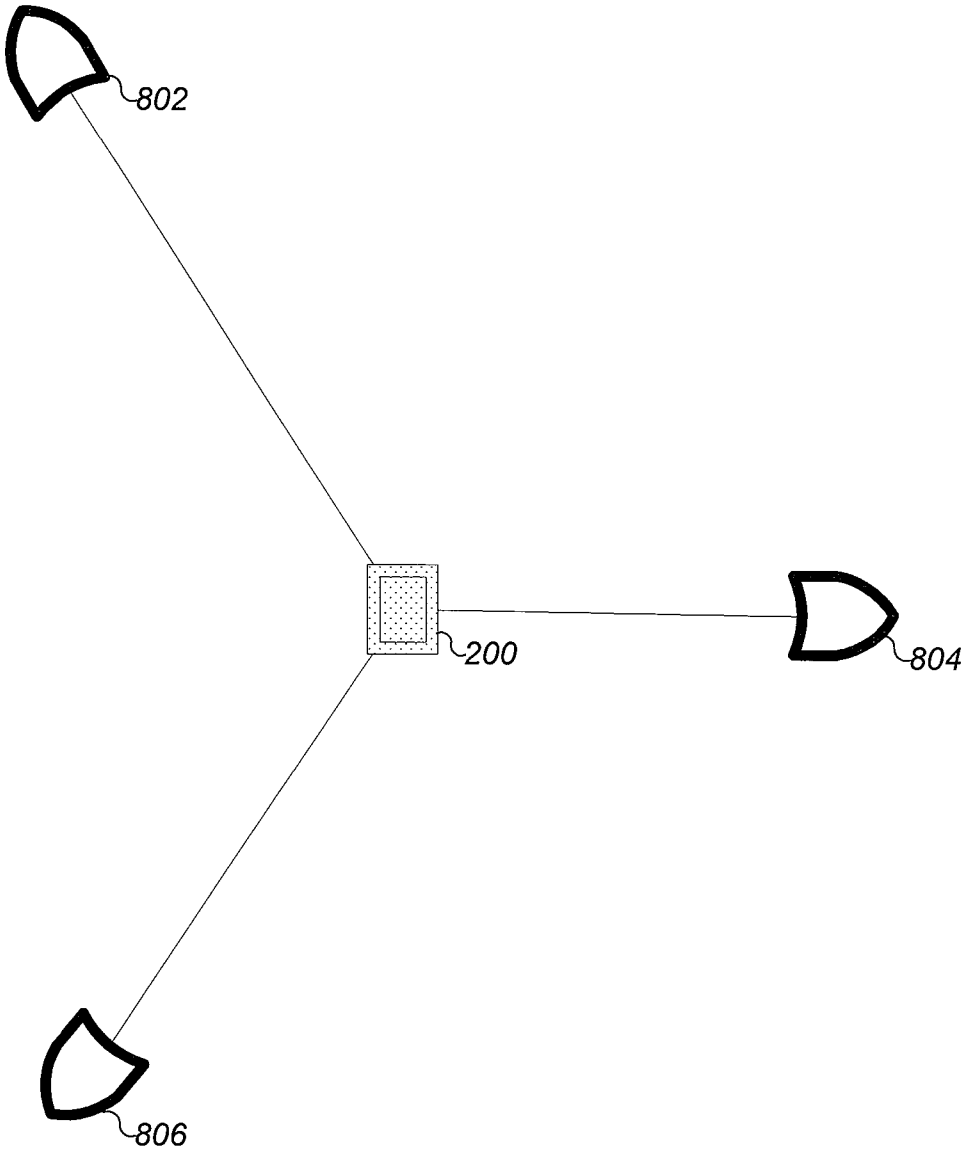

Fig. 8A

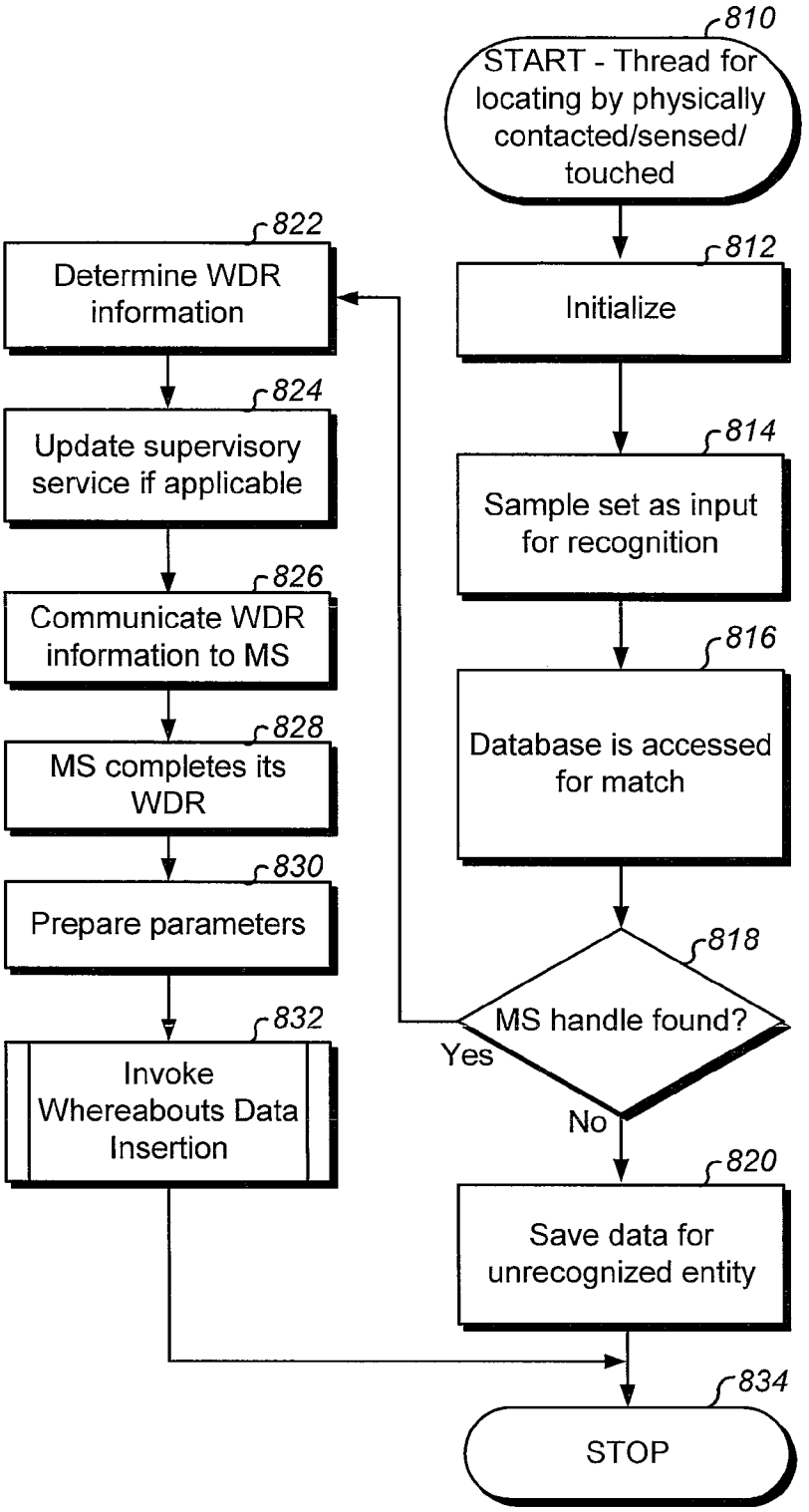
810
START - Thread for locating by physically contacted/sensed/ touched
812
Initialize
814
Sample set as input for recognition
816
Database is accessed for match
818
MS handle found?
Yes
No
820
Save data for unrecognized entity
822
Determine WDR information
824
Update supervisory service if applicable
826
Communicate WDR information to MS
828
MS completes its WDR
830
Prepare parameters
832
Invoke Whereabouts Data Insertion
834
STOP

Fig. 8B

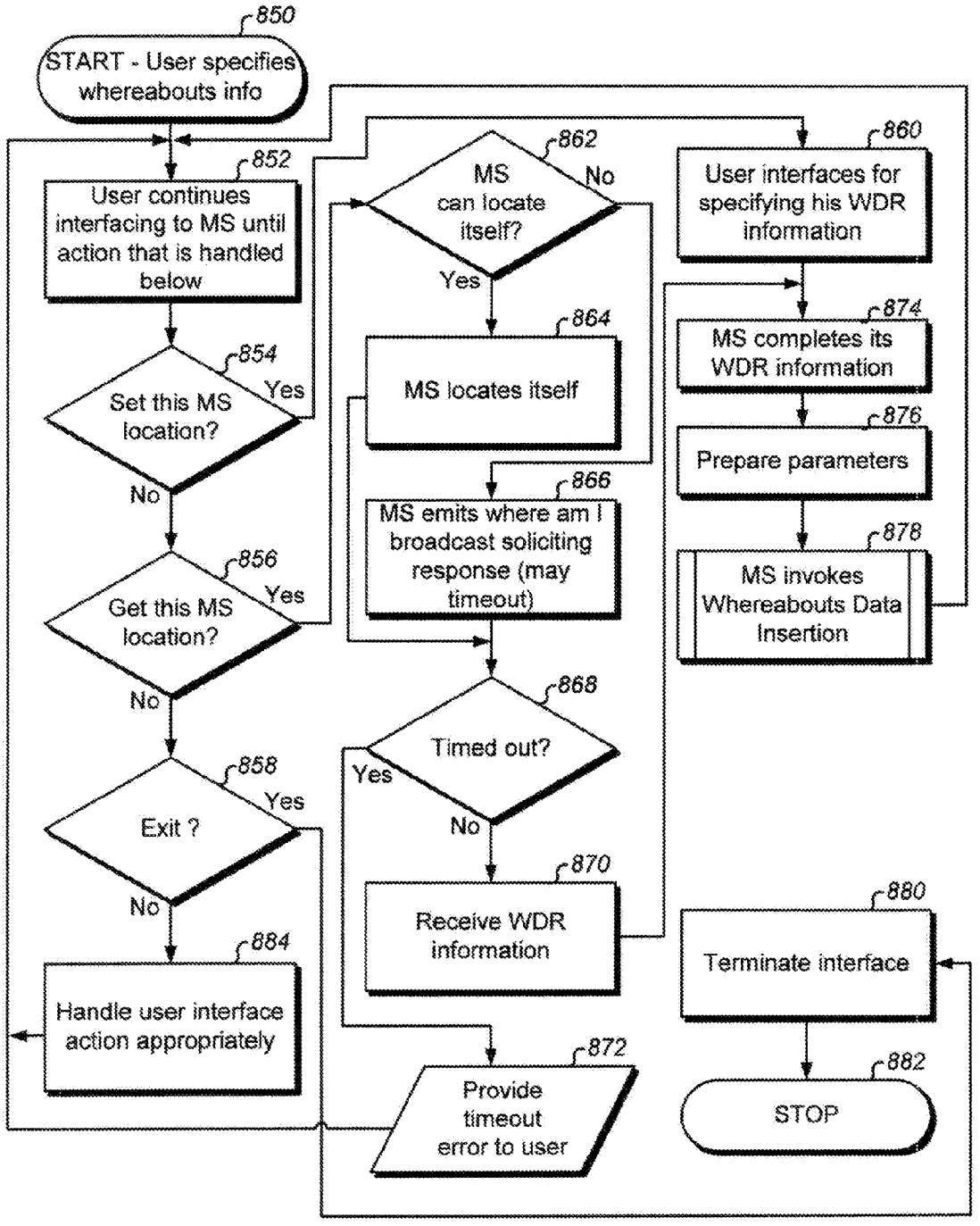
850
START - User specifies whereabouts info
852
User continues interfacing to MS until action that is handled below
854
Set this MS location?
Yes
No
856
Get this MS location?
Yes
No
858
Exit ?
Yes
No
884
Handle user interface action appropriately
862
MS can locate itself?
No
Yes
864
MS locates itself
866
MS emits where am I broadcast soliciting response (may timeout)
868
Timed out?
Yes
No
870
Receive WDR information
872
Provide timeout error to user
860
User interfaces for specifying his WDR information
874
MS completes its WDR information
876
Prepare parameters
878
MS invokes Whereabouts Data Insertion
880
Terminate interface
882
STOP

Fig. 8C

		MS (id 0A12:43EF:985B:012F)
GPS	C	x
	S	
A-GPS	C	
	S	
D-GPS	C	
	S	
Graphic-Pattern(s)	C	
	S	
Graphic-Distances	C	
	S	
Graphic-Triangulate	C	
	S	
Artificial Intelligence	C	
	S	
Cell Range	C	
	S	x
Cell AOA	C	
	S	
Cell TDOA	C	
	S	x
Cell MPT	C	
	S	x
Antenna Range	C	
	S	x
Antenna AOA	C	
	S	x
Antenna TDOA	C	
	S	x
Antenna MPT	C	
	S	x
LIDAR/optics	C	
	S	
Manual	C	
	S	
Contact	C	
	S	x
MPT	C	
	S	x
Client Logical Connect	C	
	S	
Server Logical Connect	C	
	S	
Client Physical Connect	C	
	S	
Server Physical Connect	C	
	S	
Sound/Acoustics	C	
	S	
Microdot/ RFI	C	
	S	
Transponder	C	
	S	
Others	C	
	S	
...	C	
	S	

Fig. 9A

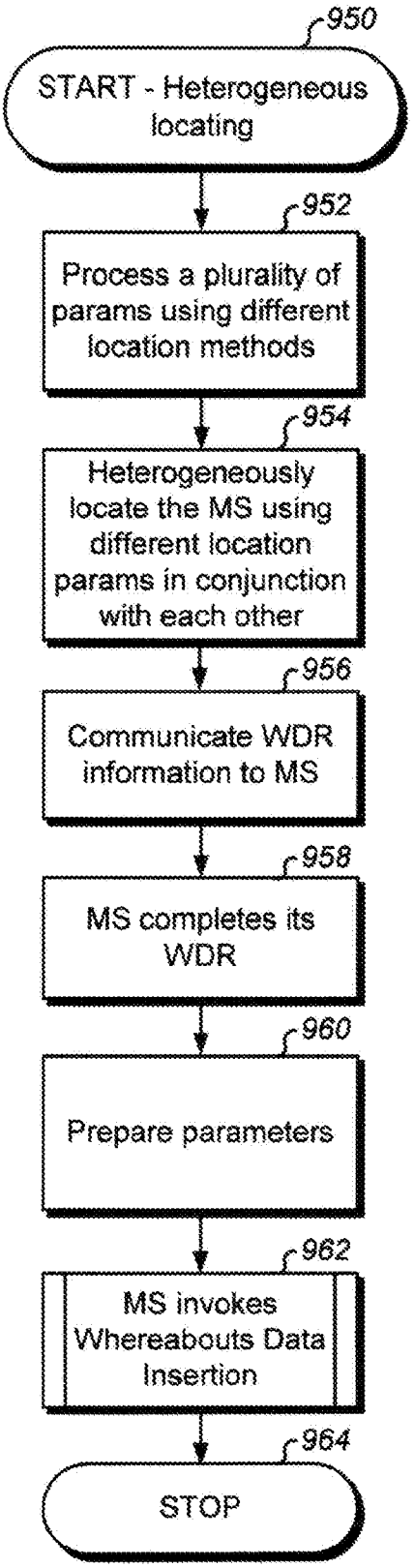
950
START - Heterogeneous locating
952
Process a plurality of params using different location methods
954
Heterogeneously locate the MS using different location params in conjunction with each other
956
Communicate WDR information to MS
958
MS completes its WDR
960
Prepare parameters
962
MS invokes Whereabouts Data Insertion
964
STOP

Fig. 9B

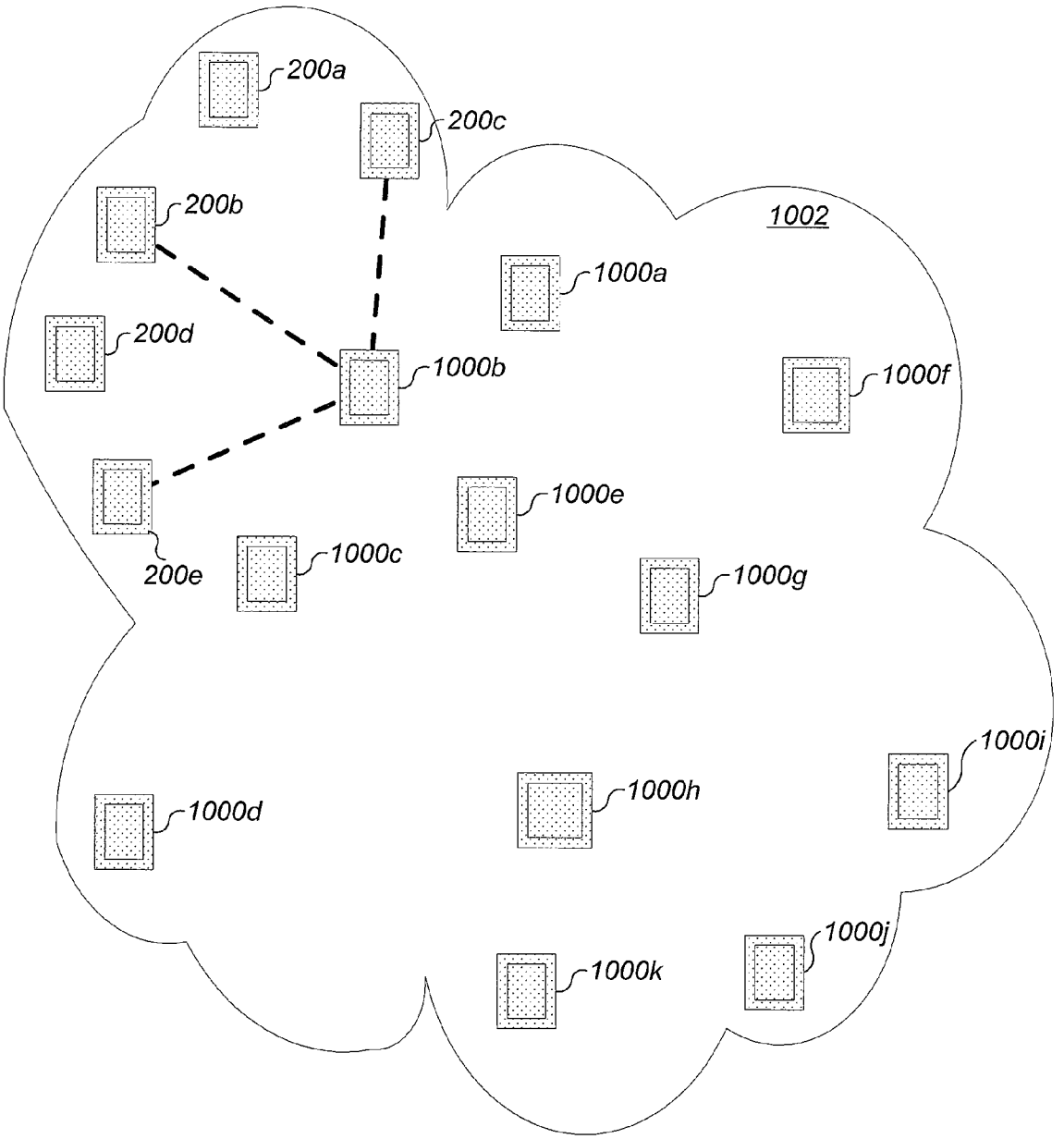
200a
200c
200b
1002
1000a
200d
1000b
1000f
1000e
200e
1000c
1000g
1000i
1000d
1000h
1000j
1000k

Fig. 10A

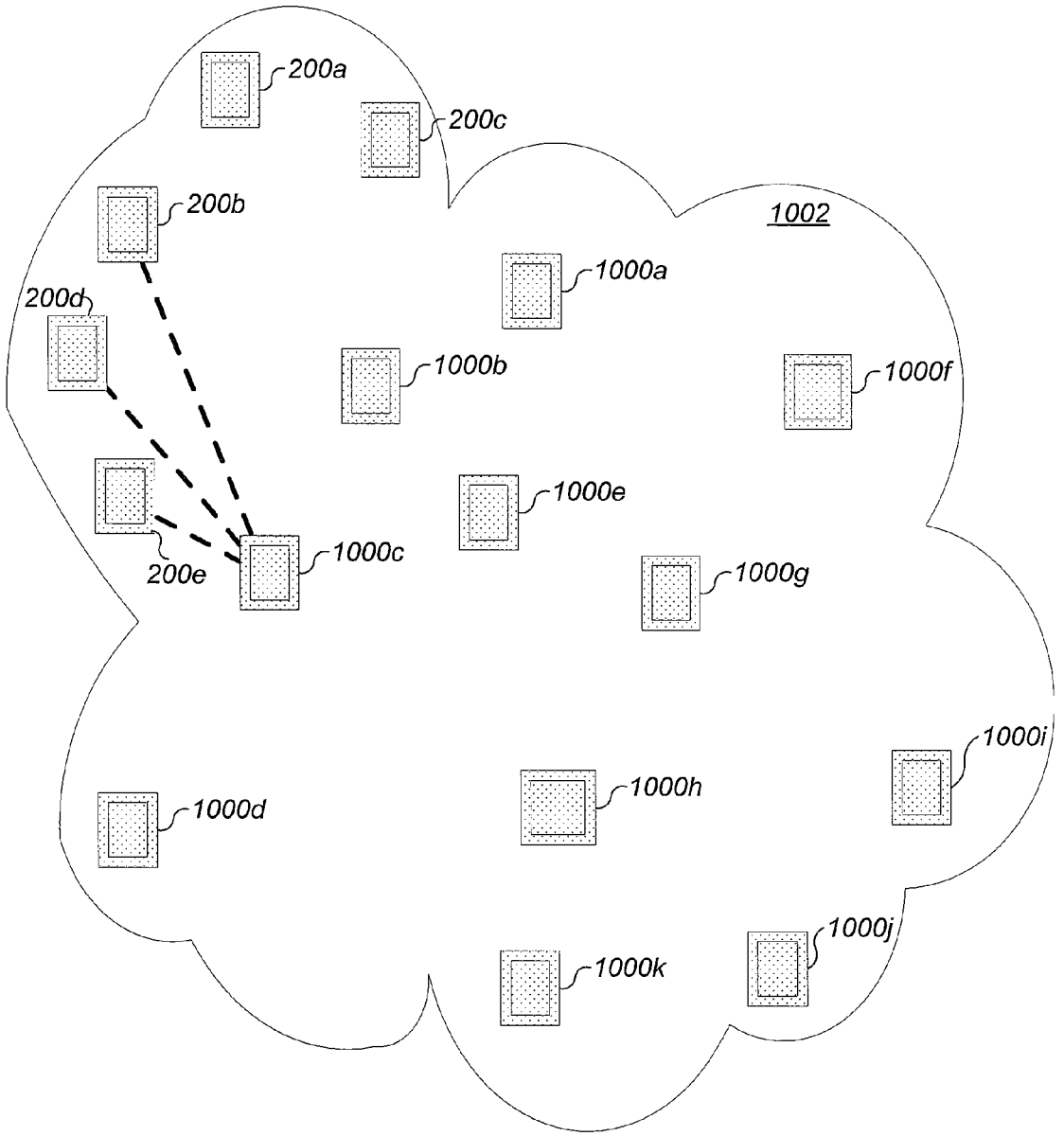
200a
200c
200b
1002
1000a
200d
1000b
1000f
1000e
1000c
200e
1000g
1000i
1000h
1000d
1000j
1000k

Fig. 10B

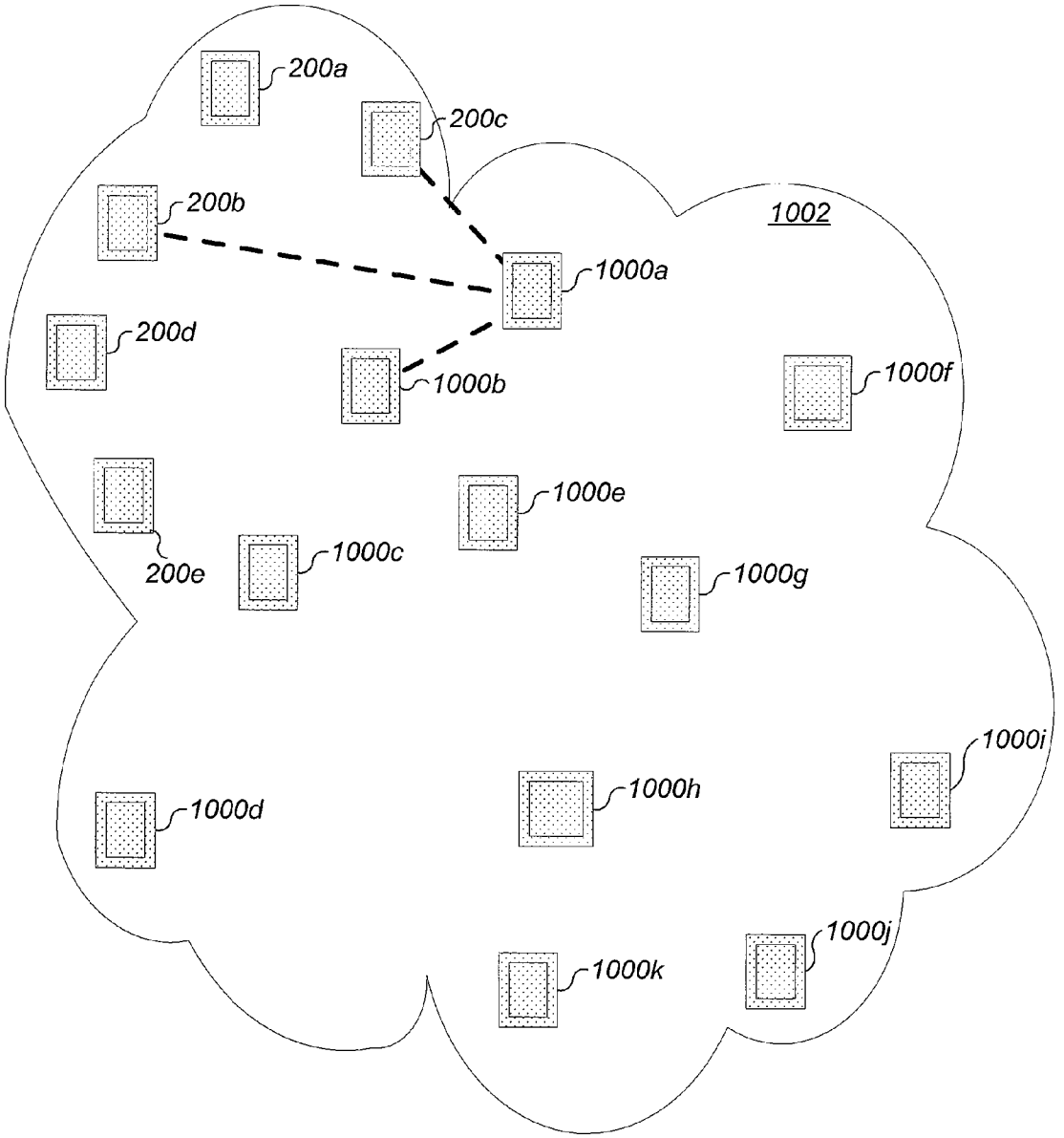
200a
200c
200b
1002
1000a
200d
1000b
1000f
1000e
200e
1000c
1000g
1000i
1000h
1000d
1000j
1000k

Fig. 10C

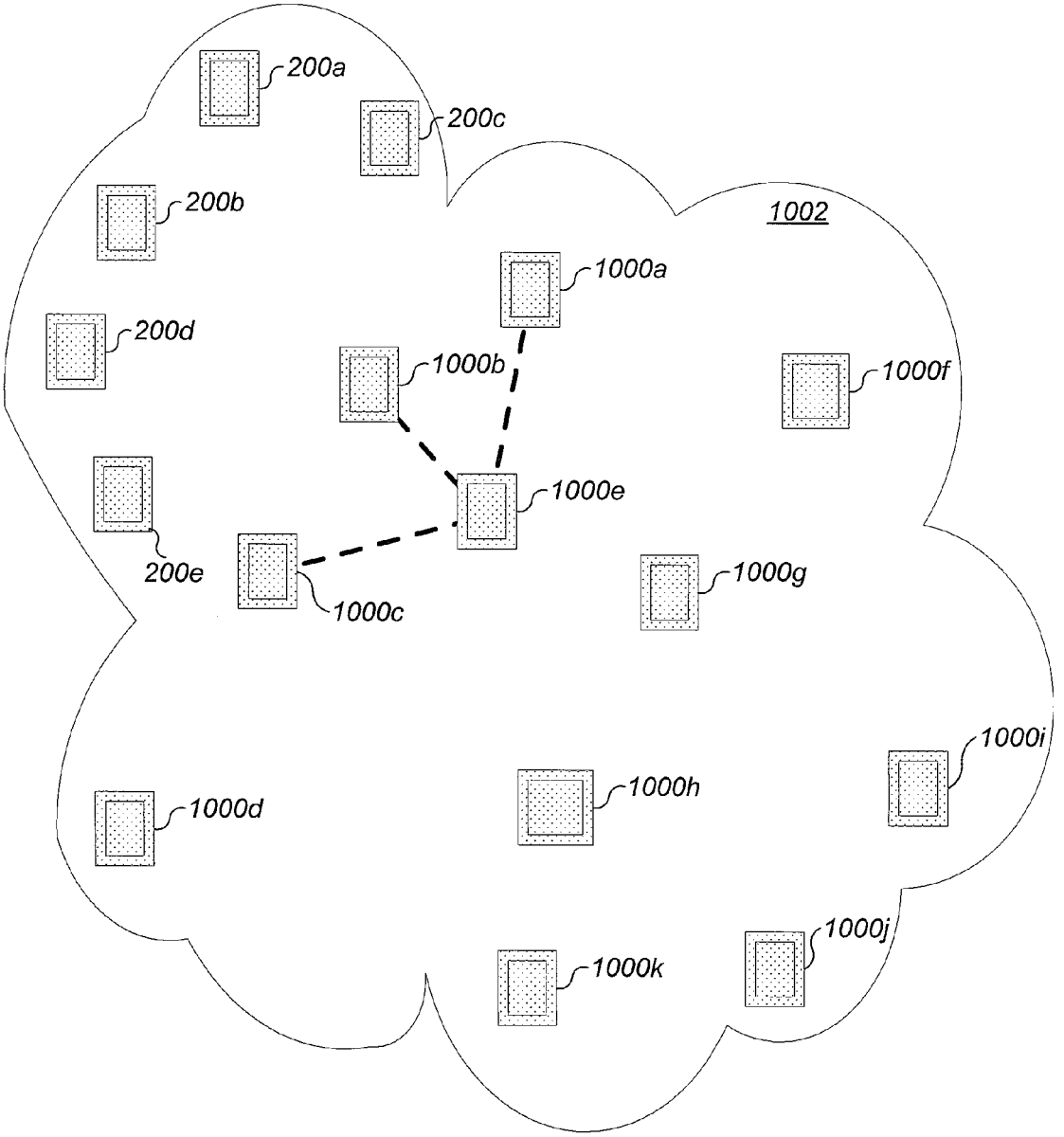
200a
200c
200b
1002
1000a
200d
1000b
1000f
1000e
200e
1000c
1000g
1000i
1000d
1000h
1000j
1000k

Fig. 10D

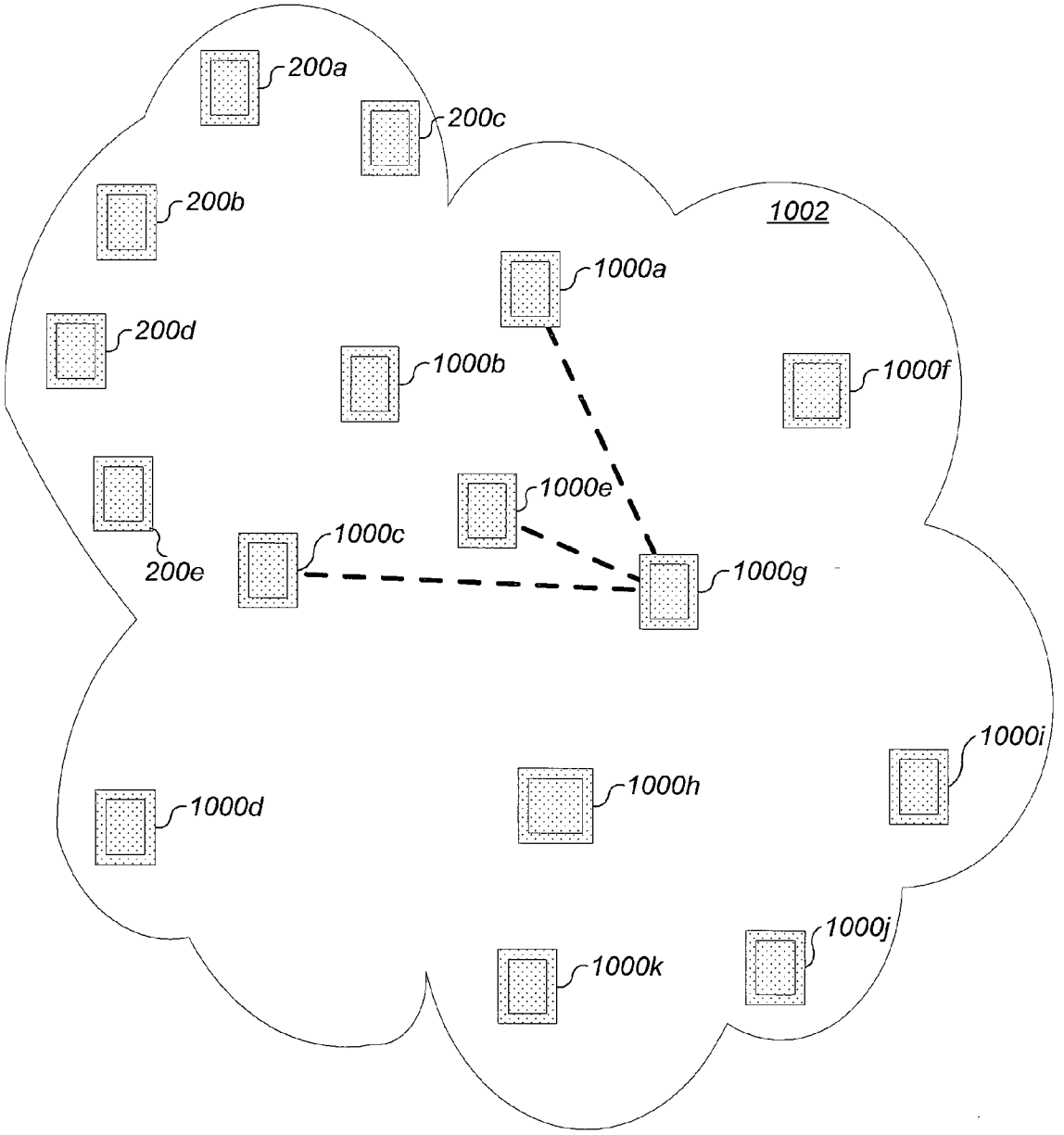
200a
200c
200b
1002
1000a
200d
1000b
1000f
1000e
1000c
200e
1000g
1000i
1000h
1000d
1000j
1000k

Fig. 10E

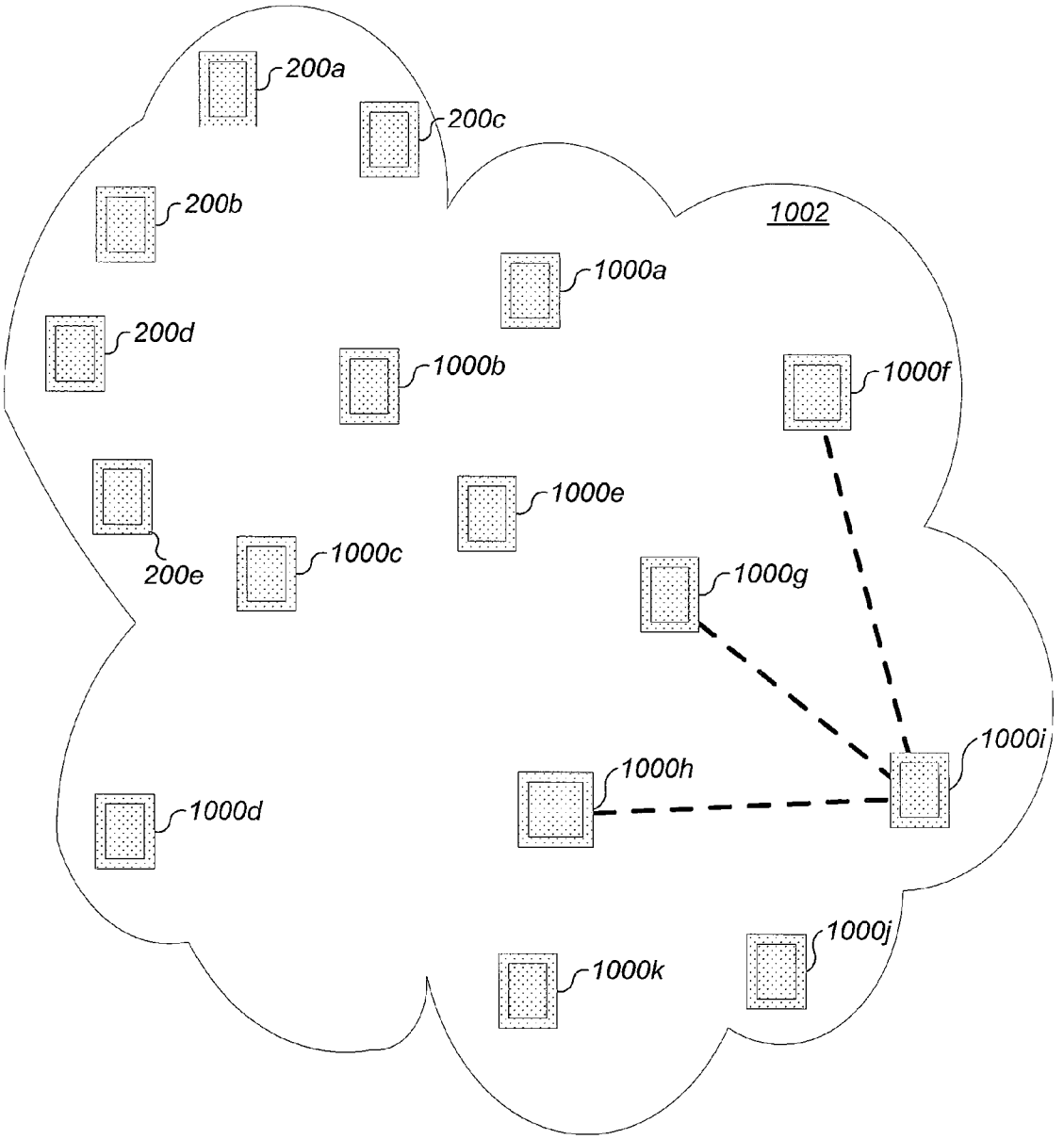
200a
200c
200b
1002
1000a
200d
1000b
1000f
1000e
200e
1000c
1000g
1000i
1000h
1000d
1000j
1000k

Fig. 10F

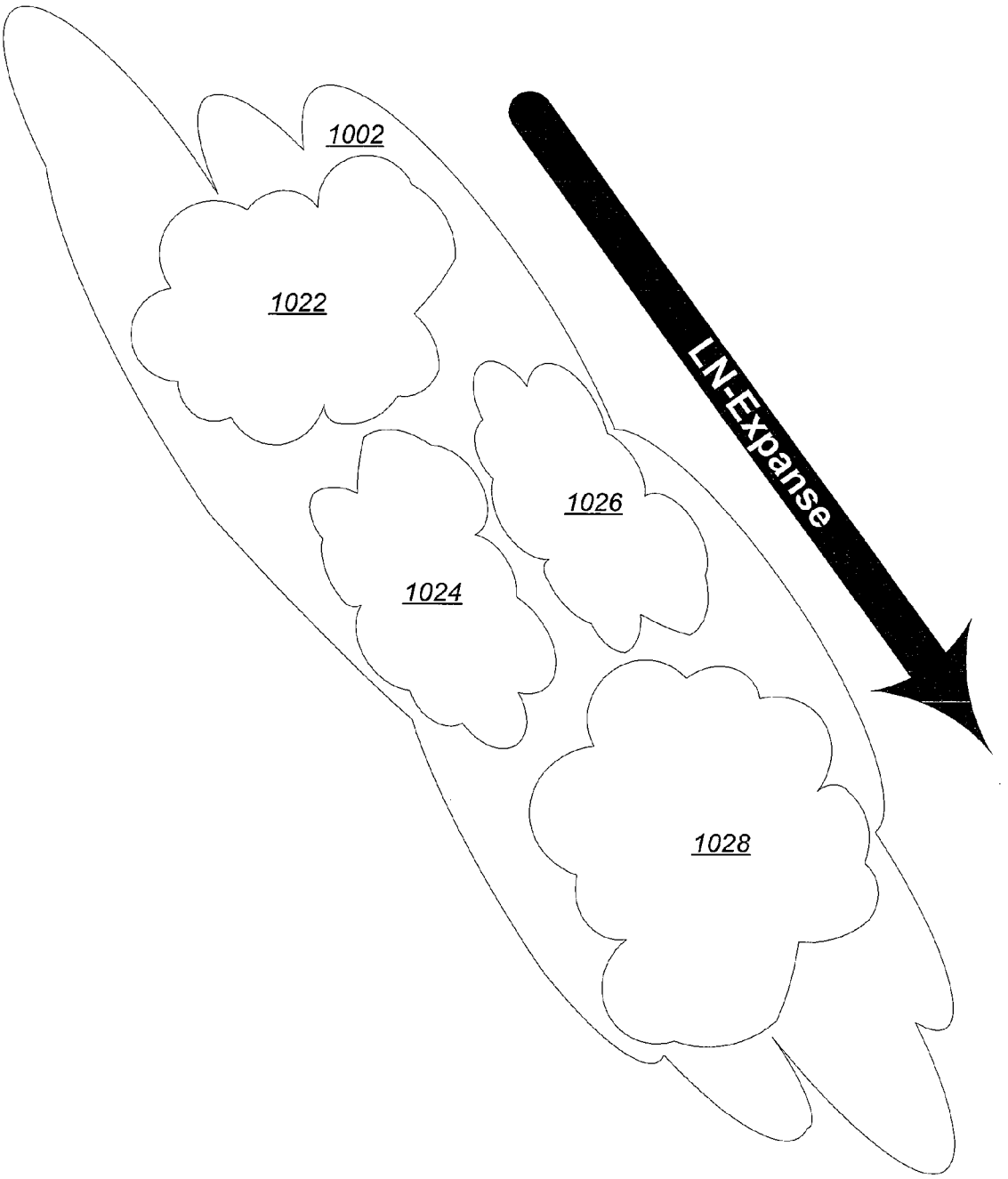

Fig. 10G

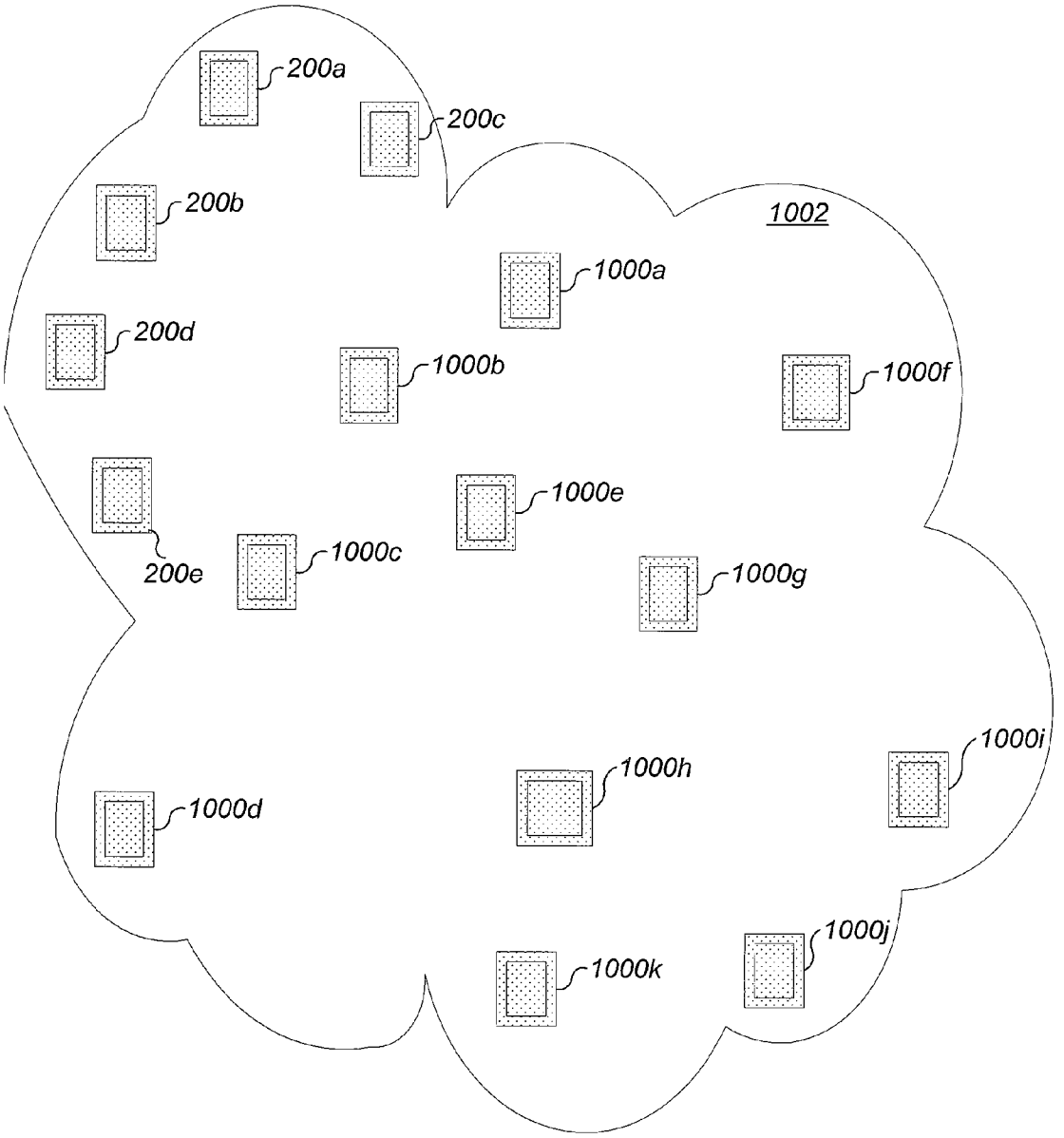
200a
200c
200b
1002
1000a
200d
1000b
1000f
1000e
200e
1000c
1000g
1000i
1000h
1000d
1000j
1000k

Fig. 10H

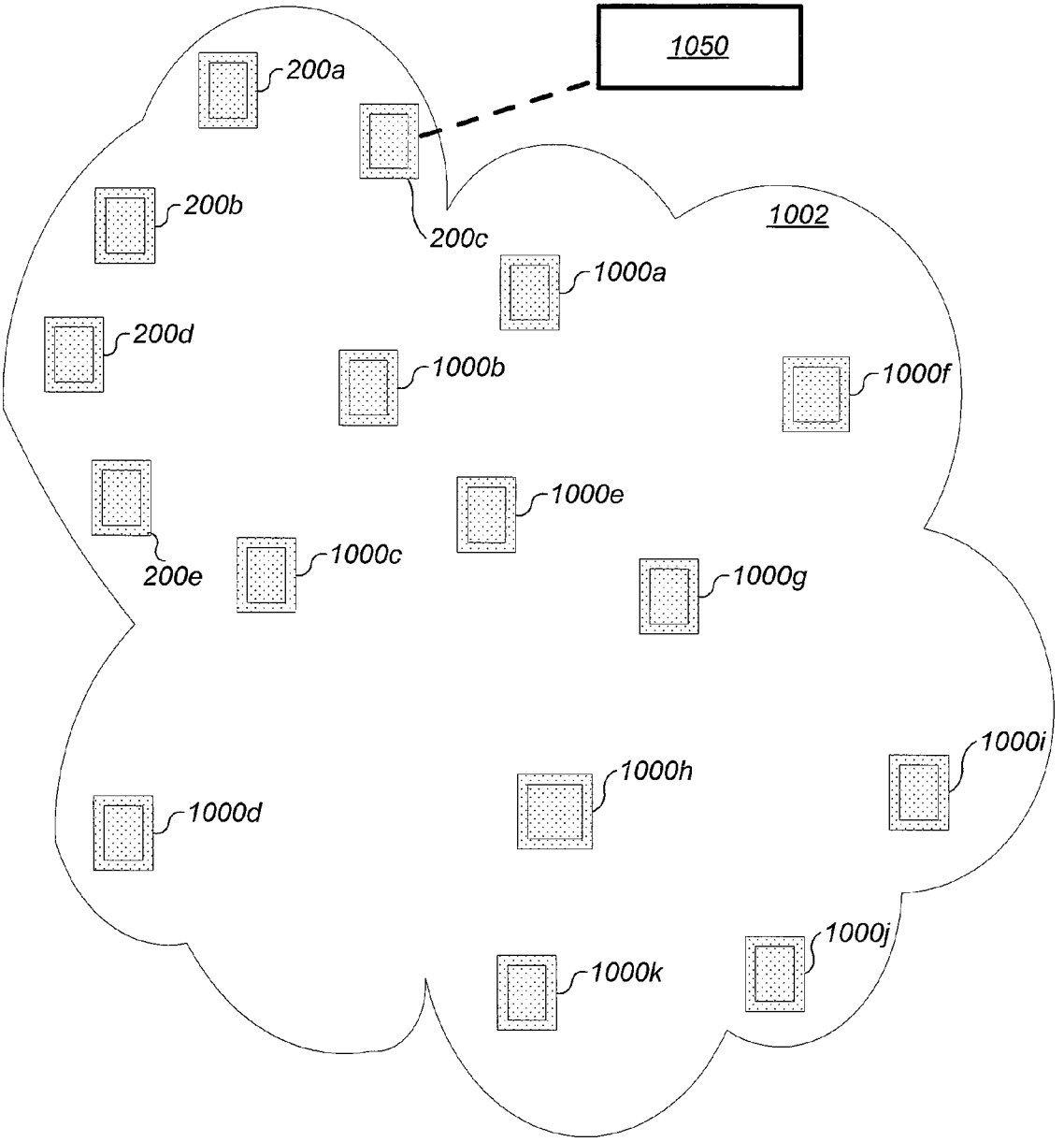
1050
200a
200b
200c
1002
1000a
200d
1000b
1000f
1000e
200e
1000c
1000g
1000i
1000h
1000d
1000j
1000k

Fig. 10I

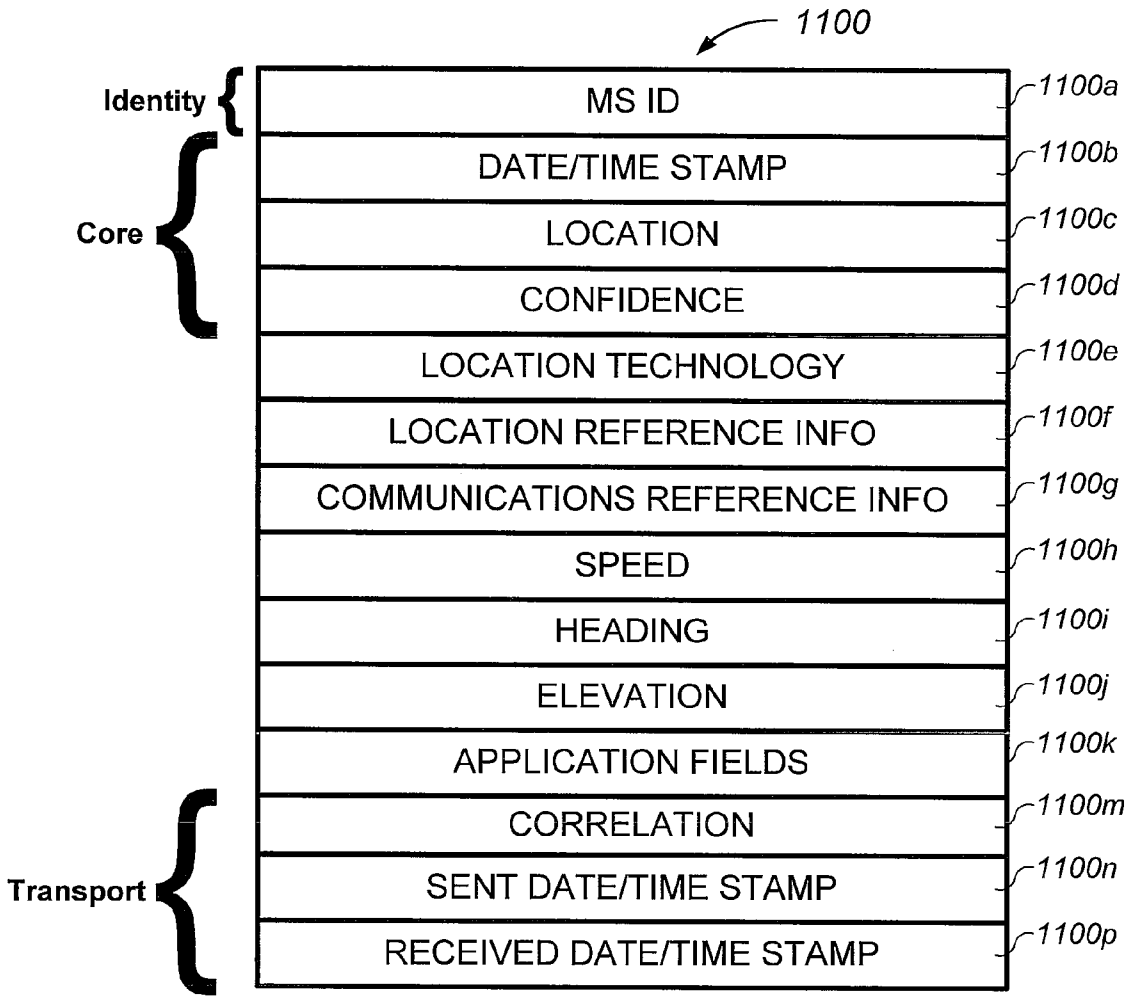
1100
Identity
Core
Transport
MS ID
DATE/TIME STAMP
LOCATION
CONFIDENCE
LOCATION TECHNOLOGY
LOCATION REFERENCE INFO
COMMUNICATIONS REFERENCE INFO
SPEED
HEADING
ELEVATION
APPLICATION FIELDS
CORRELATION
SENT DATE/TIME STAMP
RECEIVED DATE/TIME STAMP
1100a
1100b
1100c
1100d
1100e
1100f
1100g
1100h
1100i
1100j
1100k
1100m
1100n
1100p

Fig. 11A

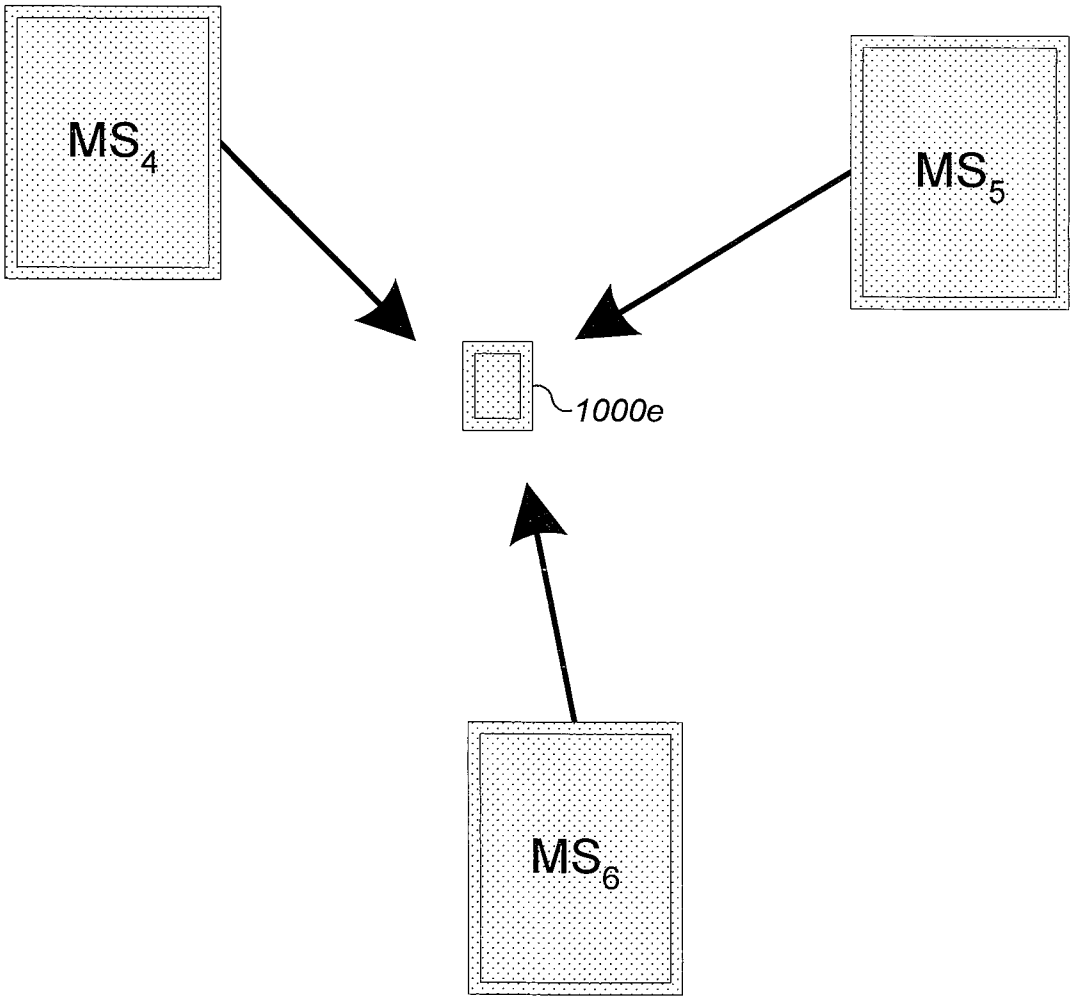

Fig. 11B

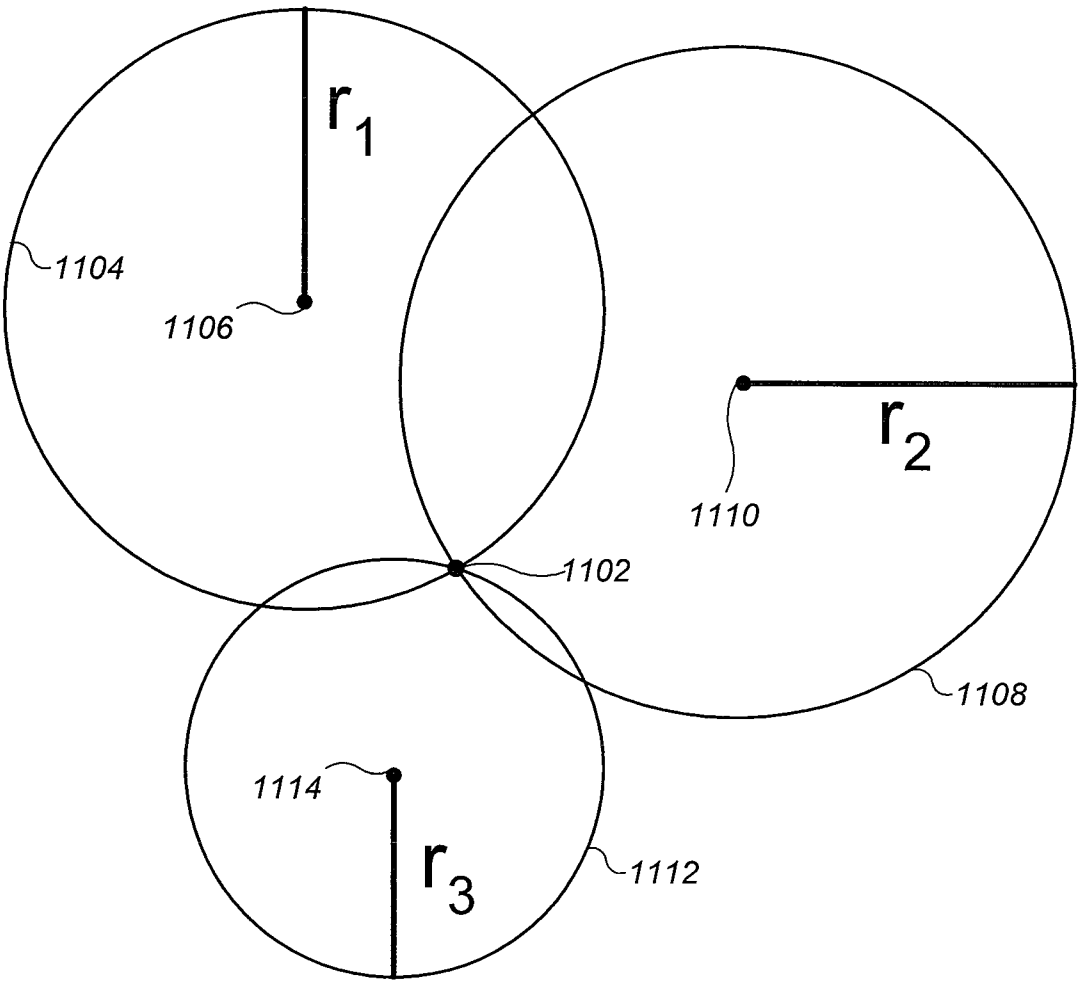

Fig. 11C

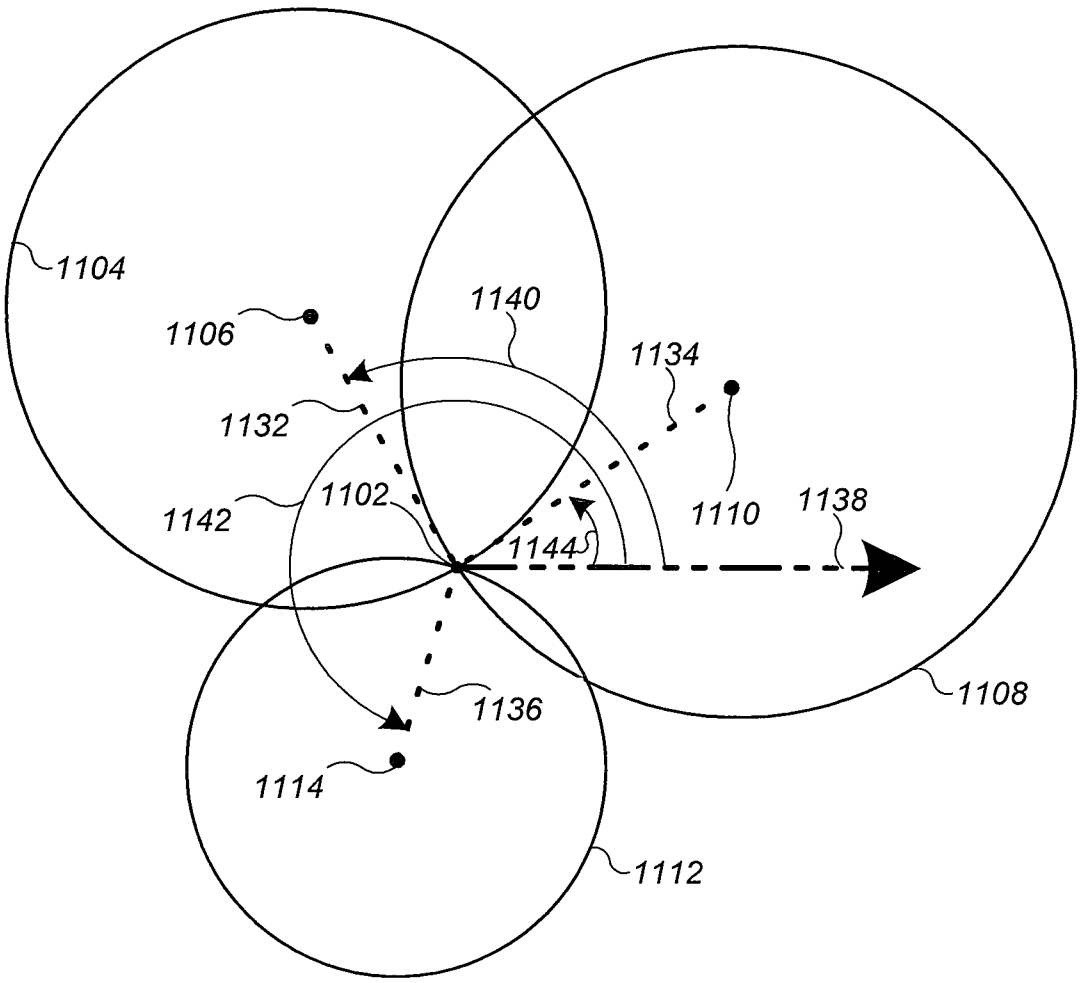
1104
1106
1140
1134
1132
1142
1102
1110
1138
1144
1108
1136
1114
1112

Fig. 11D

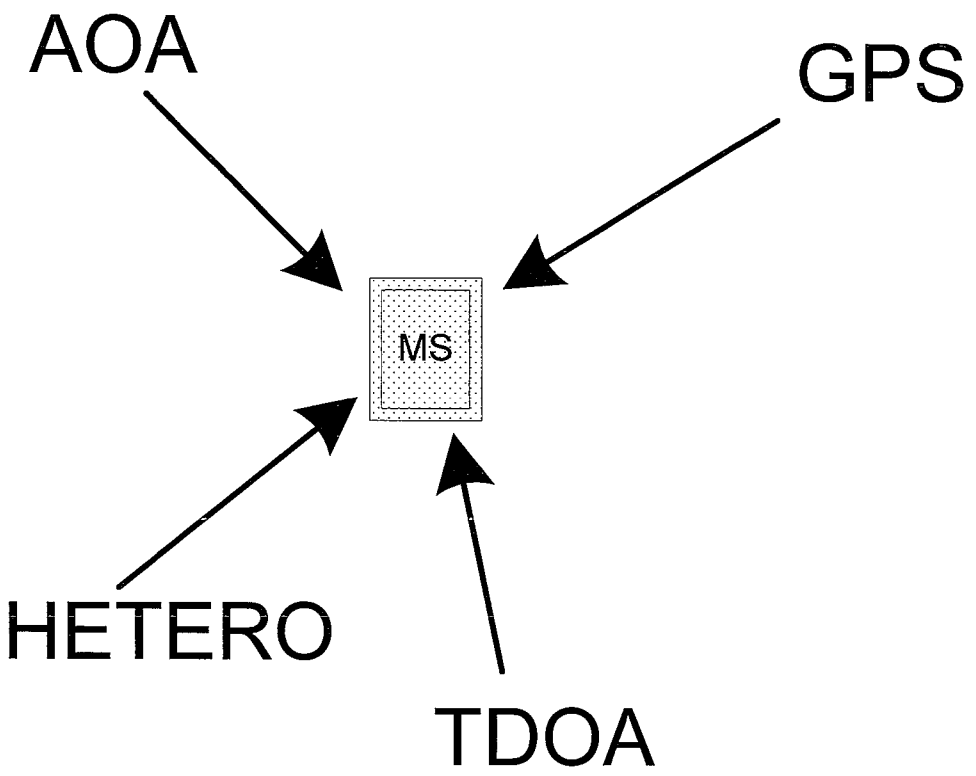

Fig. 11E

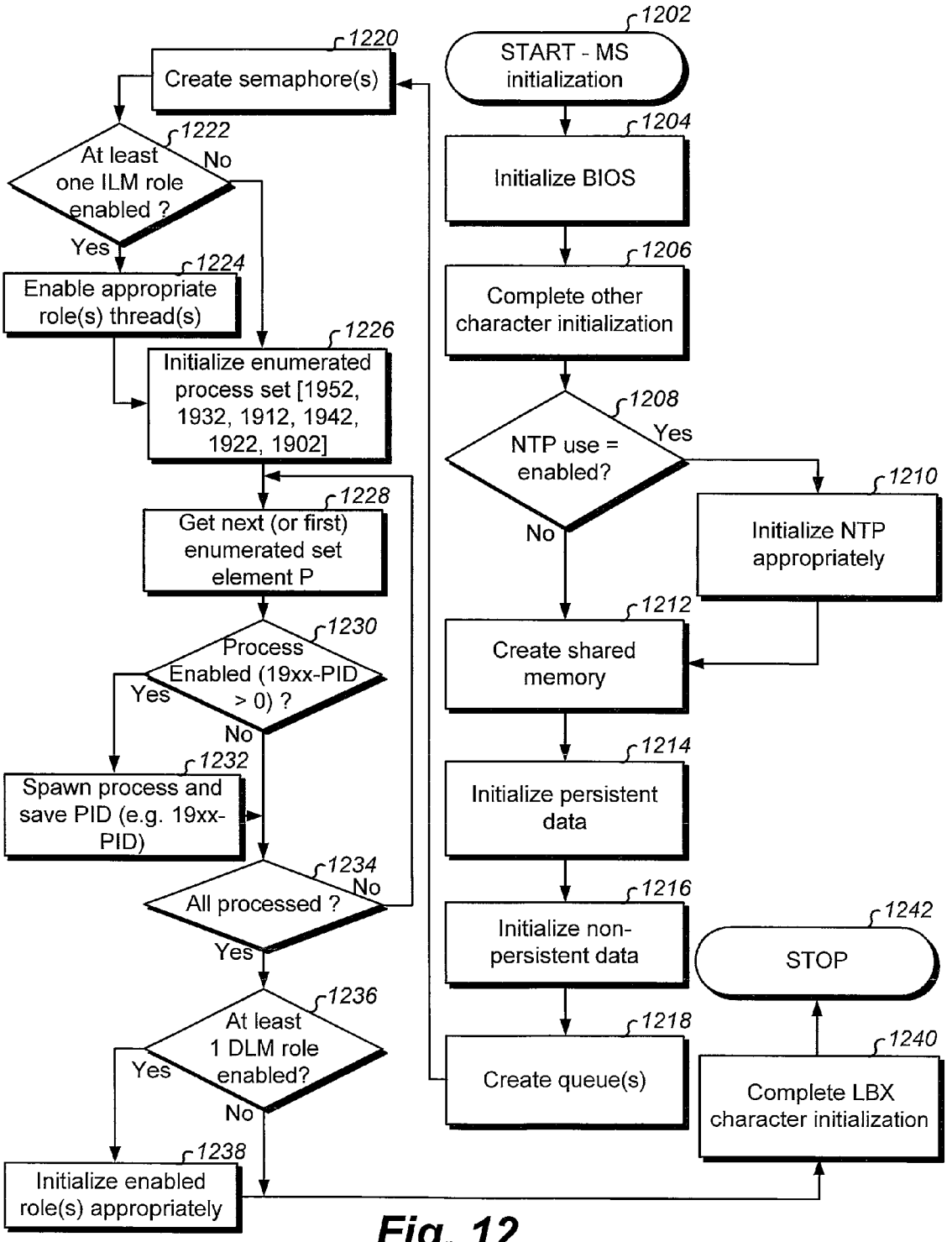
1202
START - MS initialization
1204
Initialize BIOS
1206
Complete other character initialization
1208
NTP use = enabled?
Yes
No
1210
Initialize NTP appropriately
1212
Create shared memory
1214
Initialize persistent data
1216
Initialize non-persistent data
1218
Create queue(s)
1220
Create semaphore(s)
1222
At least one ILM role enabled ?
No
Yes
1224
Enable appropriate role(s) thread(s)
1226
Initialize enumerated process set [1952, 1932, 1912, 1942, 1922, 1902]
1228
Get next (or first) enumerated set element P
1230
Process Enabled (19xx-PID > 0) ?
Yes
No
1232
Spawn process and save PID (e.g. 19xx-PID)
1234
All processed ?
No
Yes
1236
At least 1 DLM role enabled?
Yes
No
1238
Initialize enabled role(s) appropriately
1240
Complete LBX character initialization
1242
STOP

Fig. 12

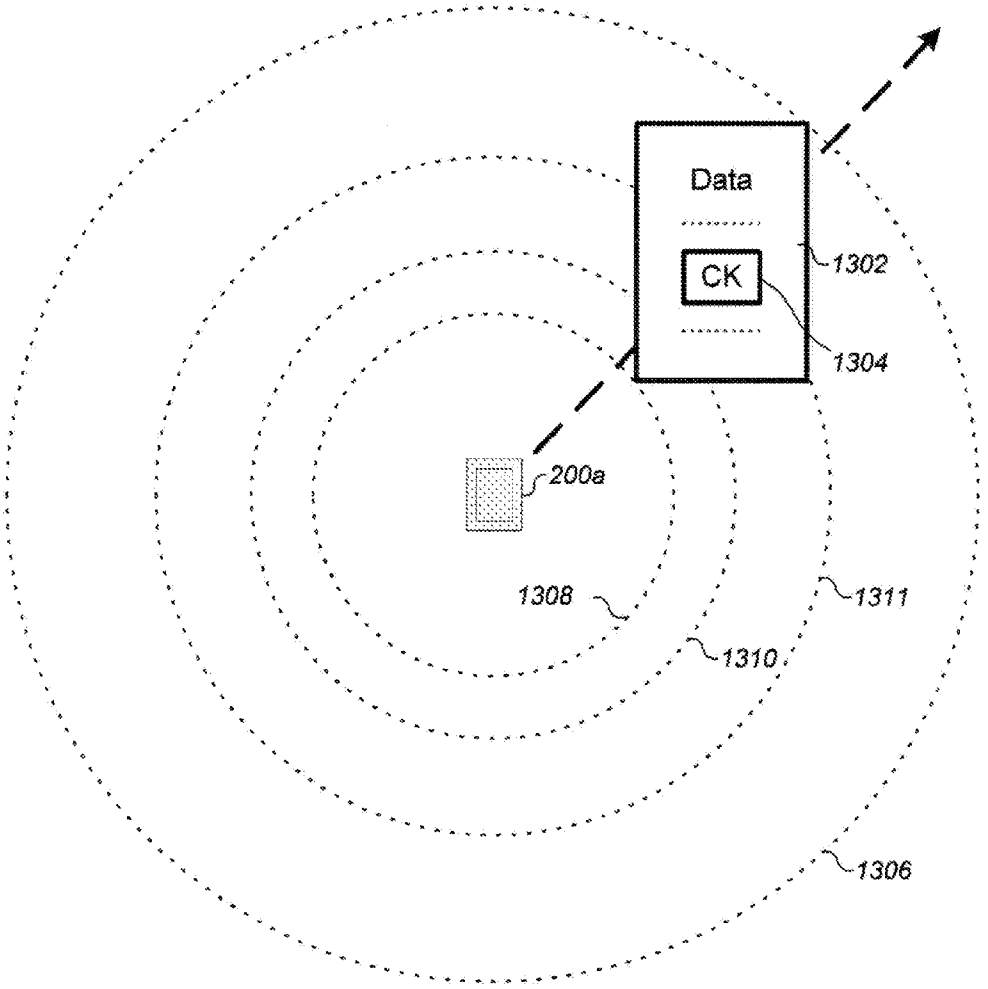

Fig. 13A

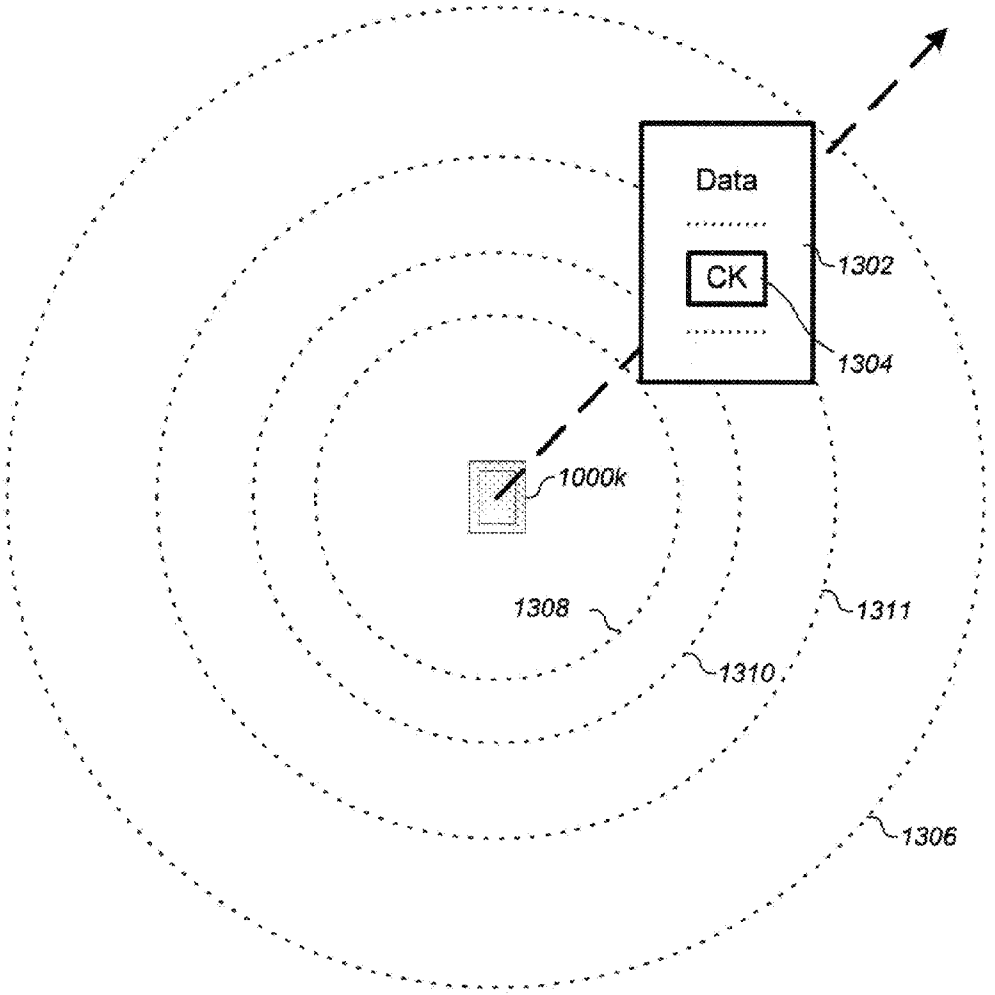

Fig. 13B

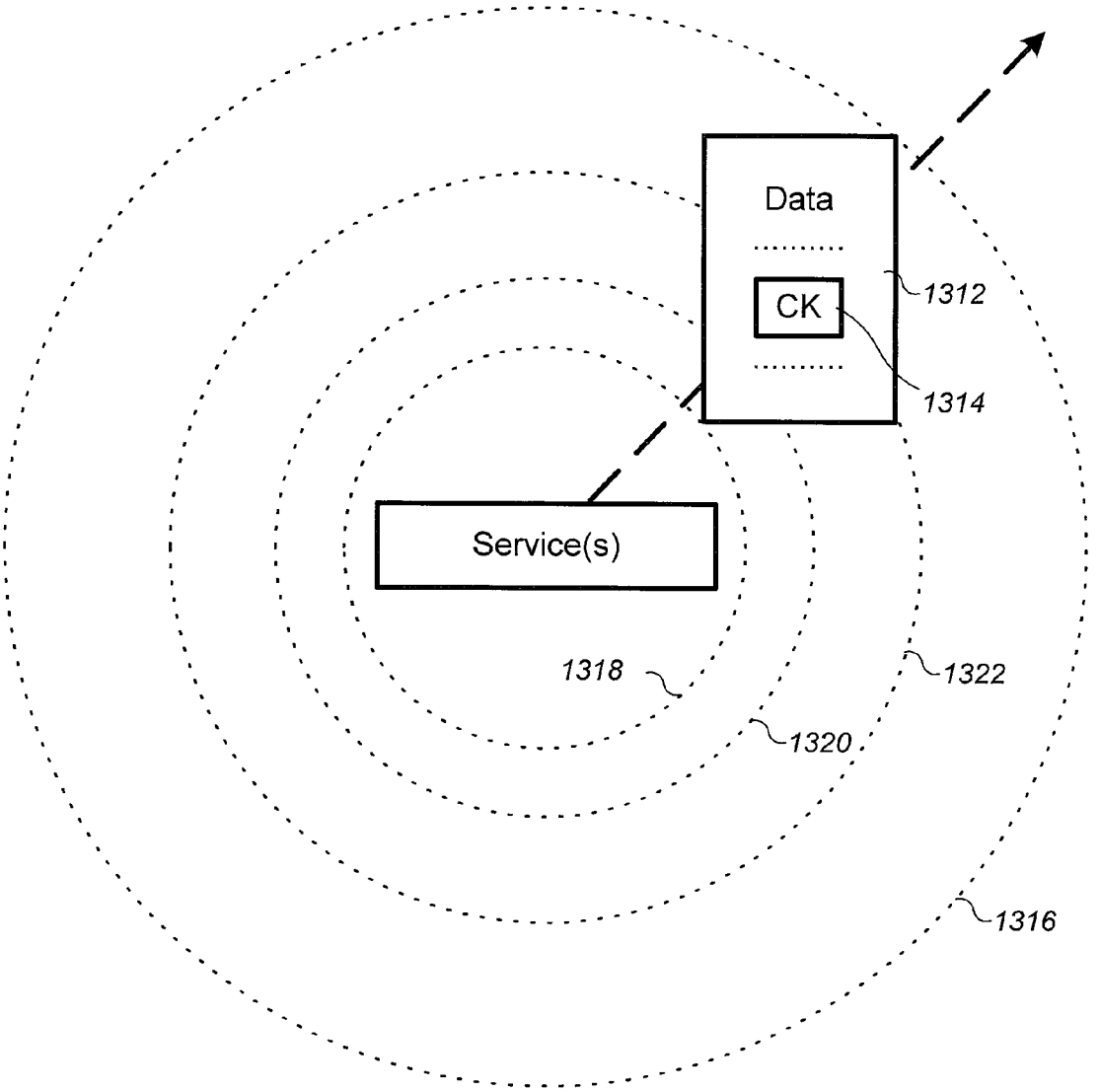

Fig. 13C

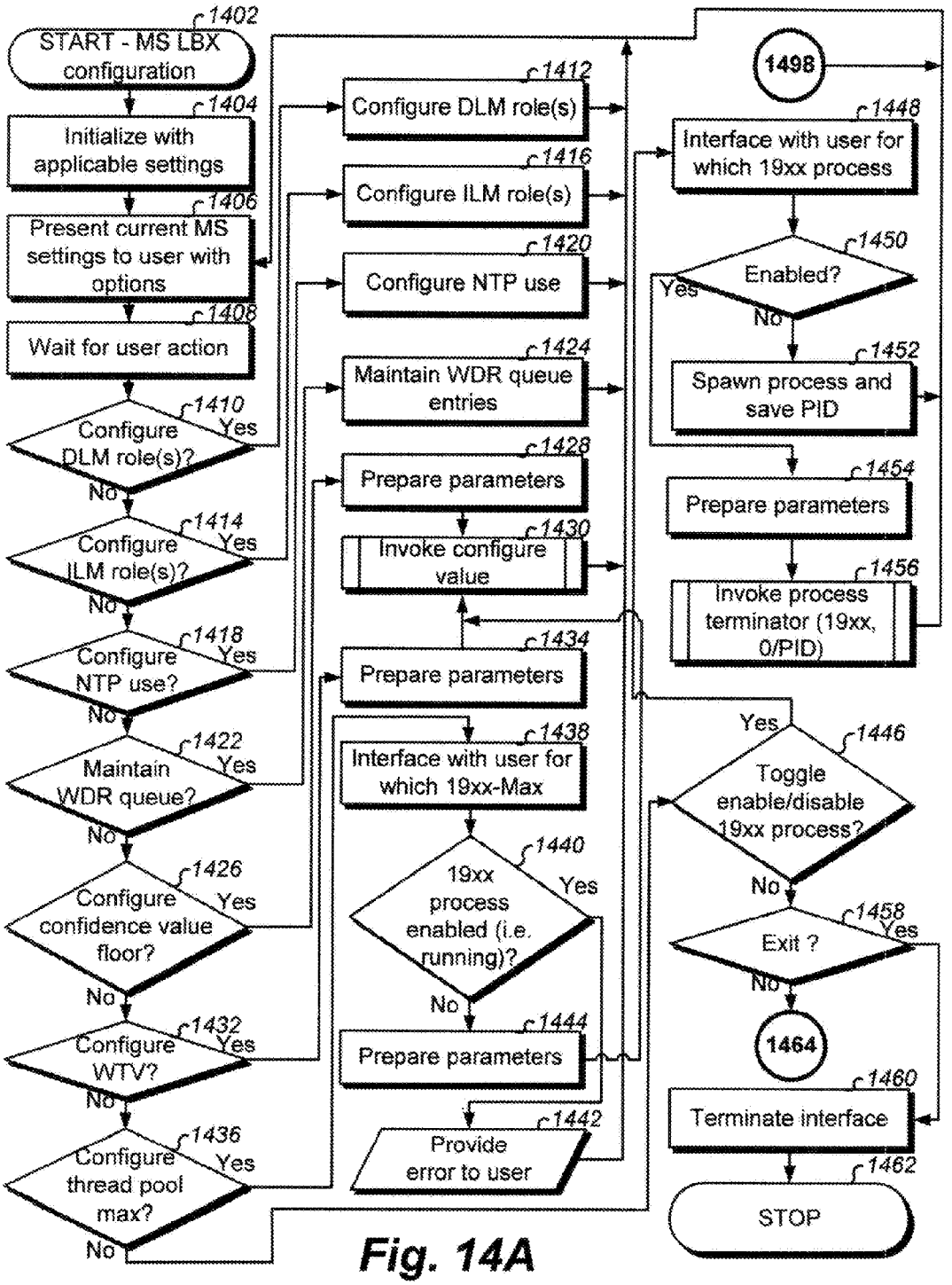
1402
START - MS LBX configuration
1404
Initialize with applicable settings
1406
Present current MS settings to user with options
1408
Wait for user action
1410
Configure DLM role(s)?
Yes
No
1414
Configure ILM role(s)?
Yes
No
1418
Configure NTP use?
Yes
No
1422
Maintain WDR queue?
Yes
No
1426
Configure confidence value floor?
Yes
No
1432
Configure WTV?
Yes
No
1436
Configure thread pool max?
Yes
No
1412
Configure DLM role(s)
1416
Configure ILM role(s)
1420
Configure NTP use
1424
Maintain WDR queue entries
1428
Prepare parameters
1430
Invoke configure value
1434
Prepare parameters
1438
Interface with user for which 19xx-Max
1440
19xx process enabled (i.e. running)?
Yes
No
1444
Prepare parameters
1442
Provide error to user
1498
1448
Interface with user for which 19xx process
1450
Enabled?
Yes
No
1452
Spawn process and save PID
1454
Prepare parameters
1456
Invoke process terminator (19xx, 0/PID)
Yes
1446
Toggle enable/disable 19xx process?
No
1458
Exit ?
Yes
No
1464
1460
Terminate interface
1462
STOP

Fig. 14A

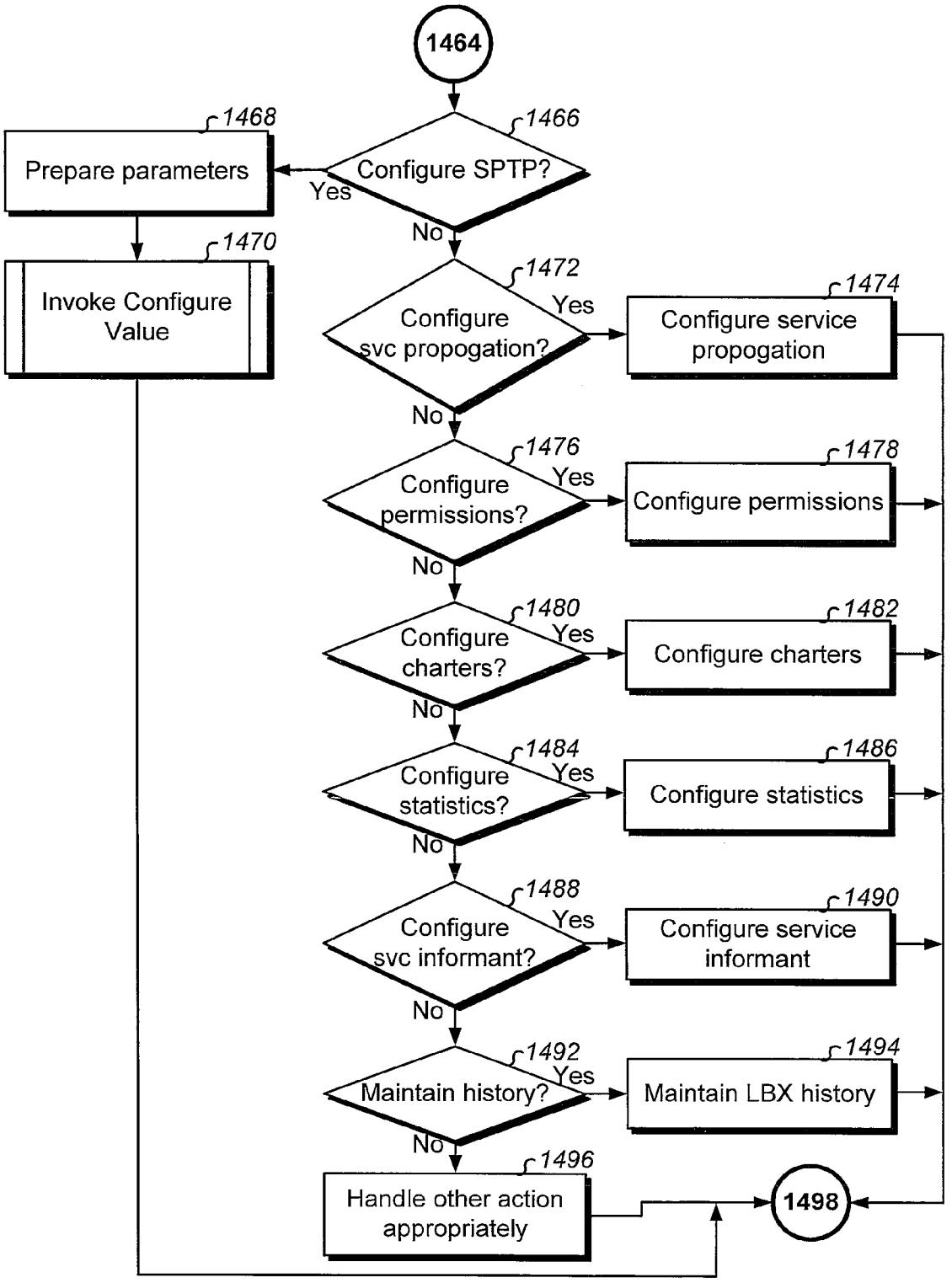
1464
1466
Configure SPTP?
Yes
1468
Prepare parameters
No
1470
Invoke Configure Value
1472
Configure svc propogation?
Yes
1474
Configure service propogation
No
1476
Configure permissions?
Yes
1478
Configure permissions
No
1480
Configure charters?
Yes
1482
Configure charters
No
1484
Configure statistics?
Yes
1486
Configure statistics
No
1488
Configure svc informant?
Yes
1490
Configure service informant
No
1492
Maintain history?
Yes
1494
Maintain LBX history
No
1496
Handle other action appropriately
1498

Fig. 14B

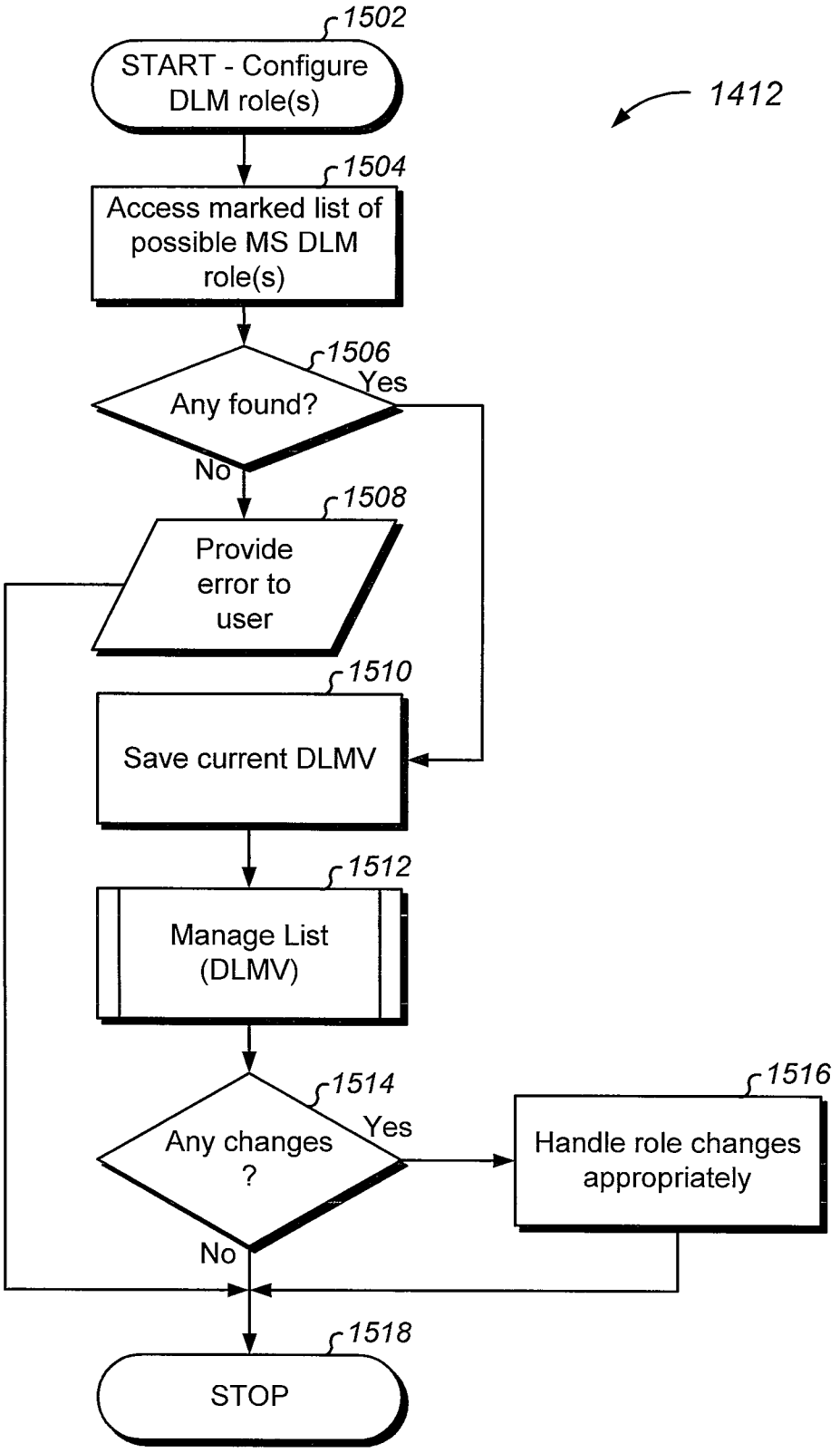
1502
START - Configure DLM role(s)
1412
1504
Access marked list of possible MS DLM role(s)
1506
Any found?
Yes
No
1508
Provide error to user
1510
Save current DLMV
1512
Manage List (DLMV)
1514
Any changes ?
Yes
No
1516
Handle role changes appropriately
1518
STOP

Fig. 15A

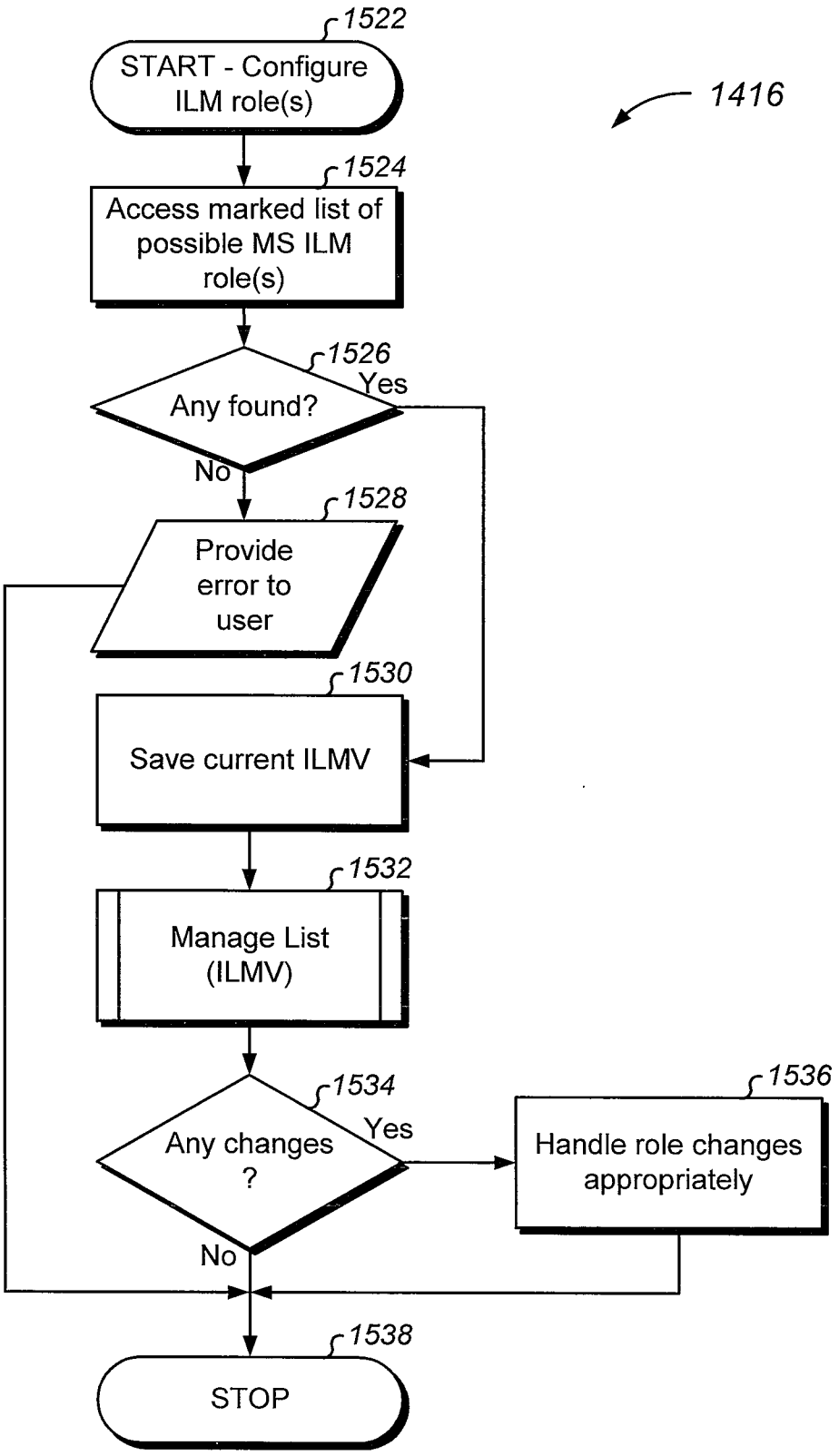
1522
START - Configure ILM role(s)
1416
1524
Access marked list of possible MS ILM role(s)
1526
Any found?
Yes
No
1528
Provide error to user
1530
Save current ILMV
1532
Manage List (ILMV)
1534
Any changes ?
Yes
No
1536
Handle role changes appropriately
1538
STOP

Fig. 15B

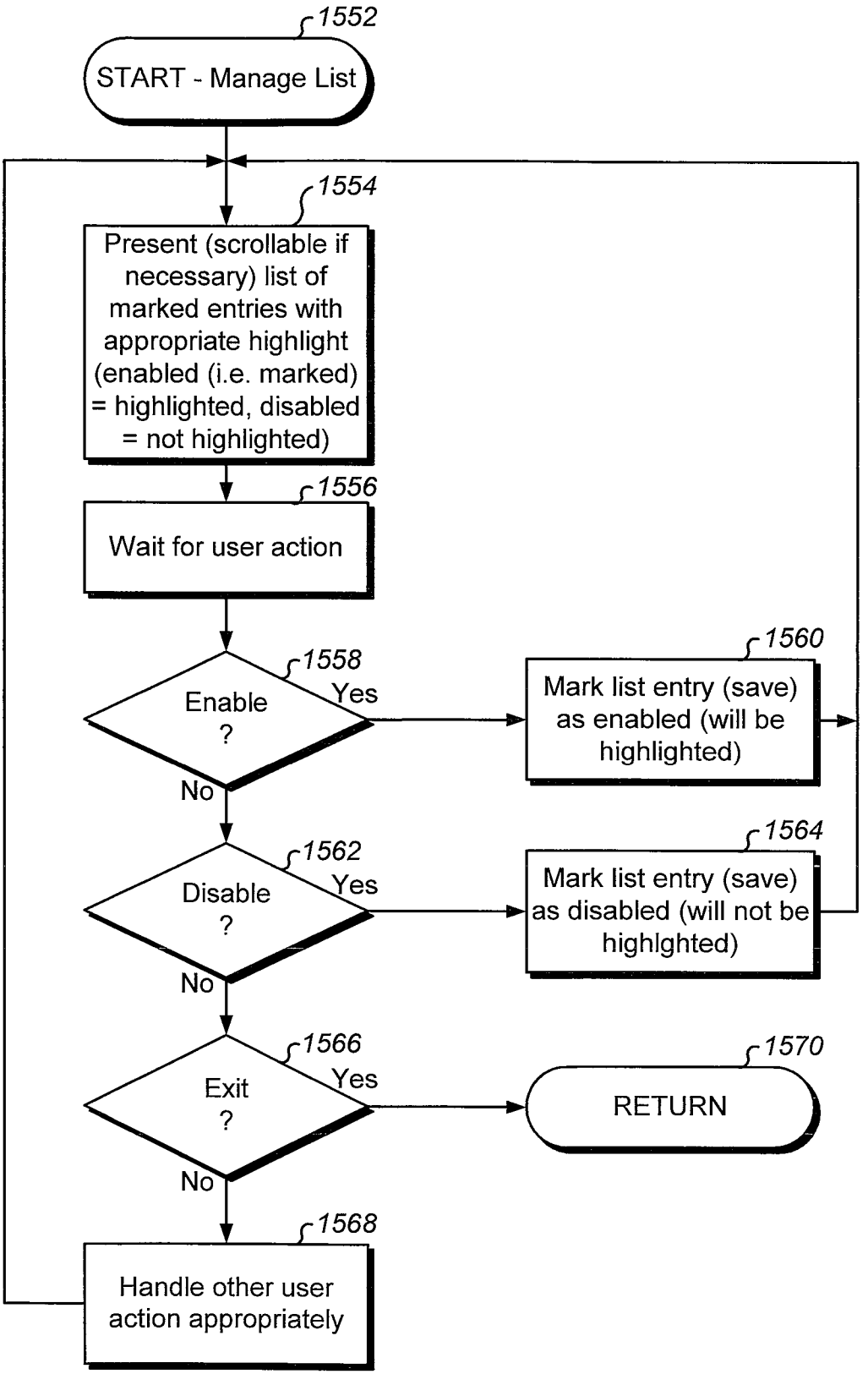
1552
START - Manage List
1554
Present (scrollable if necessary) list of marked entries with appropriate highlight (enabled (i.e. marked) = highlighted, disabled = not highlighted)
1556
Wait for user action
1558
Enable ?
Yes
No
1560
Mark list entry (save) as enabled (will be highlighted)
1562
Disable ?
Yes
No
1564
Mark list entry (save) as disabled (will not be highlghted)
1566
Exit ?
Yes
No
1570
RETURN
1568
Handle other user action appropriately

Fig. 15C

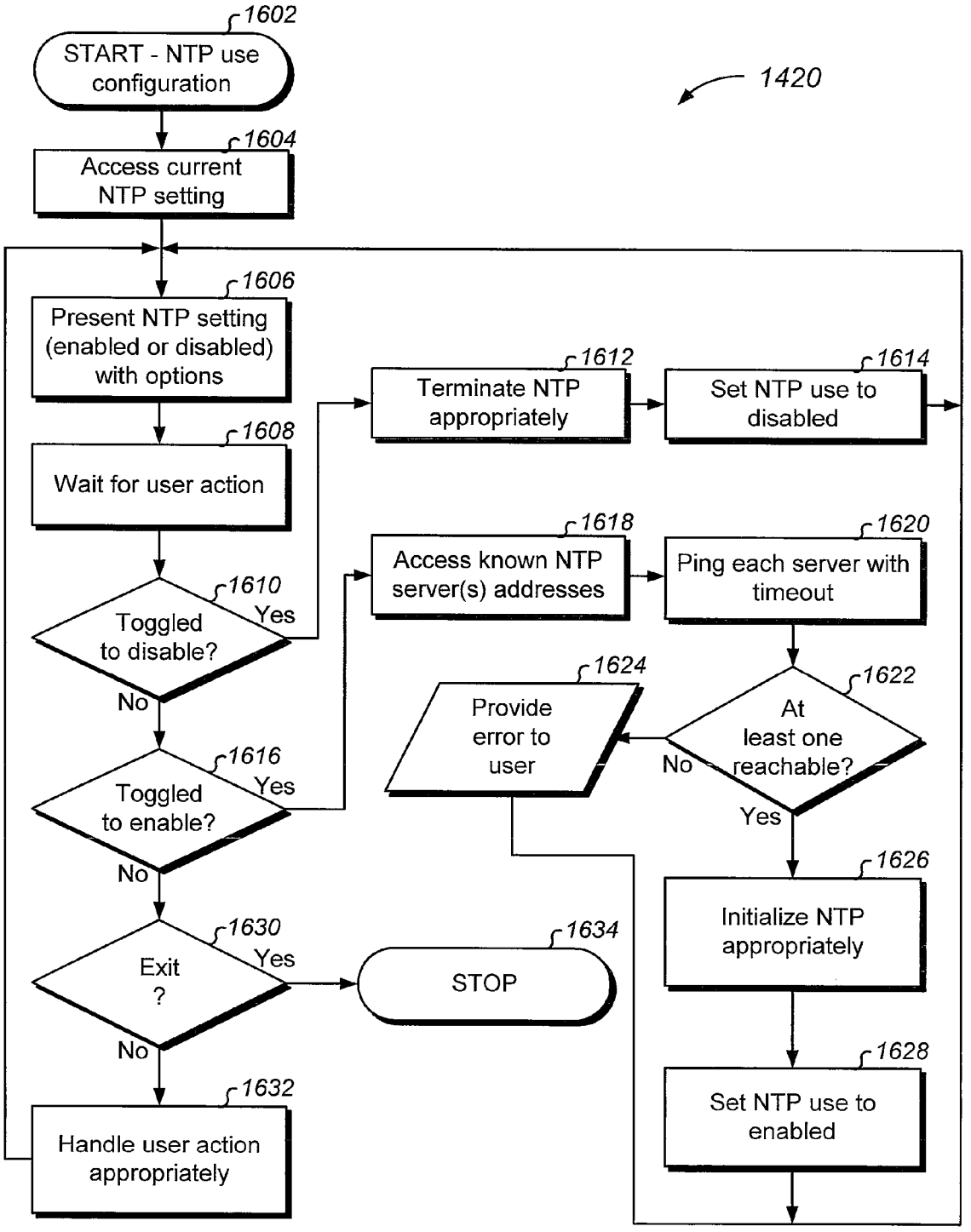
1602
START - NTP use configuration
1420
1604
Access current NTP setting
1606
Present NTP setting (enabled or disabled) with options
1608
Wait for user action
1610
Toggled to disable?
Yes
No
1612
Terminate NTP appropriately
1614
Set NTP use to disabled
1616
Toggled to enable?
Yes
No
1618
Access known NTP server(s) addresses
1620
Ping each server with timeout
1622
At least one reachable?
No
Yes
1624
Provide error to user
1626
Initialize NTP appropriately
1628
Set NTP use to enabled
1630
Exit ?
Yes
No
1634
STOP
1632
Handle user action appropriately

Fig. 16

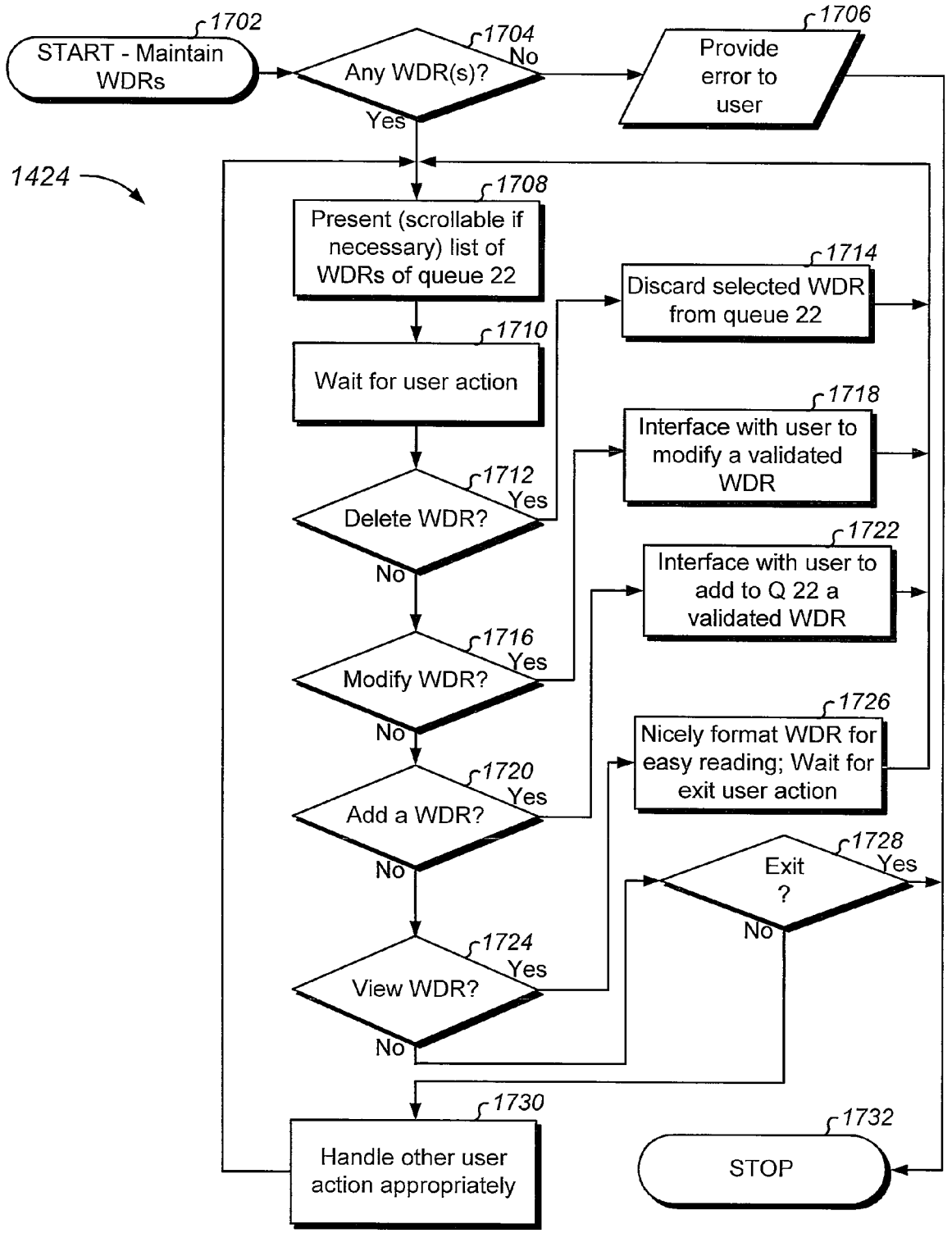
1424
1702
START - Maintain WDRs
1704
Any WDR(s)?
No
Yes
1706
Provide error to user
1708
Present (scrollable if necessary) list of WDRs of queue 22
1710
Wait for user action
1712
Delete WDR?
Yes
No
1714
Discard selected WDR from queue 22
1716
Modify WDR?
Yes
No
1718
Interface with user to modify a validated WDR
1720
Add a WDR?
Yes
No
1722
Interface with user to add to Q 22 a validated WDR
1724
View WDR?
Yes
No
1726
Nicely format WDR for easy reading; Wait for exit user action
1728
Exit ?
Yes
No
1730
Handle other user action appropriately
1732
STOP

Fig. 17

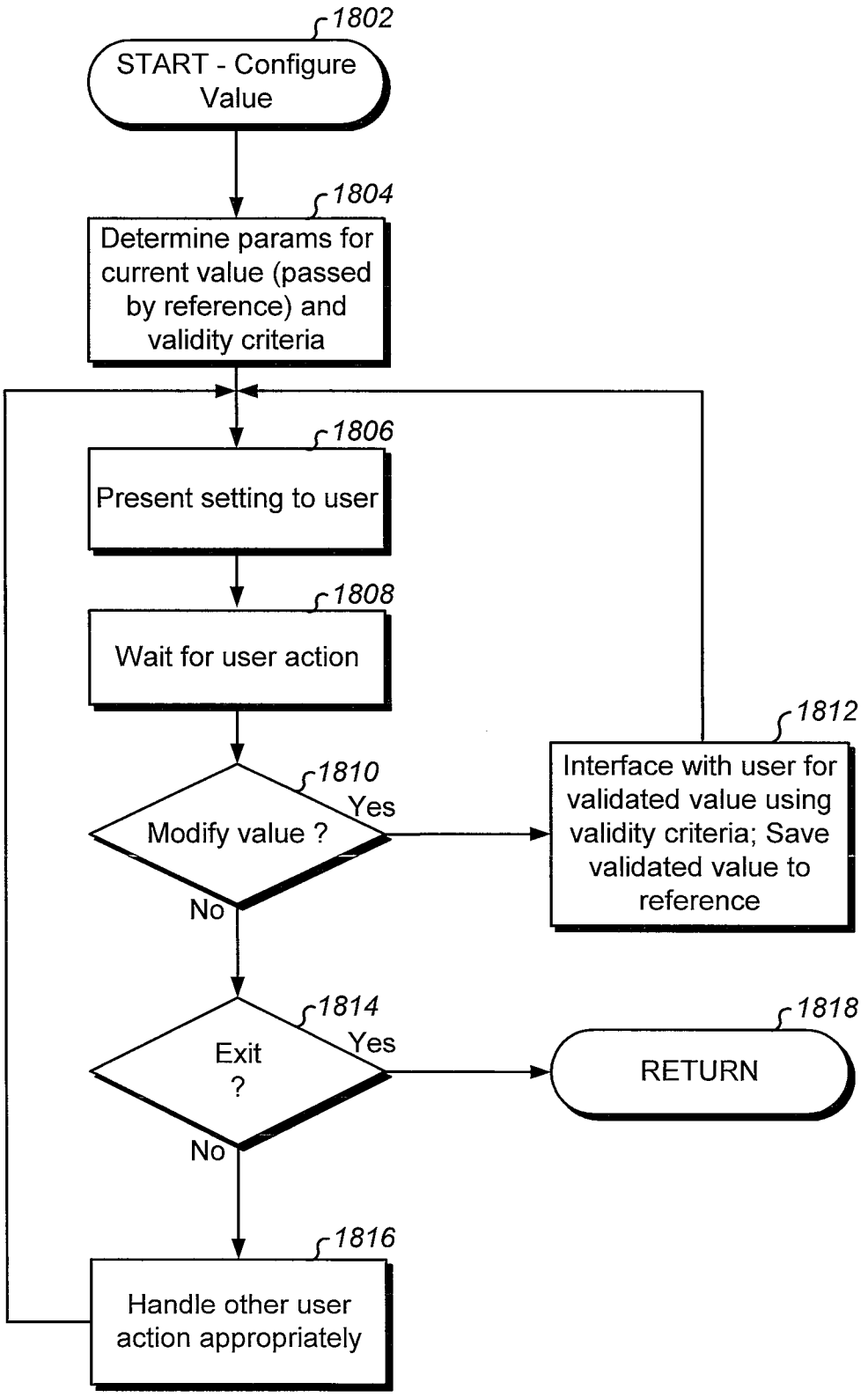
1802
START - Configure Value
1804
Determine params for current value (passed by reference) and validity criteria
1806
Present setting to user
1808
Wait for user action
1810
Modify value ?
Yes
No
1812
Interface with user for validated value using validity criteria; Save validated value to reference
1814
Exit ?
Yes
No
1818
RETURN
1816
Handle other user action appropriately

Fig. 18

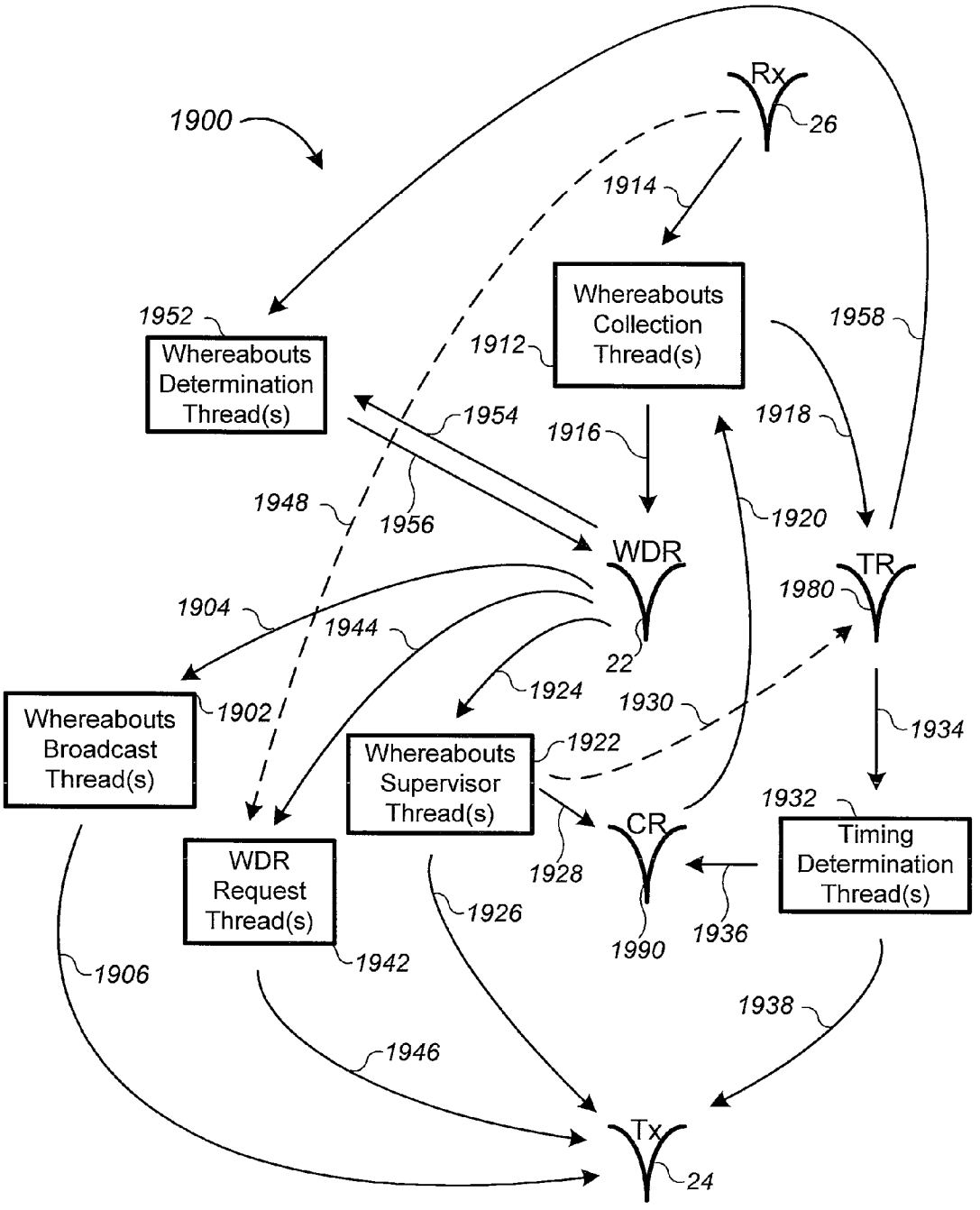
1900
Rx
26
1914
1952
Whereabouts Determination Thread(s)
1912
Whereabouts Collection Thread(s)
1958
1954
1916
1918
1948
1956
1920
WDR
TR
1980
1904
1944
22
1924
1930
1934
Whereabouts Broadcast Thread(s)
1902
Whereabouts Supervisor Thread(s)
1922
1932
CR
Timing Determination Thread(s)
WDR Request Thread(s)
1928
1926
1936
1990
1906
1942
1938
1946
Tx
24

Fig. 19

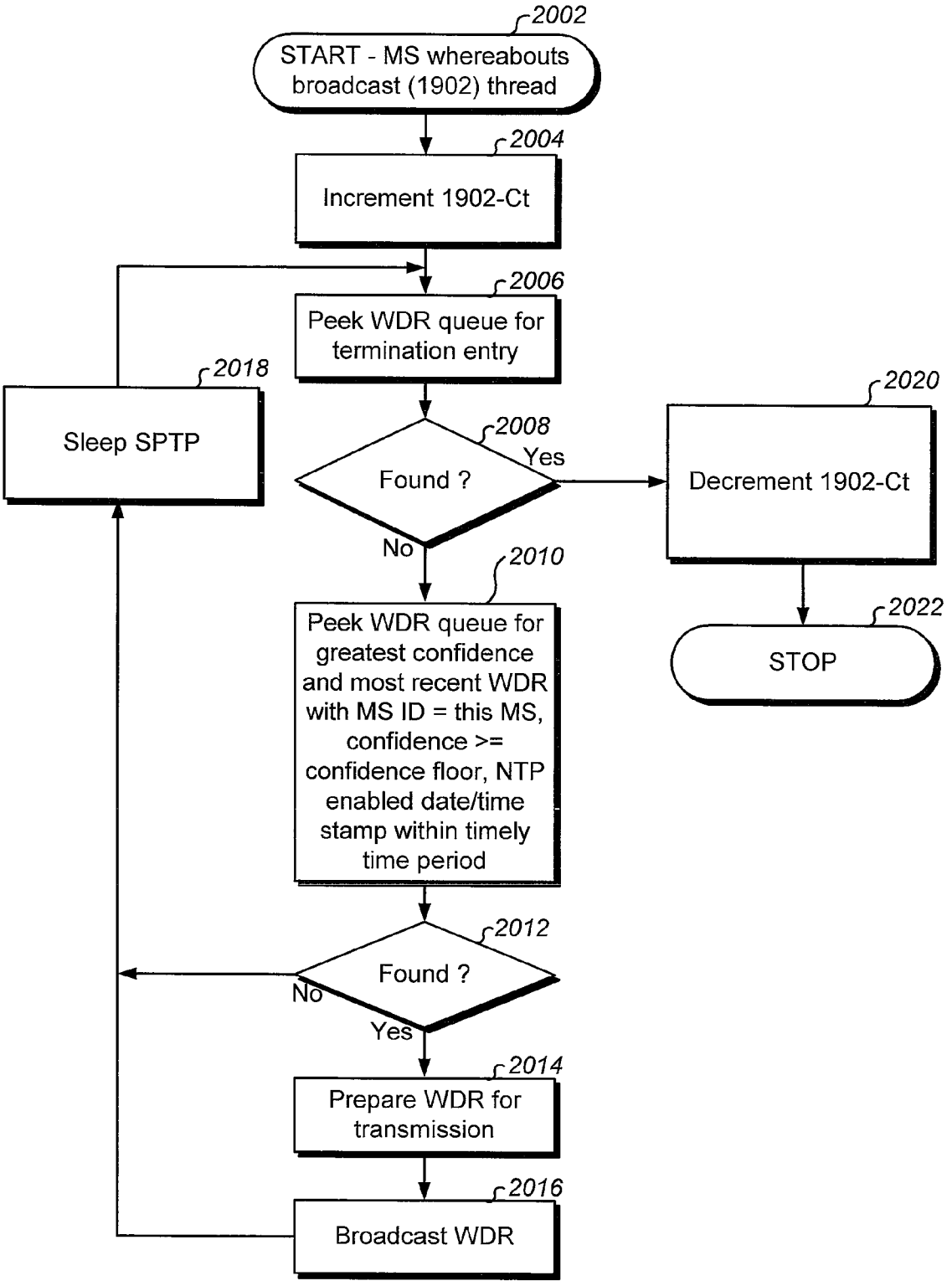
2002
START - MS whereabouts broadcast (1902) thread
2004
Increment 1902-Ct
2006
Peek WDR queue for termination entry
2008
Found ?
Yes
No
2018
Sleep SPTP
2020
Decrement 1902-Ct
2022
STOP
2010
Peek WDR queue for greatest confidence and most recent WDR with MS ID = this MS, confidence >= confidence floor, NTP enabled date/time stamp within timely time period
2012
Found ?
No
Yes
2014
Prepare WDR for transmission
2016
Broadcast WDR

Fig. 20

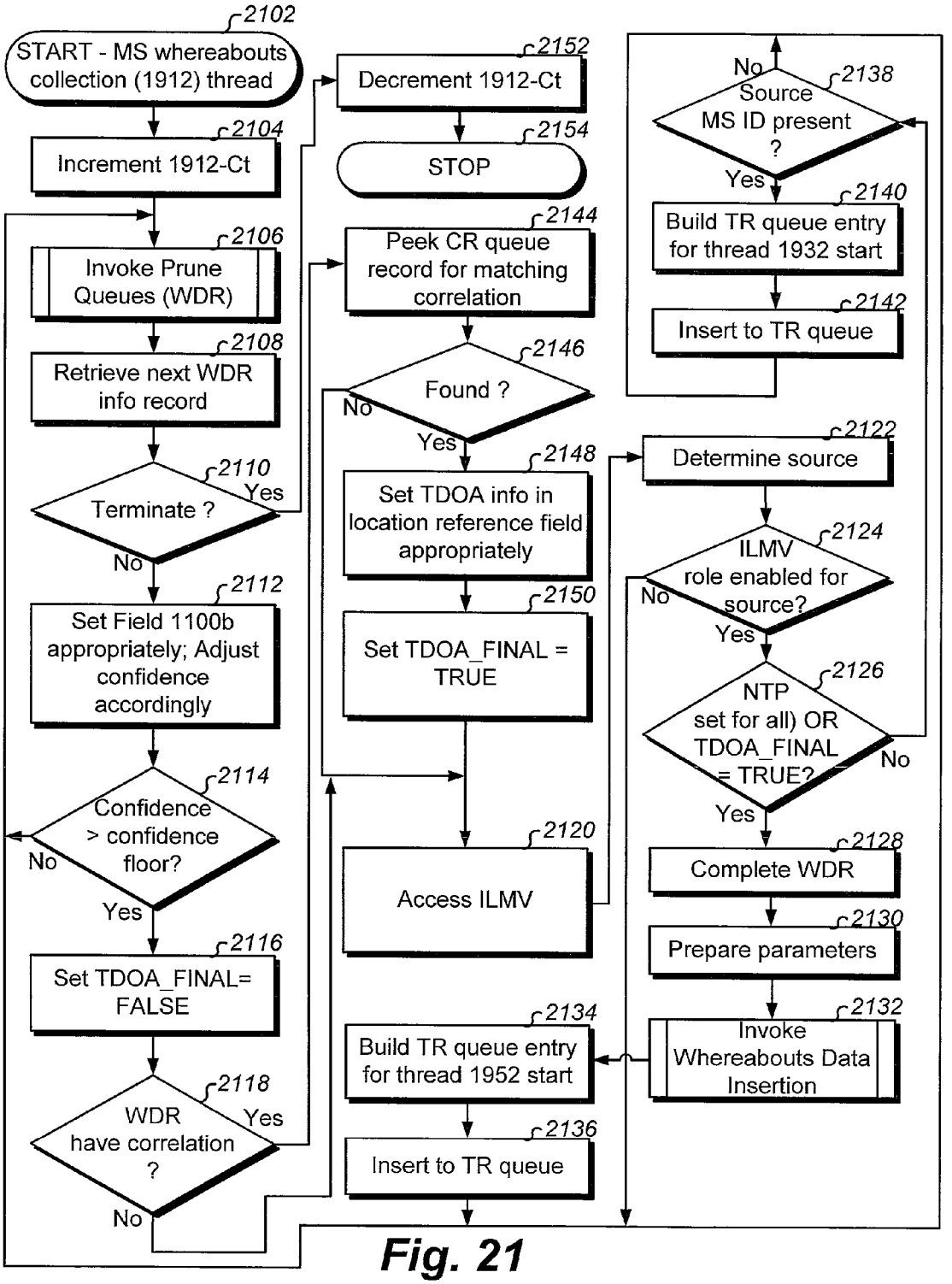
2102
START - MS whereabouts collection (1912) thread
2104
Increment 1912-Ct
2106
Invoke Prune Queues (WDR)
2108
Retrieve next WDR info record
2110
Terminate ?
Yes
No
2112
Set Field 1100b appropriately; Adjust confidence accordingly
2114
Confidence > confidence floor?
No
Yes
2116
Set TDOA_FINAL= FALSE
2118
WDR have correlation ?
Yes
No
2152
Decrement 1912-Ct
2154
STOP
2144
Peek CR queue record for matching correlation
2146
Found ?
No
Yes
2148
Set TDOA info in location reference field appropriately
2150
Set TDOA_FINAL = TRUE
2120
Access ILMV
2134
Build TR queue entry for thread 1952 start
2136
Insert to TR queue
No
2138
Source MS ID present ?
Yes
2140
Build TR queue entry for thread 1932 start
2142
Insert to TR queue
2122
Determine source
2124
ILMV role enabled for source?
No
Yes
2126
NTP set for all) OR TDOA_FINAL = TRUE?
No
Yes
2128
Complete WDR
2130
Prepare parameters
2132
Invoke Whereabouts Data Insertion

Fig. 21

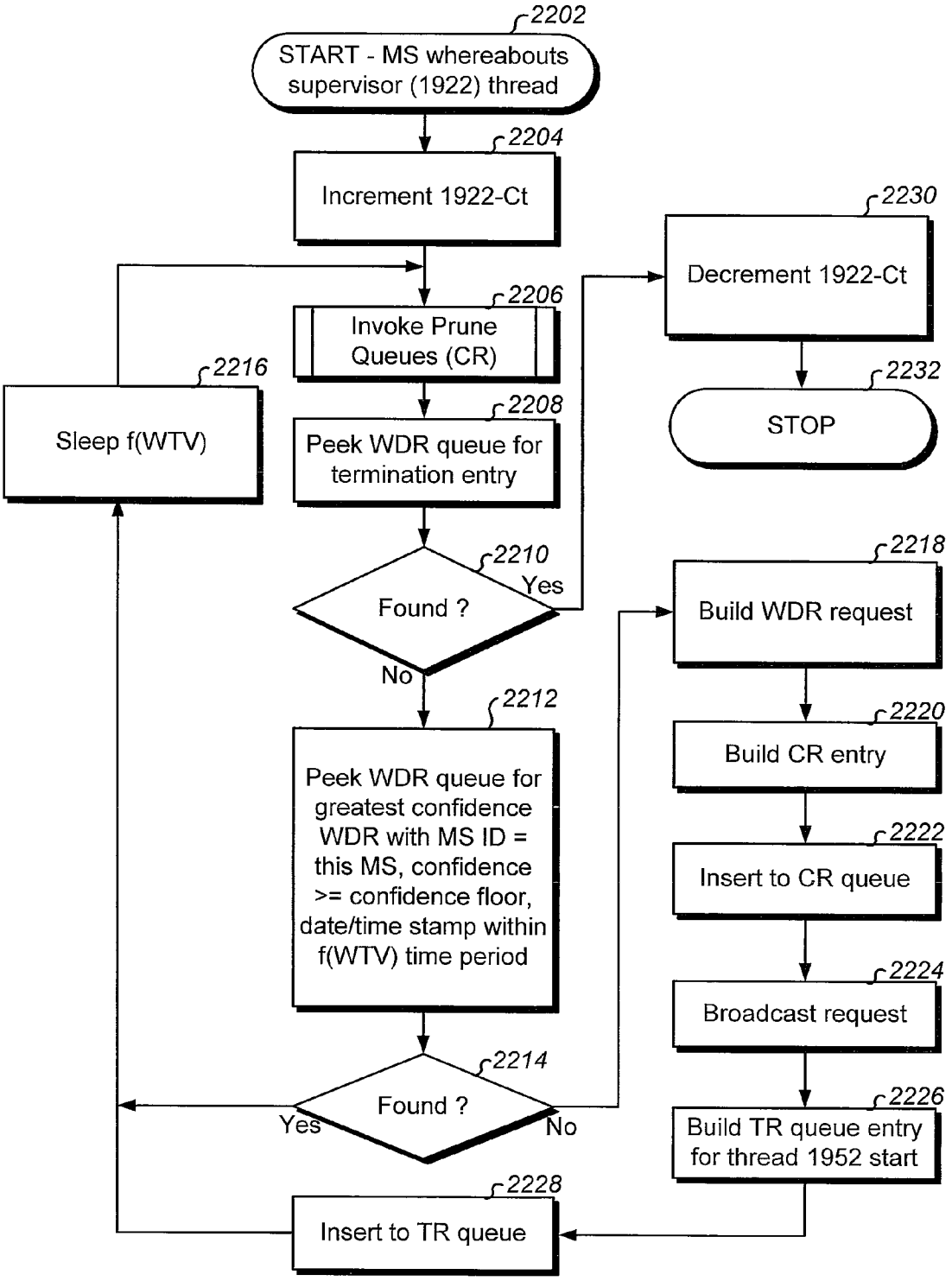
2202
START - MS whereabouts supervisor (1922) thread
2204
Increment 1922-Ct
2206
Invoke Prune Queues (CR)
2208
Peek WDR queue for termination entry
2210
Found ?
Yes
No
2212
Peek WDR queue for greatest confidence WDR with MS ID = this MS, confidence >= confidence floor, date/time stamp within f(WTV) time period
2214
Found ?
Yes
No
2216
Sleep f(WTV)
2218
Build WDR request
2220
Build CR entry
2222
Insert to CR queue
2224
Broadcast request
2226
Build TR queue entry for thread 1952 start
2228
Insert to TR queue
2230
Decrement 1922-Ct
2232
STOP

Fig. 22

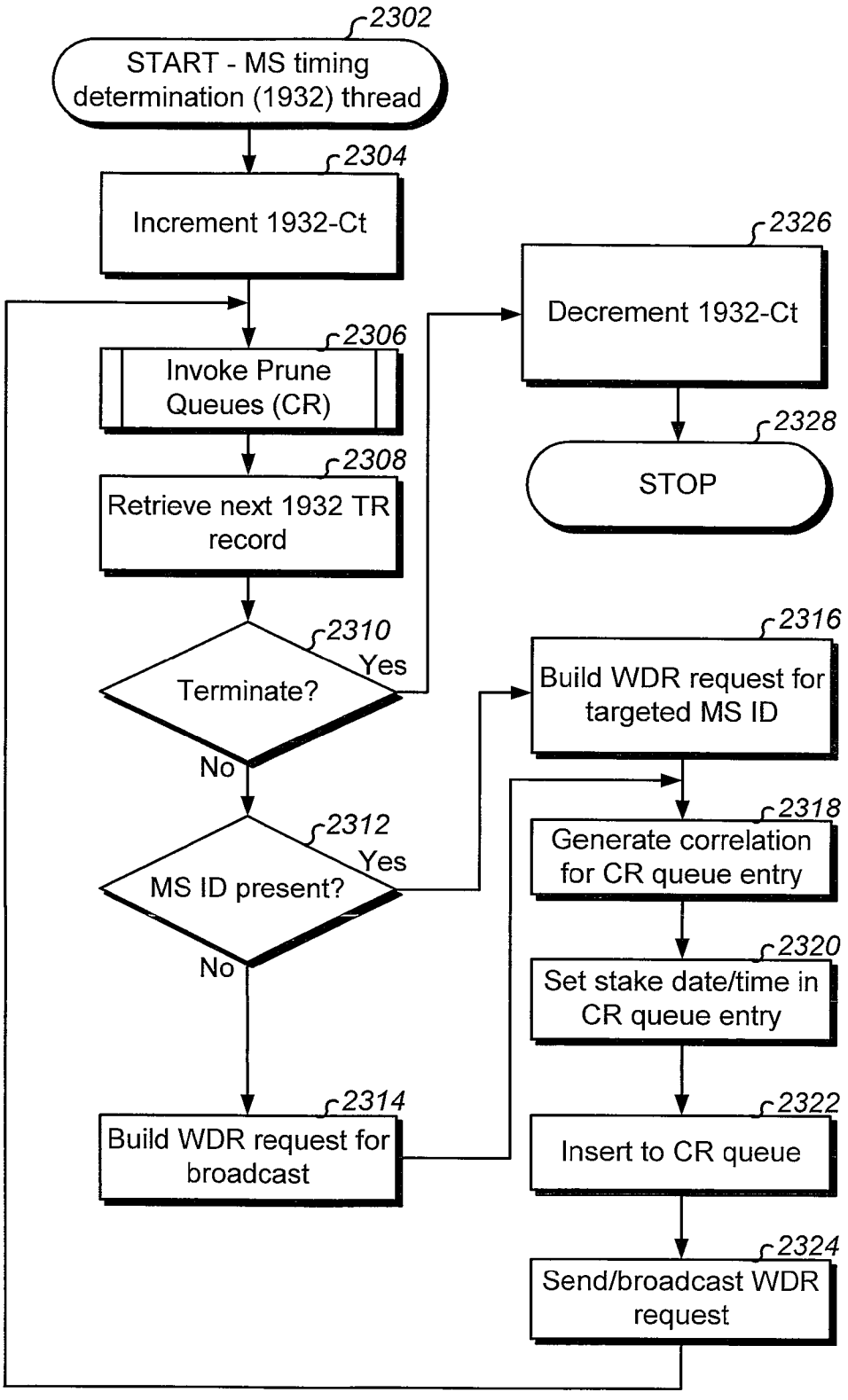
2302
START - MS timing determination (1932) thread
2304
Increment 1932-Ct
2306
Invoke Prune Queues (CR)
2308
Retrieve next 1932 TR record
2310
Terminate?
Yes
No
2312
MS ID present?
Yes
No
2314
Build WDR request for broadcast
2316
Build WDR request for targeted MS ID
2318
Generate correlation for CR queue entry
2320
Set stake date/time in CR queue entry
2322
Insert to CR queue
2324
Send/broadcast WDR request
2326
Decrement 1932-Ct
2328
STOP

Fig. 23

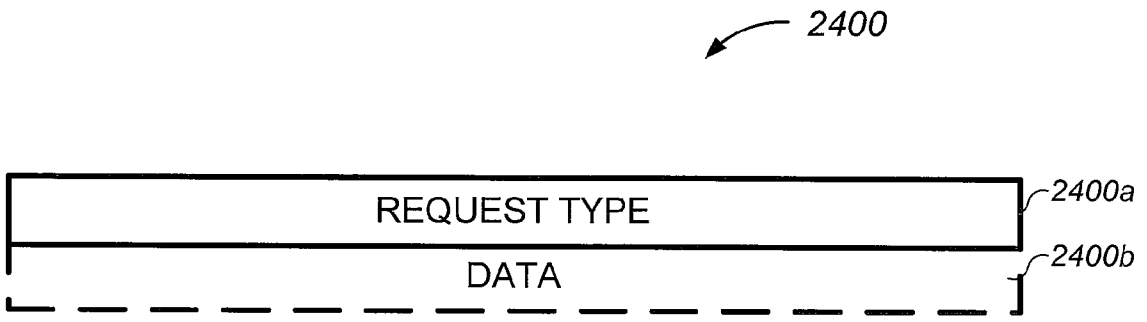

Fig. 24A

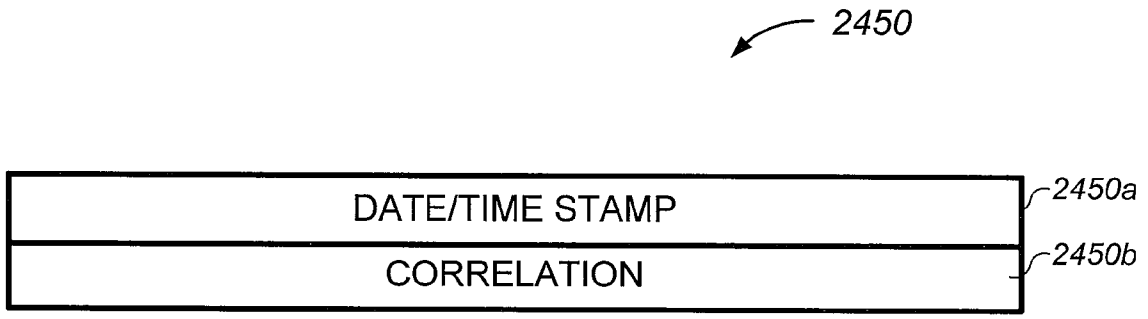

Fig. 24B

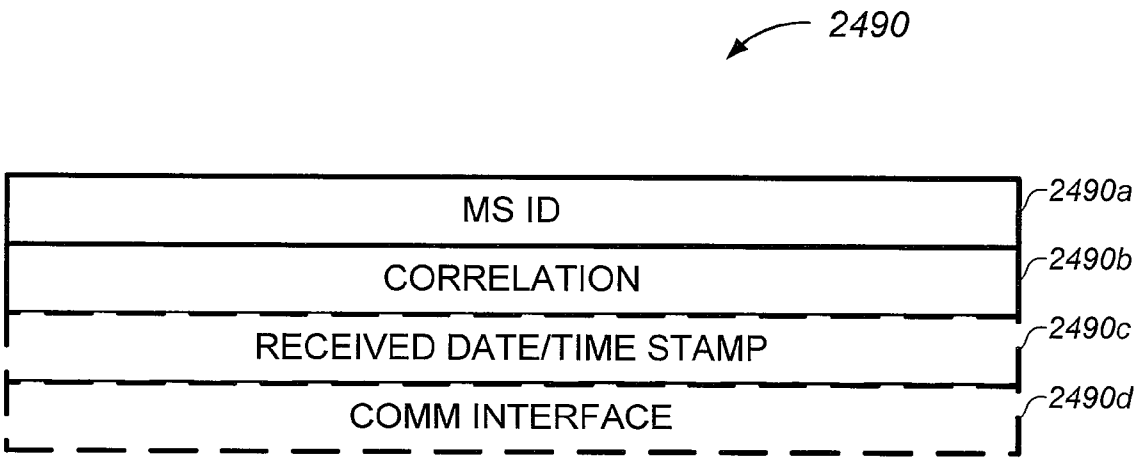
2490
MS ID
2490a
CORRELATION
2490b
RECEIVED DATE/TIME STAMP
2490c
COMM INTERFACE
2490d

Fig. 24C

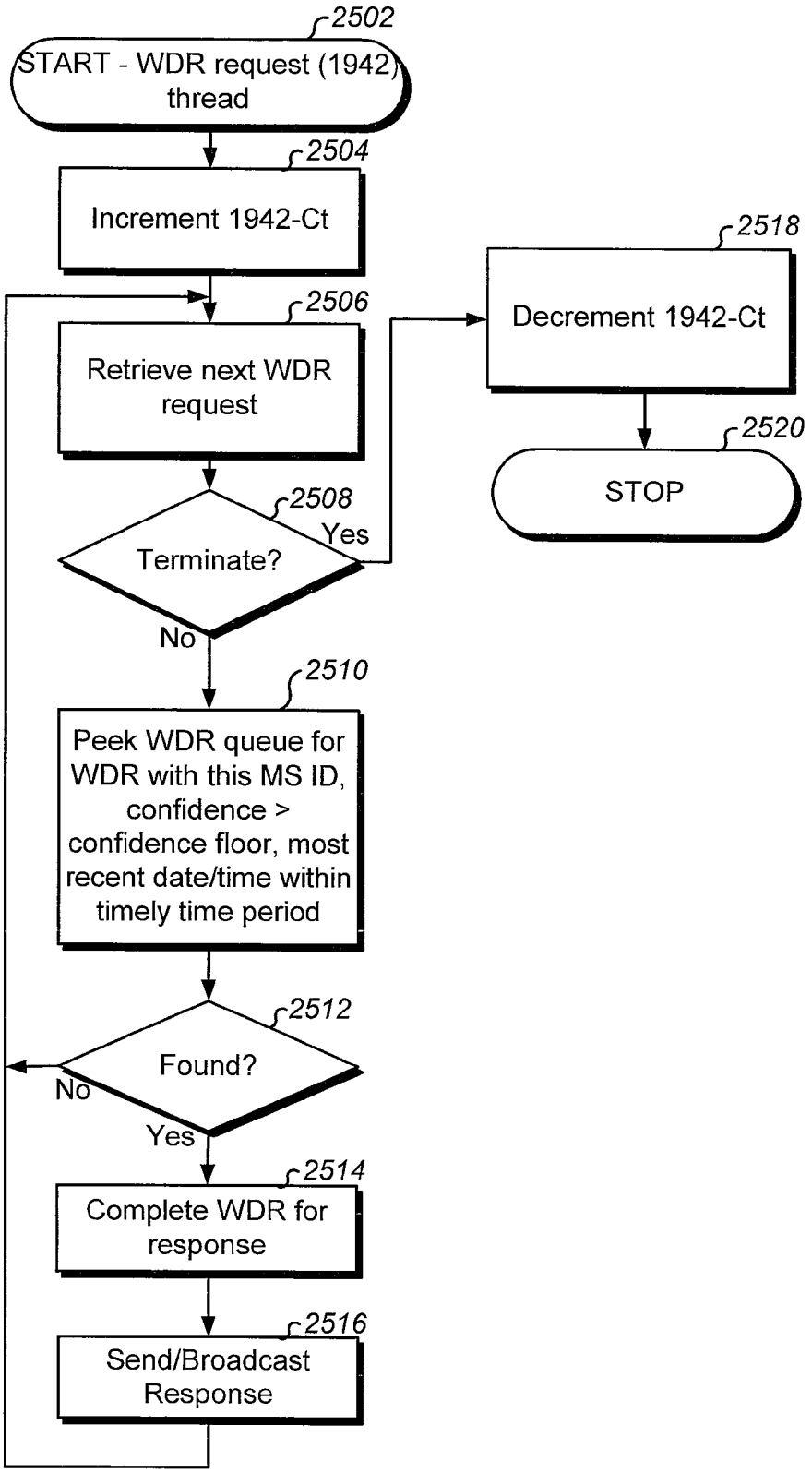
2502
START - WDR request (1942) thread
2504
Increment 1942-Ct
2506
Retrieve next WDR request
2508
Terminate?
Yes
No
2510
Peek WDR queue for WDR with this MS ID, confidence > confidence floor, most recent date/time within timely time period
2512
Found?
No
Yes
2514
Complete WDR for response
2516
Send/Broadcast Response
2518
Decrement 1942-Ct
2520
STOP

Fig. 25

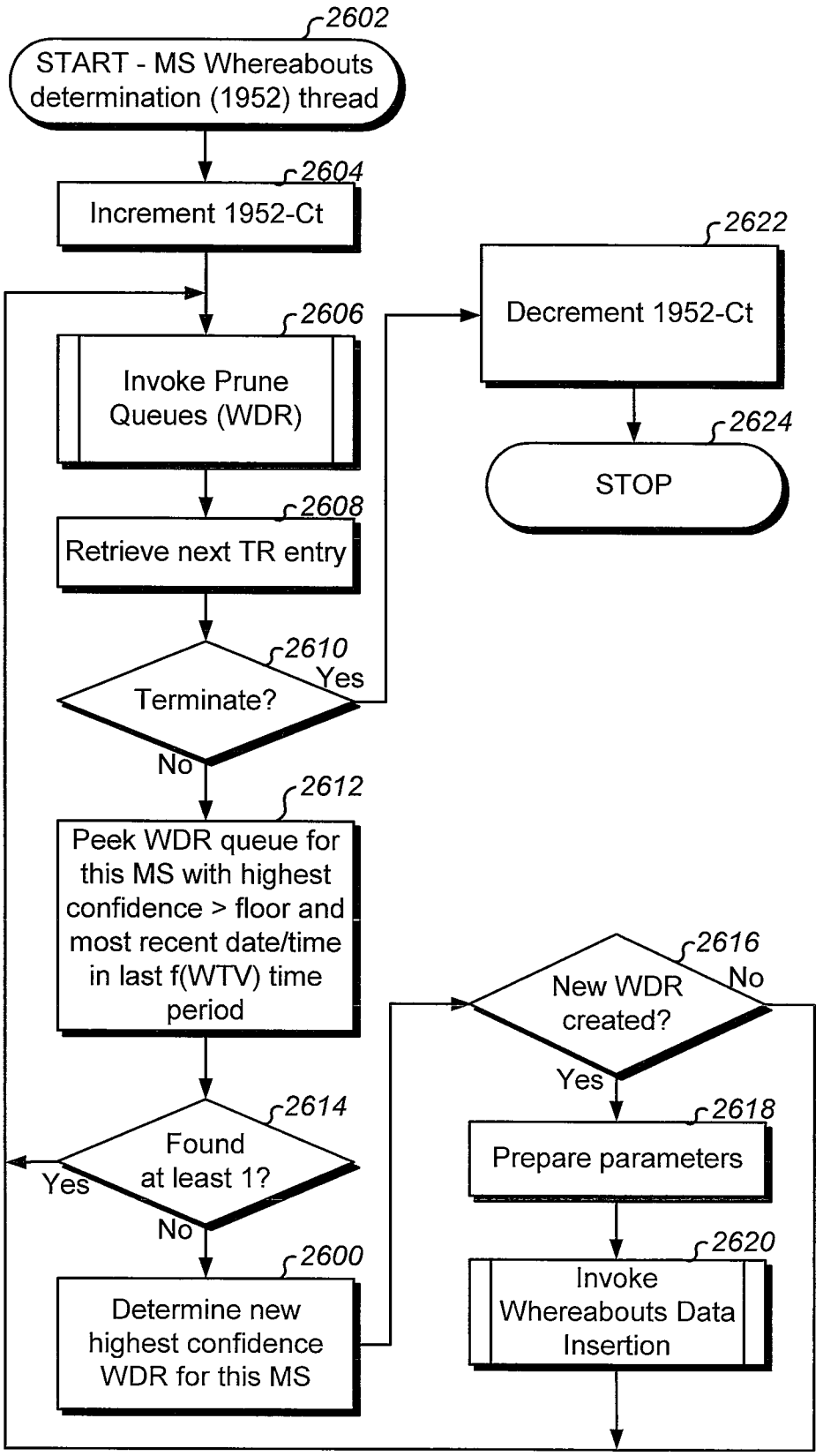
2602
START - MS Whereabouts determination (1952) thread
2604
Increment 1952-Ct
2606
Invoke Prune Queues (WDR)
2608
Retrieve next TR entry
2610
Terminate?
Yes
No
2612
Peek WDR queue for this MS with highest confidence > floor and most recent date/time in last f(WTV) time period
2614
Found at least 1?
Yes
No
2600
Determine new highest confidence WDR for this MS
2622
Decrement 1952-Ct
2624
STOP
2616
New WDR created?
No
Yes
2618
Prepare parameters
2620
Invoke Whereabouts Data Insertion

Fig. 26A

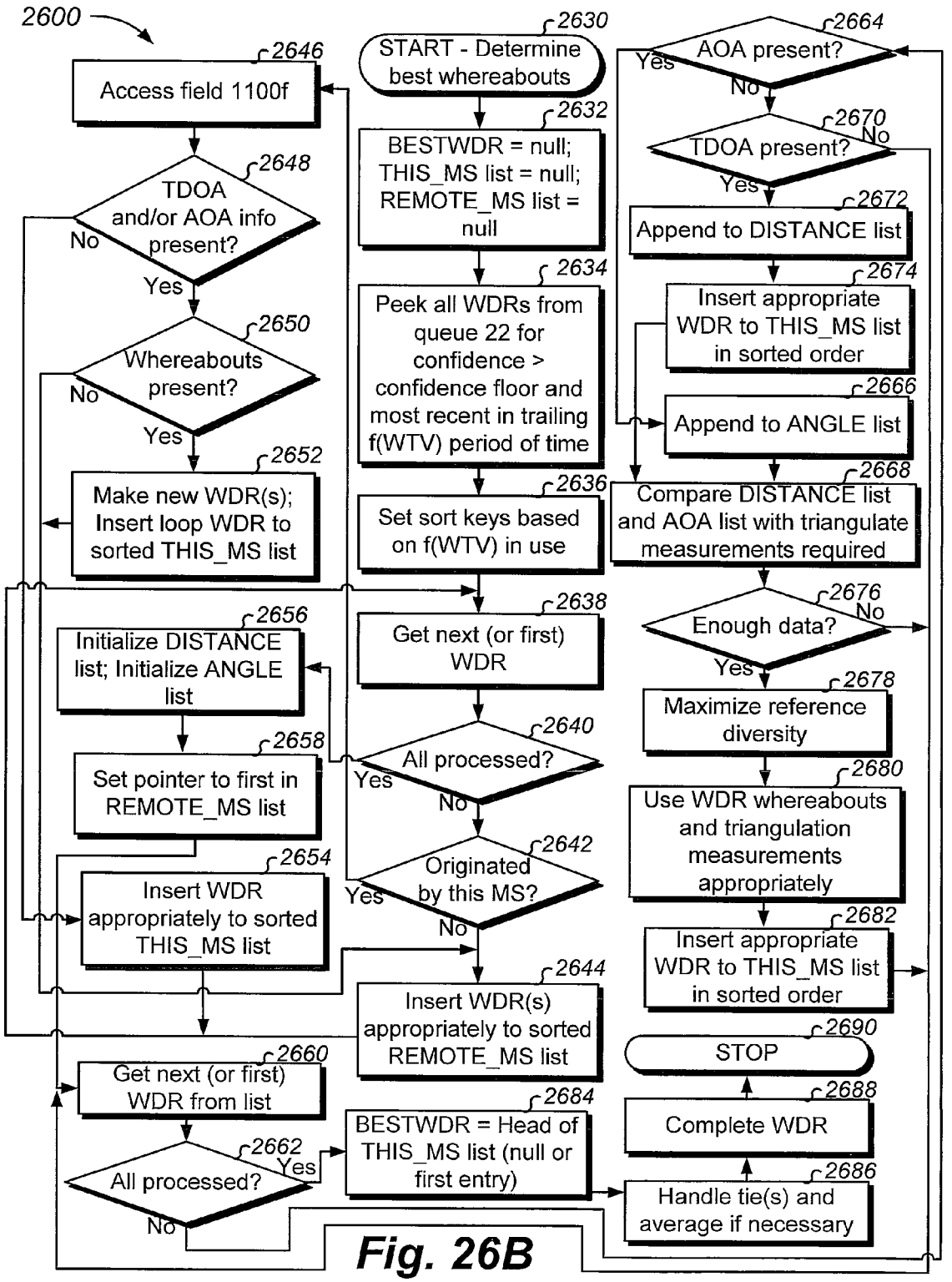
2600
2630
START - Determine best whereabouts
2632
BESTWDR = null; THIS_MS list = null; REMOTE_MS list = null
2634
Peek all WDRs from queue 22 for confidence > confidence floor and most recent in trailing f(WTV) period of time
2636
Set sort keys based on f(WTV) in use
2638
Get next (or first) WDR
2640
All processed?
Yes
No
2642
Originated by this MS?
Yes
No
2644
Insert WDR(s) appropriately to sorted REMOTE_MS list
2646
Access field 1100f
2648
TDOA and/or AOA info present?
No
Yes
2650
Whereabouts present?
No
Yes
2652
Make new WDR(s); Insert loop WDR to sorted THIS_MS list
2654
Insert WDR appropriately to sorted THIS_MS list
2656
Initialize DISTANCE list; Initialize ANGLE list
2658
Set pointer to first in REMOTE_MS list
2660
Get next (or first) WDR from list
2662
All processed?
Yes
No
2664
AOA present?
Yes
No
2666
Append to ANGLE list
2668
Compare DISTANCE list and AOA list with triangulate measurements required
2670
TDOA present?
No
Yes
2672
Append to DISTANCE list
2674
Insert appropriate WDR to THIS_MS list in sorted order
2676
Enough data?
No
Yes
2678
Maximize reference diversity
2680
Use WDR whereabouts and triangulation measurements appropriately
2682
Insert appropriate WDR to THIS_MS list in sorted order
2684
BESTWDR = Head of THIS_MS list (null or first entry)
2686
Handle tie(s) and average if necessary
2688
Complete WDR
2690
STOP

Fig. 26B

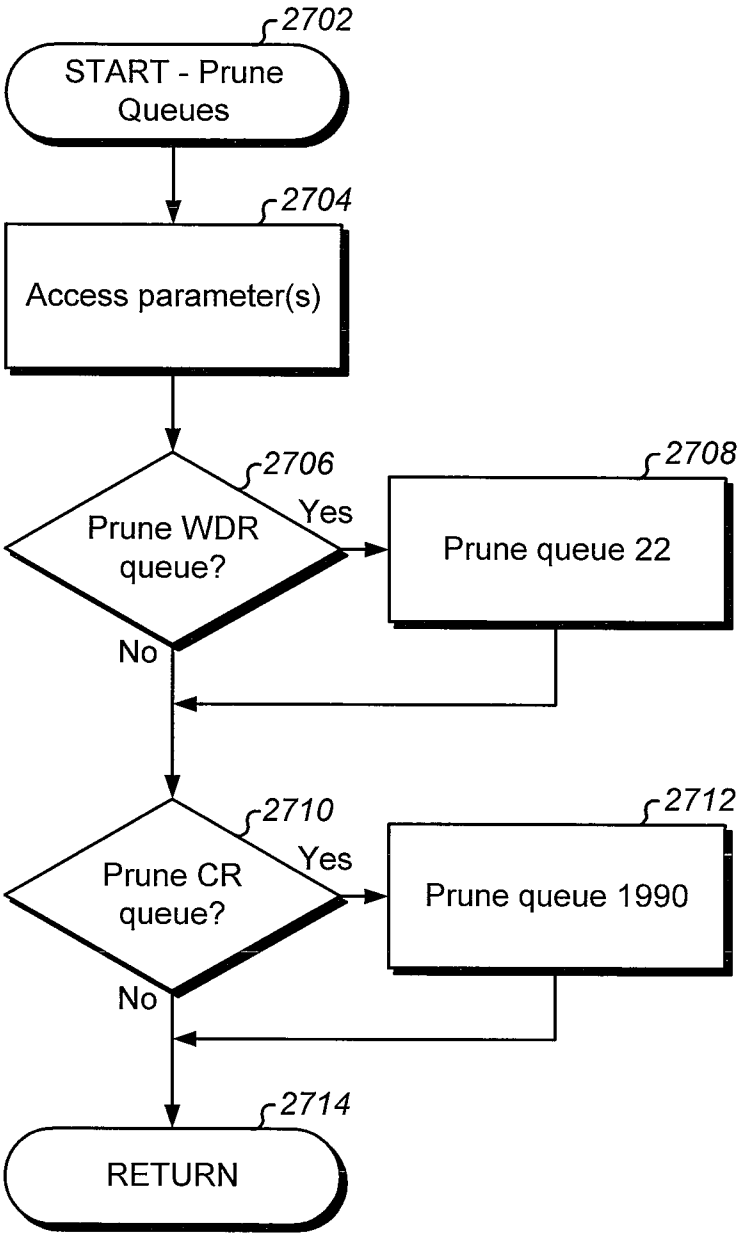
2702
START - Prune Queues
2704
Access parameter(s)
2706
Prune WDR queue?
Yes
No
2708
Prune queue 22
2710
Prune CR queue?
Yes
No
2712
Prune queue 1990
2714
RETURN

Fig. 27

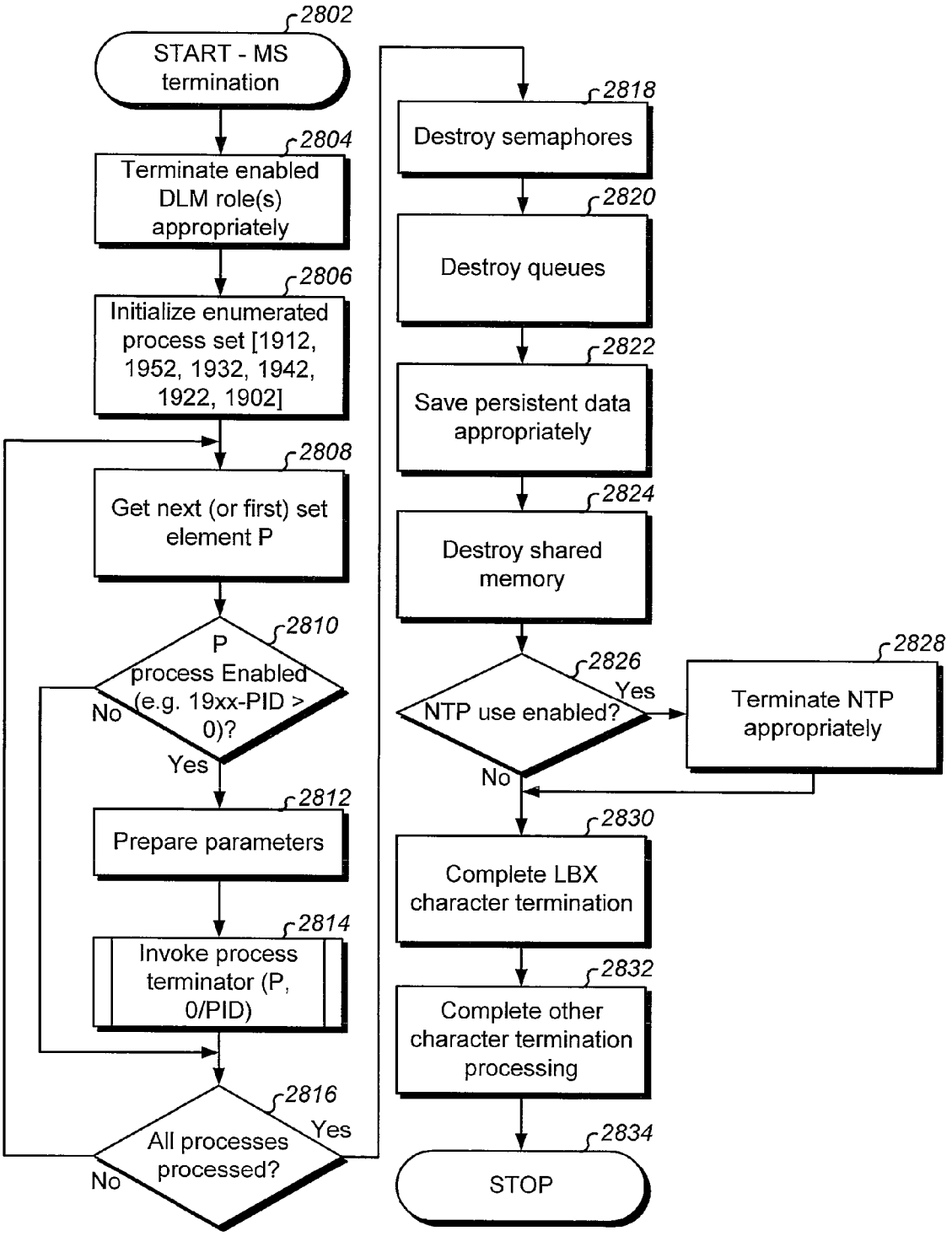
2802
START - MS termination
2804
Terminate enabled DLM role(s) appropriately
2806
Initialize enumerated process set [1912, 1952, 1932, 1942, 1922, 1902]
2808
Get next (or first) set element P
2810
P process Enabled (e.g. 19xx-PID > 0)?
No
Yes
2812
Prepare parameters
2814
Invoke process terminator (P, 0/PID)
2816
All processes processed?
Yes
No
2818
Destroy semaphores
2820
Destroy queues
2822
Save persistent data appropriately
2824
Destroy shared memory
2826
NTP use enabled?
Yes
No
2828
Terminate NTP appropriately
2830
Complete LBX character termination
2832
Complete other character termination processing
2834
STOP

Fig. 28

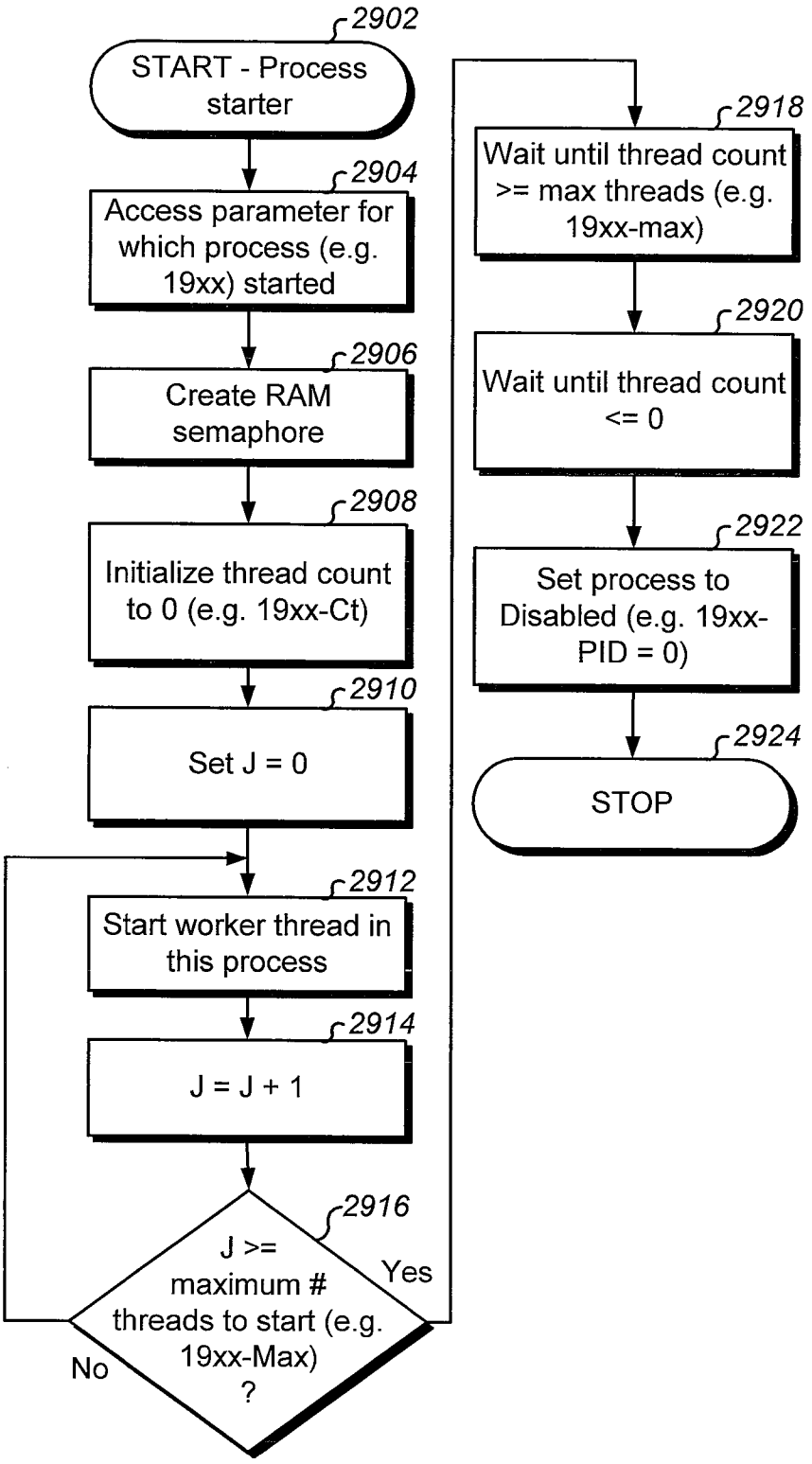
2902
START - Process starter
2904
Access parameter for which process (e.g. 19xx) started
2906
Create RAM semaphore
2908
Initialize thread count to 0 (e.g. 19xx-Ct)
2910
Set J = 0
2912
Start worker thread in this process
2914
J = J + 1
2916
J >= maximum # threads to start (e.g. 19xx-Max) ?
Yes
No
2918
Wait until thread count >= max threads (e.g. 19xx-max)
2920
Wait until thread count <= 0
2922
Set process to Disabled (e.g. 19xx-PID = 0)
2924
STOP

Fig. 29A

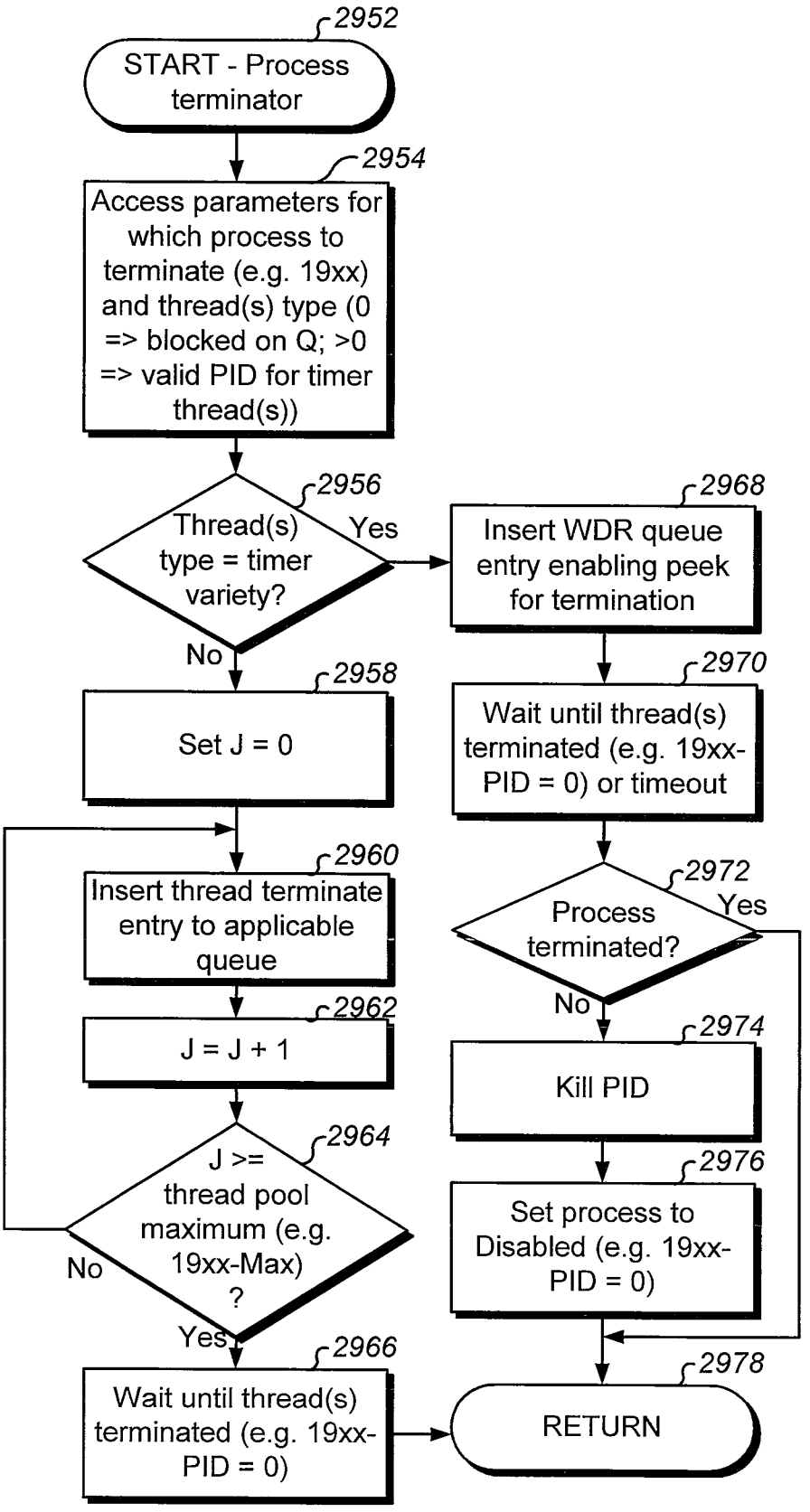
2952
START - Process terminator
2954
Access parameters for which process to terminate (e.g. 19xx) and thread(s) type (0 => blocked on Q; >0 => valid PID for timer thread(s))
2956
Thread(s) type = timer variety?
Yes
No
2958
Set J = 0
2960
Insert thread terminate entry to applicable queue
2962
J = J + 1
2964
J >= thread pool maximum (e.g. 19xx-Max) ?
No
Yes
2966
Wait until thread(s) terminated (e.g. 19xx-PID = 0)
2968
Insert WDR queue entry enabling peek for termination
2970
Wait until thread(s) terminated (e.g. 19xx-PID = 0) or timeout
2972
Process terminated?
Yes
No
2974
Kill PID
2976
Set process to Disabled (e.g. 19xx-PID = 0)
2978
RETURN

Fig. 29B

SYSTEM AND METHOD FOR LOCATION BASED EXCHANGES OF DATA FACILITATING DISTRIBUTED LOCATIONAL APPLICATIONS

FIELD OF THE INVENTION

The present disclosure relates generally to location based services for mobile data processing systems, and more particularly to location based exchanges of data between distributed mobile data processing systems for locational applications. A common connected service is not required for location based functionality and features. Location based exchanges of data between distributed mobile data processing systems enable location based features and functionality in a peer to peer manner.

BACKGROUND OF THE INVENTION

The internet has exploded with new service offerings. Websites yahoo.com, google.com, ebay.com, amazon.com, and itunes.com have demonstrated well the ability to provide valuable services to a large dispersed geographic audience through the internet (ebay, yahoo, google, amazon and itunes (Apple) are trademarks of the respective companies). Thousands of different types of web services are available for many kinds of functionality. Advantages of having a service as the intermediary point between clients, users, and systems, and their associated services, includes centralized processing, centralized maintaining of data, for example to have an all knowing database for scope of services provided, having a supervisory point of control, providing an administrator with access to data maintained by users of the web service, and other advantages associated with centralized control. The advantages are analogous to those provided by the traditional mainframe computer to its clients wherein the mainframe owns all resources, data, processing, and centralized control for all users and systems (clients) that access its services. However, as computers declined in price and adequate processing power was brought to more distributed systems, such as Open Systems (i.e. Windows, UNIX, Linux, and Mac environments), the mainframe was no longer necessary for many of the daily computing tasks. In fact, adequate processing power is incorporated in highly mobile devices, various handheld mobile data processing systems, and other mobile data processing systems. Technology continues to drive improved processing power and data storage capabilities in less physical space of a device. Just as Open Systems took much of the load of computing off of mainframe computers, so to can mobile data processing systems offload tasks usually performed by connected web services. As mobile data processing systems are more capable, there is no need for a service to middleman interactions possible between them.

While a centralized service has its advantages, there are also disadvantages. A service becomes a clearinghouse for all web service transactions. Regardless of the number of-threads of processing spread out over hardware and processor platforms, the web service itself can become a bottleneck causing poor performance for timely response, and can cause a large amount of data that must be kept for all connected users and/or systems. Even large web services mentioned above suffer from performance and maintenance overhead. A web service response will likely never be fast enough. Additionally, archives must be kept to ensure recovery in the event of a disaster because the service houses all data for its operations. Archives also require storage, processing power, planning, and maintenance. A significantly large and costly

data center is necessary to accommodate millions of users and/or systems to connect to the service. There is a tremendous amount of overhead in providing such a service. Data center processing power, data capacity, data transmission bandwidth and speed, infrastructure entities, and various performance considerations are quite costly. Costs include real estate required, utility bills for electricity and cooling, system maintenance, personnel to operate a successful business with service(s), etc. A method is needed to prevent large data center costs while eliminating performance issues for features sought. It is inevitable that as users are hungry for more features and functionality on their mobile data processing systems, processing will be moved closer to the device for optimal performance and infrastructure cost savings.

Service delivered location dependent content was disclosed in U.S. Pat. Nos. 6,456,234; 6,731,238; 7,187,997 (Johnson). Anonymous location based services was disclosed in U.S. PTO Publication 2006/0022048 (Johnson). The Johnson patents and published application operate as most web services do in that the clients connecting to the service benefit from the service by having some connectivity to the service. U.S. Publication 2006/0022048 (Johnson) could cause large numbers of users to inundate the service with device heartbeats and data to maintain, depending on the configurations made. While this may be of little concern to a company that has successfully deployed substantially large web service resources, it may be of great concern to other more frugal companies. A method is needed for enabling location dependent features and functionality without the burden of requiring a service.

Users are skeptical about their privacy as internet services proliferate. A service by its very nature typically holds information for a user maintained in a centralized service database. The user's preferences, credential information, permissions, customizations, billing information, surfing habits, and other conceivable user configurations and activity monitoring, can be housed by the service at the service. Company insiders, as well as outside attackers, may get access. Most people are concerned with preventing personal information of any type being kept in a centralized database which may potentially become compromised from a security standpoint. Location based services are of even more concern, in particular when the locations of the user are to be known to a centralized service. A method and system is needed for making users comfortable with knowing that their personal information is at less risk of being compromised.

A reasonable requirement is to push intelligence out to the mobile data processing systems themselves, for example, in knowing their own locations and perhaps the locations of other nearby mobile data processing systems. Mobile data processing systems can intelligently handle many of their own application requirements without depending on some remote service. Just as two people in a business organization should not need a manager to speak to each other, no two mobile data processing systems should require a service middleman for useful location dependent features and functionality. The knowing of its own location should not be the end of social interaction implementation local to the mobile data processing systems, but rather the starting place for a large number of useful distributed local applications that do not require a service.

Different users use different types of Mobile data processing Systems (MSs) which are also called mobile devices: laptops, tablet computers, Personal Computers (PCs), Personal Digital Assistants (PDAs), cell phones, automobile dashboard mounted data processing systems, shopping cart mounted data processing systems, mobile vehicle or appara-

tus mounted data processing systems, Personal Navigational Devices (PNDs), iPhones (iPhone is a trademark of Apple, Inc.), various handheld mobile data processing systems, etc. MSs move freely in the environment, and are unpredictably moveable (i.e. can be moved anywhere, anytime). Many of these Mobile data processing Systems (MSs) do not have capability of being automatically located, or are not using a service for being automatically located. Conventional methods use directly relative stationary references such as. satellites, antennas, etc. to locate MSs. Stationary references are expensive to deploy, and risk obsolescence as new technologies are introduced to the marketplace. Stationary references have finite scope of support for locating MSs.

While the United States E911 mandate for cellular devices documents requirements for automatic location of a Mobile data processing System (MS) such as a cell phone, the mandate does not necessarily promote real time location and tracking of the MSs, nor does it define architecture for exploiting Location Based Services (LBS). We are in an era where Location Based Services (LBS), and location dependent features and functionality, are among the most promising technologies in the world. Automatic locating of every Mobile data processing System (MS) is an evolutionary trend. A method is needed to shorten the length of time for automatically locating every MS. Such a goal can be costly using prior art technologies such as GPS (Global Positioning System), radio wave triangulation, coming within range to a known located sensor, or the like. Complex system infrastructure, or added hardware costs to the MSs themselves, make such ventures costly and time constrained by schedules and costs involved in engineering, construction, and deployment.

A method is needed for enabling users to get location dependent features and functionality through having their mobile locations known, regardless of whether or not their MS is equipped for being located. Also, new and modern location dependent features and functionality can be provided to a MS unencumbered by a connected service.

BRIEF SUMMARY OF THE INVENTION

LBS (Location Based Services) is a term which has gained in popularity over the years as MSs incorporate various location capability. The word "Services" in that terminology plays a major role in location based features and functionality involving interaction between two or more users. This disclosure introduces a new terminology, system, and method referred to as Location Based eXchanges (LBX). LBX is an acronym used interchangeably/contextually throughout this disclosure for the singular term "Location Based Exchange" and for the plural term "Location Based Exchanges", much the same way LBS is used interchangeably/contextually for the single term "Location Based Service" and for the plural term "Location Based Services". LBX describes leveraging the distributed nature of connectivity between MSs in lieu of leveraging a common centralized service nature of connectivity between MSs. The line can become blurred between LBS and LBX since the same or similar features and functionality are provided, and in some cases strengths from both may be used. The underlying architectural shift differentiates LBX from LBS for depending less on centralized services, and more on distributed interactions between MSs. LBX provide server-free and server-less location dependent features and functionality.

Disclosed are many different aspects to LBX, starting with the foundation requirement for each participating MS to know, at some point in time, their own whereabouts. LBX is enabled when an MS knows its own whereabouts. It is therefore a goal to first make as many MSs know their own whereabouts as possible. When two or more MSs know their own whereabouts, LBX enables distributed locational applications whereby a server is not required to middleman social interactions between the MSs. The MSs interact as peers. LBX disclosed include purely peer to peer interactions, peer to peer interactions for routing services, peer to peer interactions for delivering distributed services, and peer to peer interactions for location dependent features and functionality. One embodiment of an LBX enabled MS is referred to as an lbxPhone™.

It is an advantage herein to have no centralized service governing location based features and functionality among MSs. Avoiding a centralized service prevents performance issues, infrastructure costs, and solves many of the issues described above. No centralized service also prevents a user's information from being kept in one accessible place. LBS contain centralized data that is personal in nature to its users. This is a security concern. Having information for all users in one place increases the likelihood that a disaster to the data will affect more than a single user. LBX spreads data out across participating systems so that a disaster affecting one user does not affect any other user.

It is an advantage herein for enabling useful distributed applications without the necessity of having a service, and without the necessity of users and/or systems registering with a service. MSs interact as peers in preferred embodiments, rather than as clients to a common service (e.g. internet connected web service).

It is an advantage herein for locating as many MSs as possible in a wireless network, and without additional deployment costs on the MSs or the network. Conventional locating capability includes GPS (Global Positioning System) using stationary orbiting satellites, improved forms of GPS, for example AGPS (Adjusted GPS) and DGPS (Differential GPS) using stationary located ground stations, wireless communications to stationary located cell tower base stations, TDOA (Time Difference of Arrival) or AOA (Angle of Arrival) triangulation using stationary located antennas, presence detection in vicinity of a stationary located antenna, presence detection at a wired connectivity stationary network location, or other conventional locating systems and methods. Mobile data processing systems, referred to as Indirectly Located Mobile data processing systems (ILMs), are automatically located using automatically detected locations of Directly Located Mobile data processing systems (DLMs) and/or automatically detected locations of other ILMs. ILMs are provided with the ability to participate in the same LBS, or LBX, as a DLM (Directly Located Mobile data processing system). DLMs are located using conventional locating capability mentioned above. DLMs provide reference locations for automatically locating ILMs, regardless of where any one is currently located. DLMs and ILMs can be highly mobile, for example when in use by a user. There are a variety of novel methods for automatically locating ILMs, for example triangulating an ILM (Indirectly Located Mobile data processing system) location using a plurality of DLMs, detecting the ILM being within the vicinity of at least one DLM, triangulating an ILM location using a plurality of other ILMs, detecting the ILM being within the vicinity of at least one other ILM, triangulating an ILM location using a mixed set of DLM(s) and ILM(s), determining the ILM location from heterogeneously located DLMs and/or ILMs, and other novel methods.

MSs are automatically located without using direct conventional means for being automatically located. The conventional locating capability (i.e. conventional locating methods)

described above is also referred to as direct methods. Conventional methods are direct methods, but not all direct methods are conventional. There are new direct techniques disclosed below. Provided herein is an architecture, as well as systems and methods, for immediately bringing automatic location detection to every MS in the world, regardless of whether that MS is equipped for being directly located. MSs without capability of being directly located are located by leveraging the automatically detected locations of MSs that are directly located. This is referred to as being indirectly located. An MS which is directly located is hereinafter referred to as a Directly Located Mobile data processing system (DLM). For a plural acronym, MSs which are directly located are hereinafter referred to as Directly Located Mobile data processing systems (DLMs). MSs without capability of being directly located are located using the automatically detected locations of MSs that have already been located. An MS which is indirectly located is hereinafter referred to as an Indirectly Located Mobile data processing system (ILM). For a plural acronym, MSs which are indirectly located are hereinafter referred to as Indirectly Located Mobile data processing systems (ILMs). A DLM can be located in the following ways:

A) New triangulated wave forms;
B) Missing Part Triangulation (MPT) as disclosed below;
C) Heterogeneous direct locating methods;
D) Assisted Direct Location Technology (ADLT) using a combination of direct and indirect methods;
E) Manually specified; and/or
F) Any combinations of A) through E);

DLMs provide reference locations for automatically locating ILMs, regardless of where the DLMs are currently located. It is preferable to assure an accurate location of every DLM, or at least provide a confidence value of the accuracy. A confidence value of the accuracy is used by relative ILMs to determine which are the best set (e.g. which are of highest priority for use to determine ILM whereabouts) of relative DLMs (and/or ILMs) to use for automatically determining the location of the ILM.

In one example, the mobile locations of several MSs are automatically detected using their local GPS chips. Each is referred to as a DLM. The mobile location of a non-locatable MS is triangulated using radio waves between it and three (3) of the GPS equipped DLMs. The MS becomes an ILM upon having its location determined relative the DLMs. ILMs are automatically located using DLMs, or other already located ILMs. An ILM can be located in the following ways:

G) Triangulating an ILM location using a plurality of DLMs with wave forms of any variety (e.g. AOA, TDOA, MPT (a heterogeneous location method));
H) Detecting the ILM being within the reasonably close vicinity of at least one DLM;
I) Triangulating an ILM location using a plurality of other ILMs with wave forms of any variety;
J) Detecting the ILM being within the reasonable close vicinity of at least one other ILM;
K) Triangulating an ILM location using a mixed set of DLM(s) and ILM(s) with wave forms of any variety (referred to as ADLT);
L) Determining the ILM location from heterogeneously located DLMs and/or ILMs (i.e. heterogeneously located, as used here, implies having been located relative different location methodologies);
M) A) through F) Above; and/or
N) Any combinations of A) through M).

Locating functionality may leverage GPS functionality, including but not limited to GPS, AGPS (Adjusted GPS), DGPS, (Differential GPS), or any improved GPS embodiment to achieve higher accuracy using known locations, for example ground based reference locations. The NexTel GPS enabled iSeries cell phones provide excellent examples for use as DLMs (Nextel is a trademark of Sprint/Nextel). Locating functionality may incorporate triangulated locating of the MS, for example using a class of Radio Frequency (RF) wave spectrum (cellular, WiFi, bluetooth, etc), and may use measurements from different wave spectrums for a single location determination (depends on communications interface(s) **70** available). A MS may have its whereabouts determined using a plurality of wave spectrum classes available to it (cellular, WiFi, bluetooth, etc). Locating functionality may include in-range proximity detection for detecting the presence of the MS. Wave forms for triangulated locating also include microwaves, infrared wave spectrum relative infrared sensors, visible light wave spectrum relative light visible light wave sensors, ultraviolet wave spectrum relative ultraviolet wave sensors, X-ray wave spectrum relative X-ray wave sensors, gamma ray wave spectrum relative gamma ray wave sensors, and longwave spectrum (below AM) relative longwave sensors. While there are certainly more common methods for automatically locating a MS (e.g. radio wave triangulation, GPS, in range proximity detection), those skilled in the art recognize there are methods for different wave spectrums being detected, measured, and used for carrying information between data processing systems.

Kubler et al (U.S. PTO publications 2004/0264442, 2004/0246940, 2004/0228330, 2004/0151151) disclosed methods for detecting presence of mobile entities as they come within range of a sensor. In Kubler et al, accuracy of the location of the detected MS is not well known, so an estimated area of the whereabouts of the MS is enough to accomplish intended functionality, for example in warehouse installations. A confidence value of this disclosure associated with Kubler et al tends to be low (i.e. not confident), with lower values for long range sensors and higher values for short range sensors.

GPS and the abundance of methods for improving GPS accuracy has led to many successful systems for located MSs with high accuracy. Triangulation provides high accuracies for locating MSs. A confidence value of this disclosure associated with GPS and triangulating location methods tends to be high (i.e. confident). It is preferred that DLMs use the highest possible accuracy method available so that relative ILMs are well located. Not all DLMs need to use the same location methods. An ILM can be located relative DLMs, or other ILMs, that each has different locating methodologies utilized.

Another advantage herein is to generically locate MSs using varieties and combinations of different technologies. MSs can be automatically located using direct conventional methods for accuracy to base on the locating of other MSs. MSs can be automatically located using indirect methods. Further, it is an advantage to indirectly locate a MS relative heterogeneously located MSs. For example, one DLM may be automatically located using GPS. Another DLM may be automatically located using cell tower triangulation. A third DLM may be automatically located using within range proximity. An ILM can be automatically located at a single location, or different locations over time, relative these three differently located DLMs. The automatically detected location of the ILM may be determined using a form of triangulation relative the three DLMs just discussed, even though each DLM had a different direct location method used. In a preferred embodiment, industry standard IEEE 802.11 Wi-Fi is used to locate (triangulate) an ILM relative a plurality of DLMs (e.g. TDOA in one embodiment). This standard is

prolific among more compute trended MSs. Any of the family of 802.11 wave forms such as 802.11a, 802.11b, 802.11g, or any other similar class of wave spectrum can be used, and the same spectrum need not be used between a single ILM and multiple DLMs. 802.x used herein generally refers to the many 802.whatever variations.

Another advantage herein is to make use of existing marketplace communications hardware, communications software interfaces, and communications methods and location methods where possible to accomplish locating an MS relative one or more other MSs. While 802.x is widespread for Wi-Fi communications, other RF wave forms can be used (e.g. cell phone to cell tower communications). In fact, any wave spectrum for carrying data applies herein.

Still another advantage is for support of heterogeneous locatable devices. Different people like different types of devices as described above. Complete automation of locating functionality can be provided to a device through local automatic location detection means, or by automatic location detection means remote to the device. Also, an ILM can be located relative a laptop, a cell phone, and a PDA (i.e. different device types).

Yet another advantage is to prevent the unnecessary storing of large amounts of positioning data for a network of MSs. Keeping positioning data for knowing the whereabouts of all devices can be expensive in terms of storage, infrastructure, performance, backup, and disaster recovery. A preferred embodiment simply uses a distributed approach to determining locations of MSs without the overhead of an all-knowing database maintained somewhere. Positions of MSs can be determined "on the fly" without storing information in a master database. However, there are embodiments for storing a master database, or a subset thereof, to configurable storage destinations, when it makes sense. A subset can be stored at a MS.

Another advantage includes making use of existing location equipped MSs to expand the network of locatable devices by locating non-equipped MSs relative the location of equipped MSs. MSs themselves help increase dimensions of the locatable network of MSs. The locatable network of MSs is referred to as an LN-Expanse (i.e. Location-Network Expanse). An LN-Expanse dynamically grows and shrinks based on where MSs are located at a particular time. For example, as users travel with their personal MSs, the personal MSs themselves define the LN-Expanse since the personal MSs are used to locate other MSs. An ILM simply needs location awareness relative located MSs (DLMs and/or ILMs).

Yet another advantage is a MS interchangeably taking on the role of a DLM or ILM as it travels. MSs are chameleons in this regard, in response to location technologies that happen to be available. A MS may be equipped for DLM capability, but may be in a location at some time where the capability is inoperable. In these situations the DLM takes on the role of an ILM. When the MS again enters a location where it can be a DLM, it automatically takes on the role of the DLM. This is very important, in particular for emergency situations. A hiker has a serious accident in the mountains which prevents GPS equipped DLM capability from working. Fortunately, the MS automatically takes on the role of an ILM and is located within the vicinity of neighboring (nearby) MSs. This allows the hiker to communicate his location, operate useful locational application functions and features at his MS, and enable emergency help that can find him.

It is a further advantage that MS locations be triangulated using any wave forms (e.g. RF, microwaves, infrared, visible light, ultraviolet, X-ray, gamma ray). X-ray and gamma ray applications are special in that such waves are harmful to humans in short periods of times, and such applications should be well warranted to use such wave forms. In some medical embodiments, micro-machines may be deployed within a human body. Such micro-machines can be equipped as MSs. Wave spectrums available at the time of deployment can be used by the MSs for determining exact positions when traveling through a body.

It is another advantage to use TDOA (Time Difference Of Arrival), AOA (Angle Of Arrival), and Missing Part Triangulation (MPT) when locating a MS. TDOA uses time information to determine locations, for example for distances of sides of a triangle. AOA uses angles of arrival to antennas to geometrically assess where a MS is located by intersecting lines drawn from the antennas with detected angles. MPT is disclosed herein as using combinations of AOA and TDOA to determine a location. Exclusively using all AOA or exclusively using all TDOA is not necessary. MPT can be a direct method for locating MSs.

Yet another advantage is to locate MSs using Assisted Direct Location Technology (ADLT). ADLT is disclosed herein as using direct (conventional) location capability together with indirect location capability to confidently determine the location of a MS.

Still another advantage is to permit manual specification for identifying the location of a MS (a DLM). The manual location can then in turn be used to facilitate locating other MSs. A user interface may be used for specification of a DLM location. The user interface can be local, or remote, to the DLM. Various manual specification methods are disclosed. Manual specification is preferably used with less mobile MSs, or existing MSs such as those that use dodgeball.com (trademark of Google). The confidence value depends on how the location is specified, whether or not it was validated, and how it changes when the MS moves after being manually set. Manual specification should have limited scope in an LN-expanse unless inaccuracies can be avoided.

Another advantage herein is locating a MS using any of the methodologies above, any combinations of the methodologies above, and any combinations of direct and/or indirect location methods described.

Another advantage is providing synergy between different locating technologies for smooth operations as an MS travels. There are large numbers of methods and combinations of those methods for keeping an MS informed of its whereabouts. Keeping an MS informed of its whereabouts in a timely manner is critical in ensuring LBX operate optimally, and for ensuring nearby MSs without certain locating technologies can in turn be located.

It is another advantage for locating an MS with multiple location technologies during its travels, and in using the best of breed data from multiple location technologies to infer a MS location confidently. Confidence values are associated with reference location information to ensure an MS using the location information can assess accuracy. A DLM is usually an "affirmifier". An affirmifier is an MS with its whereabouts information having high confidence of accuracy and can serve as a reference for other MSs. An ILM can also be an affirmifier provided there is high confidence that the ILM location is known. An MS (e.g. ILM) may be a "pacifier". A pacifier is an MS having location information for its whereabouts with a low confidence for accuracy. While it can serve as a reference to other ILMs, it can only do so by contributing a low confidence of accuracy.

It is an advantage to synergistically make use of the large number of locating technologies available to prevent one

particular type of technology to dominate others while using the best features of each to assess accurate mobile locations of MSs.

A further advantage is to leverage a data processing system with capability of being located for co-locating another data processing system without any capability of being located. For example, a driver owns an older model automobile, has a useful second data processing system in the automobile without means for being automatically located. The driver also own a cell phone, called a first data processing system, which does have means for being automatically located. The location of the first data processing system can be shared with the second data processing system for locating the second data processing system. Further still, the second data processing system without means for being automatically located is located relative a first set (plurality) of data processing systems which are not at the same location as the second data processing system. So, data processing systems are automatically located relative at least one other data processing which can be automatically located.

Another advantage is a LBX enabled MS includes a service informant component for keeping a supervisory service informed. This prevents an MS from operating in total isolation, and prevents an MS from operating in isolation with those MSs that are within its vicinity (e.g. within maximum range **1306**) at some point in time, but to also participate when the same MSs are great distances from each other. There are LBX which would fit well into an LBS model, but a preferred embodiment chooses to use the LBX model. For example, multiple MS users are seeking to carpool to and from a common destination. The service informant component can perform timely updates to a supervisory service for route comparisons between MSs, even though periods of information are maintained only at the MSs. For example, users find out that they go to the same church with similar schedules, or coworkers find out they live nearby and have identical work schedules. The service informant component can keep a service informed of MS whereabouts to facilitate novel LBX applications.

It is a further advantage in leveraging the vast amount of MS WiFi deployment underway in the United States. More widespread WiFi availability enhances the ability for well performing peer to peer types of features and functionality disclosed.

It is a further advantage to prevent unnecessary established connections from interfering with successfully triangulating a MS position. As the MS roams and encounters various wave spectrum signals, that is all that is required for determining the MS location. Broadcast signaling contains the necessary location information for automatically locating the MS.

Yet another advantage is to leverage Network Time Protocol (NTP) for eliminating bidirectional communications in determining Time of Arrival (TOA) and TDOA (Time Difference Of Arrival) measurements (TDOA as used in the disclosure generally refers to both TOA and TDOA). NTP enables a single unidirectional transmission of data to carry all that is necessary in determining TDOA, provided the sending data processing system and the receiving data processing system are NTP synchronized to an adequate granulation of time.

A further advantage herein is to leverage existing "usual communications" data transmissions for carrying new data that is ignored by existing MS processing, but observed by new MS processing, for carrying out processing maximizing location functions and features across a large geography. Alternatively, new data can be transmitted between systems for the same functionality.

Further features and advantages of the disclosure, as well as the structure and operation of various embodiments of the disclosure, are described in detail below with reference to the accompanying drawings. In the drawings, like reference numbers generally indicate identical, functionally similar, and/or structurally similar elements. The drawing in which an element first appears is indicated by the leftmost digit(s) in the corresponding reference number, except that reference numbers **1** through **99** may be found on the first 4 drawings of FIGS. **1**A through **1**D. None of the drawings, discussions, or materials herein is to be interpreted as limiting to a particular embodiment. The broadest interpretation is intended. Other embodiments accomplishing same functionality are within the spirit and scope of this disclosure. It should be understood that information is presented by example and many embodiments exist without departing from the spirit and scope of this disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

There is no guarantee that there are descriptions in this specification for explaining every novel feature found in the drawings. The present disclosure will be described with reference to the accompanying drawings, wherein:

FIG. **1**A depicts a preferred embodiment high level example componentization of a MS in accordance with the present disclosure;

FIG. **1**B depicts a Location Based eXchanges (LBX) architectural illustration for discussing the present disclosure;

FIG. **1**C depicts a Location Based Services (LBS) architectural illustration for discussing prior art of the present disclosure;

FIG. **1**D depicts a block diagram of a data processing system useful for implementing a MS, ILM, DLM, centralized server, or any other data processing system disclosed herein;

FIG. **1**E depicts a network illustration for discussing various deployments of whereabouts processing aspects of the present disclosure;

FIG. **2**A depicts an illustration for describing automatic location of a MS through the MS coming into range of a stationary cellular tower;

FIG. **2**B depicts an illustration for describing automatic location of a MS through the MS coming into range of some stationary antenna;

FIG. **2**C depicts an illustration for discussing an example of automatically locating a MS through the MS coming into range of some stationary antenna;

FIG. **2**D depicts a flowchart for describing a preferred embodiment of a service whereabouts update event of an antenna in-range detected MS when MS location awareness is monitored by a stationary antenna or cell tower;

FIG. **2**E depicts a flowchart for describing a preferred embodiment of an MS whereabouts update event of an antenna in-range detected MS when MS location awareness is monitored by the MS;

FIG. **2**F depicts a flowchart for describing a preferred embodiment of a procedure for inserting a Whereabouts Data Record (WDR) to an MS whereabouts data queue;

FIG. **3**A depicts a locating by triangulation illustration for discussing automatic location of a MS;

FIG. **3**B depicts a flowchart for describing a preferred embodiment of the whereabouts update event of a triangulated MS when MS location awareness is monitored by some remote service;

FIG. **3**C depicts a flowchart for describing a preferred embodiment of the whereabouts update event of a triangulated MS when MS location awareness is monitored by the MS;

FIG. **4**A depicts a locating by GPS triangulation illustration for discussing automatic location of a MS;

FIG. **4**B depicts a flowchart for describing a preferred embodiment of the whereabouts update event of a GPS triangulated MS;

FIG. **5**A depicts a locating by stationary antenna triangulation illustration for discussing automatic location of a MS;

FIG. **5**B depicts a flowchart for describing a preferred embodiment of the whereabouts update event of a stationary antenna triangulated MS;

FIG. **6**A depicts a flowchart for describing a preferred embodiment of a service whereabouts update event of a physically or logically connected MS;

FIG. **6**B depicts a flowchart for describing a preferred embodiment of a MS whereabouts update event of a physically or logically connected MS;

FIGS. **7**A, **7**B and **7**C depict a locating by image sensory illustration for discussing automatic location of a MS;

FIG. **7**D depicts a flowchart for describing a preferred embodiment of graphically locating a MS, for example as illustrated by FIGS. **7**A through **7**C;

FIG. **8**A heterogeneously depicts a locating by arbitrary wave spectrum illustration for discussing automatic location of a MS;

FIG. **8**B depicts a flowchart for describing a preferred embodiment of locating a MS through physically contacting the MS;

FIG. **8**C depicts a flowchart for describing a preferred embodiment of locating a MS through a manually entered whereabouts of the MS;

FIG. **9**A depicts a table for illustrating heterogeneously locating a MS;

FIG. **9**B depicts a flowchart for describing a preferred embodiment of heterogeneously locating a MS;

FIGS. **10**A and **10**B depict an illustration of a Locatable Network expanse (LN-Expanse) for describing locating of an ILM with all DLMs;

FIG. **10**C depicts an illustration of a Locatable Network expanse (LN-Expanse) for describing locating of an ILM with an ILM and DLM;

FIGS. **10**D, **10**E, and **10**F depict an illustration of a Locatable Network expanse (LN-Expanse) for describing locating of an ILM with all ILMs;

FIGS. **10**G and **10**H depict an illustration for describing the infinite reach of a Locatable Network expanse (LN-Expanse) according to MSs;

FIG. **10**I depicts an illustration of a Locatable Network expanse (LN-Expanse) for describing a supervisory service;

FIG. **11**A depicts a preferred embodiment of a Whereabouts Data Record (WDR) **1100** for discussing operations of the present disclosure;

FIGS. **11**B, **11**C and **11**D depict an illustration for describing various embodiments for determining the whereabouts of an MS;

FIG. **11**E depicts an illustration for describing various embodiments for automatically determining the whereabouts of an MS;

FIG. **12** depicts a flowchart for describing an embodiment of MS initialization processing;

FIGS. **13**A through **13**C depict an illustration of data processing system wireless data transmissions over some wave spectrum;

FIG. **14**A depicts a flowchart for describing a preferred embodiment of MS LBX configuration processing;

FIG. **14**B depicts a continued portion flowchart of FIG. **14**A for describing a preferred embodiment of MS LBX configuration processing;

FIG. **15**A depicts a flowchart for describing a preferred embodiment of DLM role configuration processing;

FIG. **15**B depicts a flowchart for describing a preferred embodiment of ILM role configuration processing;

FIG. **15**C depicts a flowchart for describing a preferred embodiment of a procedure for Manage List processing;

FIG. **16** depicts a flowchart for describing a preferred embodiment of NTP use configuration processing;

FIG. **17** depicts a flowchart for describing a preferred embodiment of WDR maintenance processing;

FIG. **18** depicts a flowchart for describing a preferred embodiment of a procedure for variable configuration processing;

FIG. **19** depicts an illustration for describing a preferred embodiment multithreaded architecture of peer interaction processing of a MS in accordance with the present disclosure;

FIG. **20** depicts a flowchart for describing a preferred embodiment of MS whereabouts broadcast processing;

FIG. **21** depicts a flowchart for describing a preferred embodiment of MS whereabouts collection processing;

FIG. **22** depicts a flowchart for describing a preferred embodiment of MS whereabouts supervisor processing;

FIG. **23** depicts a flowchart for describing a preferred embodiment of MS timing determination processing;

FIG. **24**A depicts an illustration for describing a preferred embodiment of a thread request queue record;

FIG. **24**B depicts an illustration for describing a preferred embodiment of a correlation response queue record;

FIG. **24**C depicts an illustration for describing a preferred embodiment of a WDR request record;

FIG. **25** depicts a flowchart for describing a preferred embodiment of MS WDR request processing;

FIG. **26**A depicts a flowchart for describing a preferred embodiment of MS whereabouts determination processing;

FIG. **26**B depicts a flowchart for describing a preferred embodiment of processing for determining a highest possible confidence whereabouts;

FIG. **27** depicts a flowchart for describing a preferred embodiment of queue prune processing;

FIG. **28** depicts a flowchart for describing a preferred embodiment of MS termination processing;

FIG. **29**A depicts a flowchart for describing a preferred embodiment of a process for starting a specified number of threads in a specified thread pool; and

FIG. **29**B depicts a flowchart for describing a preferred embodiment of a procedure for terminating the process started by FIG. **29**A.

DETAILED DESCRIPTION OF THE INVENTION

With reference now to detail of the drawings, the present disclosure is described. Obvious error handling is omitted from the flowcharts in order to focus on the key aspects of the present disclosure. Obvious error handling includes database I/O errors, field validation errors, errors as the result of database table/data constraints or unique keys, data access errors, communications interface errors or packet collision, hardware failures, checksum validations, bit error detections/corrections, and any other error handling as well known to those skilled in the relevant art in context of this disclosure. A semicolon may be used in flowchart blocks to represent, and separate, multiple blocks of processing within a single physi-

cal block. This allows simpler flowcharts with less blocks in the drawings by placing multiple blocks of processing description in a single physical block of the flowchart. Flowchart processing is intended to be interpreted in the broadest sense by example, and not for limiting methods of accomplishing the same functionality. Preferably, field validation in the flowcharts checks for SQL injection attacks, communications protocol sniff and hack attacks, preventing of spoofing MS addresses, syntactical appropriateness, and semantics errors where appropriate. Disclosed user interface processing and/or screenshots are also preferred embodiment examples that can be implemented in other ways without departing from the spirit and scope of this disclosure. Alternative user interfaces (since this disclosure is not to be limiting) will use similar mechanisms, but may use different mechanisms without departing from the spirit and scope of this disclosure.

Locational terms such as whereabouts, location, position, area, destination, perimeter, radius, geofence, situational location, or any other related two or three dimensional locational term used herein to described position(s) and/or locations and/or whereabouts is to be interpreted in the broadest sense. Location field **1100***c* may include an area (e.g. on earth), a point (e.g. on earth), or a three dimensional bounds in space. In another example, a radius may define a sphere in space, rather than a circle in a plane. In some embodiments, a planet field forms part of the location (e.g. Earth, Mars, etc as part of field **1100***c*) for which other location information (e.g. latitude and longitude on Mars also part of field **1100***c*) is relative. In some embodiments, elevations (or altitudes) from known locatable point(s), distances from origin(s) in the universe, etc. can denote where exactly is a point of three dimensional space, or three dimensional sphere, area, or solid, is located. That same point can provide a mathematical reference to other points of the solid area/region in space. Descriptions for angles, pitches, rotations, etc from some reference point(s) may be further provided. Three dimensional areas/regions include a conical shape, cubical shape, spherical shape, pyramidal shape, irregular shapes, or any other shape either manipulated with a three dimensional graphic interface, or with mathematical model descriptions. Areas/regions in space can be occupied by a MS, passed through (e.g. by a traveler) by a MS, or referenced through configuration by a MS. In a three dimensional embodiment, nearby/nearness is determined in terms of three dimensional information, for example, a spherical radius around one MS intersecting a spherical radius around another MS. In a two dimensional embodiment, nearby/nearness is determined in terms of two dimensional information, for example, a circular radius around one MS intersecting a circular radius around another MS. Points can be specified as a point in a x-y-z plane, a point in polar coordinates, or the like, perhaps the center of a planet (e.g. Earth) or the Sun, some origin in the Universe, or any other origin for distinctly locating three dimensional location(s), positions, or whereabouts in space. Elevation (e.g. for earth, or some other planet, etc) may be useful to the three dimensional point of origin, and/or for the three dimensional region in space. A region in space may also be specified with connecting x-y-z coordinates together to bound the three dimensional region in space. There are many methods for representing a location (field **1100***c*) without departing from the spirit and scope of this disclosure. MSs, for example as carried by users, can travel by airplane through three dimensional areas/regions in space, or travel under the sea through three dimensional regions in space.

Various embodiments of communications between MSs, or an MS and service(s), will share channels (e.g. frequencies) to communicate, depending on when in effect. Sharing a channel will involve carrying recognizable and processable signature to distinguish transmissions for carrying data. Other embodiments of communications between MSs, or an MS and service(s), will use distinct channels to communicate, depending on when in effect. The number of channels that can be concurrently listened on and/or concurrently transmitted on by a data processing system will affect which embodiments are preferred. The number of usable channels will also affect which embodiments are preferred. This disclosure avoids unnecessary detail in different communication channel embodiments so as to not obfuscate novel material. Independent of various channel embodiments within the scope and spirit of the present disclosure, MSs communicate with other MSs in a peer to peer manner, in some aspects like automated walkie-talkies.

Novel features disclosed herein need not be provided as all or none. Certain features may be isolated in some MS embodiments, or may appear as any subset of features and functionality in other embodiments.

Location Based eXchanges (LBX) Architecture

FIG. **1**A depicts a preferred embodiment high level example componentization of a MS in accordance with the present disclosure. A MS **2** includes processing behavior referred to as LBX Character **4** and Other Character **32**. LBX character **4** provides processing behavior causing MS **2** to take on the character of a Location Based Exchange (LBX) MS according to the present disclosure. Other Character **32** provides processing behavior causing MS to take on character of prior art MSs in context of the type of MS. Other character **32** includes at least other processing code **34**, other processing data **36**, and other resources **38**, all of which are well known to those skilled in the art for prior art MSs. In some embodiments, LBX character **4** components may, or may not, make use of IS other character **32** components **34**, **36**, and **38**. Other character **32** components may, or may not, make use of LBX character **4** components **6** through **30**.

LBX character **4** preferably includes at least Peer Interaction Processing (PIP) code **6**, Peer Interaction Processing (PIP) data **8**, self management processing code **18**, self management processing data **20**, WDR queue **22**, send queue **24**, receive queue **26**, service informant code **28**, and LBX history **30**. Peer interaction processing (PIP) code **6** comprises executable code in software, firmware, or hardware form for carrying out LBX processing logic of the present disclosure when interacting with another MS. Peer interaction processing (PIP) data **8** comprises data maintained in any sort of memory of MS **2**, for example hardware memory, flash memory, hard disk memory, a removable memory device, or any other memory means accessible to MS **2**. PIP data **8** contains intelligence data for driving LBX processing logic of the present disclosure when interacting with other MSs. Self management processing code **18** comprises executable code in software, firmware, or hardware form for carrying out the local user interface LBX processing logic of the present disclosure. Self management processing data **20** contains intelligence data for driving processing logic of the present disclosure as disclosed for locally maintained LBX features. WDR queue **22** contains Whereabouts Data Records (WDRs) **1100**, and is a First-In-First-Out (FIFO) queue when considering housekeeping for pruning the queue to a reasonable trailing history of inserted entries (i.e. remove stale entries). WDR queue **22** is preferably designed with the ability of queue entry retrieval processing similar to Standard Query Language (SQL) querying, wherein one or more entries can be retrieved by querying with a conditional match on any data

field(s) of WDR **1100** and returning lists of entries in order by an ascending or descending key on one or any ascending/descending ordered list of key fields.

All disclosed queues (e.g. **22**, **24**, **26**, **1980** and **1990** (See FIG. **19**)) are implemented with an appropriate thread-safe means of queue entry peeking (makes copy of sought queue entry without removing), discarding, retrieval, insertion, and queue entry field sorted search processing. Queues are understood to have an associated implicit semaphore to ensure appropriate synchronous access to queue data in a multi-threaded environment to prevent data corruption and misuse. Such queue interfaces are well known in popular operating systems. In MS operating system environments which do not have an implicit semaphore protected queue scheme, queue accesses in the present disclosure flowcharts are to be understood to have a previous request to a queue-assigned semaphore lock prior to queue access, and a following release of the semaphore lock after queue access. Operating systems without semaphore control may use methods to achieve similar thread-safe synchronization functionality. Queue functionality may be accomplished with lists, arrays, databases (e.g. SQL) and other methodologies without departing from the spirit and scope of queue descriptions herein.

Queue **22** alternate embodiments may maintain a plurality of WDR queues which segregate WDRs **1100** by field(s) values to facilitate timely processing. WDR queue **22** may be at least two (2) separate queues: one for maintaining the MS **2** whereabouts, and one for maintaining whereabouts of other MSs. WDR queue **22** may be a single instance WDR **1100** in some embodiments which always contains the most current MS **2** whereabouts for use by MS **2** applications (may use a sister queue **22** for maintaining WDRs from remote MSs). At least one entry is to be maintained to WDR queue **22** at all times for MS **2** whereabouts.

Send queue **24** (Transmit (Tx) queue) is used to send communications data, for example as intended for a peer MS within the vicinity (e.g. nearby as indicated by maximum range **1306**) of the MS **2**. Receive queue **26** (Receive (Rx) queue) is used to receive communications data, for example from peer MSs within the vicinity (e.g. nearby as indicated by maximum range **1306**) of the MS **2**. Queues **24** and **26** may also each comprise a plurality of queues for segregating data thereon to facilitate performance in interfacing to the queues, in particular when different queue entry types and/or sizes are placed on the queue. A queue interface for sending/receiving data to/from the MS is optimal in a multi-threaded implementation to isolate communications transport layers to processing behind the send/receive queue interfaces, but alternate embodiments may send/receive data directly from a processing thread disclosed herein. Queues **22**, **24**, and/or **26** may be embodied as a purely data form, or SQL database, maintained at MS **2** in persistent storage, memory, or any other storage means. In some embodiments, queues **24** and **26** are not necessary since other character **32** will already have accessible resources for carrying out some LBX character **4** processing.

Queue embodiments may contain fixed length records, varying length records, pointers to fixed length records, or pointers to varying length records. If pointers are used, it is assumed that pointers may be dynamically allocated for record storage on insertions and freed upon record use after discards or retrievals.

As well known to those skilled in the art, when a thread sends on a queue **24** in anticipation of a corresponding response, there is correlation data in the data sent which is sought in a response received by a thread at queue **26** so the sent data is correlated with the received data. In a preferred embodiment, correlation is built using a round-robin generated sequence number placed in data for sending along with a unique MS identifier (MS ID). If data is not already encrypted in communications, the correlation can be encrypted. While the unique MS identifier (MS ID) may help the MS identify which (e.g. wireless) data is destined for it, correlation helps identify which data at the MS caused the response. Upon receipt of data from a responder at queue **26**, correlation processing uses the returned correlation (e.g. field **1100***m*) to correlate the sent and received data. In preferred embodiments, the sequence number is incremented each time prior to use to ensure a unique number, otherwise it may be difficult to know which data received is a response to which data was sent, in particular when many data packets are sent within seconds. When the sequence number reaches a maximum value (e.g. 2**32−1), then it is round-robinned to 0 and is incremented from there all over again. This assures proper correlation of data between the MS and responders over time. There are other correlation schemes (e.g. signatures, random number generation, checksum counting, bit patterns, date/time stamp derivatives) to accomplish correlation functionality. If send and receive queues of Other Character **32** are used, then correlation can be used in a similar manner to correlate a response with a request (i.e. a send with a receipt).

There may be good reason to conceal the MS ID when transmitting it wirelessly. In this embodiment, the MS ID is a dependable and recognizable derivative (e.g. a pseudo MS ID) that can be detected in communications traffic by the MS having the pseudo MS ID, while concealing the true MS ID. This would conceal the true MS ID from would-be hackers sniffing wireless protocol. The derivative can always be reliably the same for simplicity of being recognized by the MS while being difficult to associate to a particular MS. Further still, a more protected MS ID (from would-be hackers that take time to deduce how an MS ID is scrambled) can itself be a dynamically changing correlation anticipated in forthcoming communications traffic, thereby concealing the real MS ID (e.g. phone number or serial number), in particular when anticipating traffic in a response, yet still useful for directing responses back to the originating MS (with the pseudo MS ID (e.g. correlation)). A MS would know which correlation is anticipated in a response by saving it to local storage for use until it becomes used (i.e. correlated in a matching response), or becomes stale. In another embodiment, a correlation response queue (like CR queue **1990**) can be deployed to correlate responses with requests that contain different correlations for pseudo MS IDs. In all embodiments, the MS ID (or pseudo MS ID) of the present disclosure should enable targeting communications traffic to the MS.

Service informant code **28** comprises executable code in software, firmware, or hardware form for carrying out of informing a supervisory service. The present disclosure does not require a connected web service, but there are features for keeping a service informed with activities of MS LBX. Service informant code **28** can communicate as requested any data **8**, **20**, **22**, **24**, **26**, **30**, **36**, **38**, or any other data processed at MS **2**.

LBX history **30** contains historical data useful in maintaining at MS **2**, and possibly useful for informing a supervisory service through service informant code **28**. LBX History **30** preferably has an associated thread of processing for keeping it pruned to the satisfaction of a user of MS **2** (e.g. prefers to keep last 15 days of specified history data, and 30 days of another specified history data, etc). With a suitable user interface to MS **2**, a user may browse, manage, alter, delete, or add to LBX History **30** as is relevant to processing described herein. Service informant code **28** may be used to cause

sending of an outbound email, SMS message, outbound data packet, or any other outbound communication in accordance with LBX of the MS.

PIP data **8** preferably includes at least permissions **10**, charters **12**, statistics **14**, and a service directory **16**. Permissions **10** are configured to grant permissions to other MS users for interacting the way the user of MS **2** desires for them to interact. Therefore, permissions **10** contain permissions granted from the MS **2** user to other MS users. In another embodiment, permissions **10** additionally, or alternatively, contain permissions granted from other MS users to the MS **2** user. Permissions are maintained completely local to the MS **2**. Charters **12** provide LBX behavior conditional expressions for how MSs should interact with MS **2**. Charters **12** are configured by the MS **2** user for other MS users. In another embodiment, charters **12** additionally, or alternatively, are configured by other MS users for the MS **2** user. Some charters expressions depend on permissions **10**. Statistics **14** are maintained at MS **2** for reflecting peer (MS) to peer (MS) interactions of interest that occurred at MS **2**. In another embodiment, statistics **14** additionally, or **15** alternatively, reflect peer (MS) to peer (MS) interactions that occurred at other MSs, preferably depending on permissions **10**. Service informant code **28** may, or may not, inform a service of statistics **14** maintained. Service directory **16** includes routing entries for how MS **2** will find a sought service, or how another MS can find a sought service through MS **2**.

In some embodiments, any code (e.g. **6**, **18**, **28**, **34**, **38**) can access, manage, use, alter, or discard any data (e.g. **8**, **20**, **22**, **24**, **26**, **30**, **36**, **38**) of any other component in MS **2**. Other embodiments may choose to keep processing of LBX character **4** and other character **32** disjoint from each other. Rectangular component boundaries are logical component representations and do not have to delineate who has access to what. MS (also MSs) references discussed herein in context for the new and useful features and functionality disclosed is understood to be an MS **2** (MSs **2**).

FIG. **1**B depicts a Location Based eXchanges (LBX) architectural illustration for discussing the present disclosure. LBX MSs are peers to each other for locational features and functionality. An MS **2** communicates with other MSs without requiring a service for interaction. For example, FIG. **1**B depicts a wireless network **40** of five (5) MSs. Each is able to directly communicate with others that are in the vicinity (e.g. nearby as indicated by maximum range **1306**). In a preferred embodiment, communications are limited reliability wireless broadcast datagrams having recognizable data packet identifiers. In another embodiment, wireless communications are reliable transport protocols carried out by the MSs, such as TCP/IP. In other embodiments, usual communications data associated with other character **32** include new data (e.g. Communications Key **1304**) in transmissions for being recognized by MSs within the vicinity. For example, as an MS conventionally communicates, LBX data is added to the protocol so that other MSs in the vicinity can detect, access, and use the data. The advantage to this is that as MSs use wireless communications to carry out conventional behavior, new LBX behavior is provided by simply incorporating additional information (e.g. Communications Key **1304**) to existing communications.

Regardless of the embodiment, an MS **2** can communicate with any of its peers in the vicinity using methods described below. Regardless of the embodiment, a communication path **42** between any two MSs is understood to be potentially bidirectional, but certainly at least unidirectional. The bidirectional path **42** may use one communications method for one direction and a completely different communications method for the other, but ultimately each can communicate to each other. When considering that a path **42** comprises two unidirectional communications paths, there are N*(N−1) unidirectional paths for N MSs in a network **40**. For example, 10 MSs results in 90 (i.e. 10*9) one way paths of communications between all 10 MSs for enabling them to talk to each other. Sharing of the same signaling channels is preferred to minimize the number of MS threads listening on distinct channels. Flowcharts are understood to process at incredibly high processing speeds, in particular for timely communications processing.

FIG. **1**C depicts a Location Based Services (LBS) architectural illustration for discussing prior art of the present disclosure. In order for a MS to interact for LBS with another MS, there is service architecture **44** for accomplishing the interaction. For example, to detect that MS **1** is nearby MS N, the service is indispensably involved in maintaining data and carrying out processing. For example, to detect that MS **1** is arriving to, or departing from, a geofenced perimeter area configured by MS N, the service was indispensably involved in maintaining data and carrying out processing. For example, for MS N to locate MS **1** on a live map, the service was indispensably involved in maintaining data and carrying out processing. In another example, to grant and revoke permissions from MS **1** to MS N, the service was indispensably involved in maintaining data and carrying out processing. While it is advantageous to require a single bidirectional path **46** for each MS (i.e. two unidirectional communications paths; (2 * N) unidirectional paths for N MSs), there are severe requirements for service(s) when there are lots of MSs (i.e. when N is large). Wireless MSs have advanced beyond cell phones, and are capable of housing significant parallel processing, processing speed, increased wireless transmission speeds and distances, increased memory, and richer features.

FIG. **1**D depicts a block diagram of a data processing system useful for implementing a MS, ILM, DLM, centralized server, or any other data processing system described herein. An MS **2** is a data processing system **50**. Data processing system **50** includes at least one processor **52** (e.g. Central Processing Unit (CPU)) coupled to a bus **54**. Bus **54** may include a switch, or may in fact be a switch **54** to provide dedicated connectivity between components of data processing system **50**. Bus (and/or switch) **54** is a preferred embodiment coupling interface between data processing system **50** components. The data processing system **50** also includes main memory **56**, for example, random access memory (RAM). Memory **56** may include multiple memory cards, types, interfaces, and/or technologies. The data processing system **50** may include secondary storage devices **58** such as persistent storage **60**, and/or removable storage device **62**, for example as a compact disk, floppy diskette, USB flash, or the like, also connected to bus (or switch) **54**. In some embodiments, persistent storage devices could be remote to the data processing system **50** and coupled through an appropriate communications interface. Persistent storage **60** may include flash memory, disk drive memory, magnetic, charged, or bubble storage, and/or multiple interfaces and/or technologies, perhaps in software interface form of variables, a database, shared memory, etc.

The data processing system **50** may also include a display device interface **64** for driving a connected display device (not shown). The data processing system **50** may further include one or more input peripheral interface(s) **66** to input devices such as a keyboard, keypad, Personal Digital Assistant (PDA) writing implements, touch interfaces, mouse, voice interface, or the like. User input ("user input", "user

events" and "user actions" used interchangeably) to the data processing system are inputs accepted by the input peripheral interface(s) **66**. The data processing system **50** may still further include one or more output peripheral interface(s) **68** to output devices such as a printer, facsimile device, or the like. Output peripherals may also be available via an appropriate interface.

Data processing system **50** will include a communications interface(s) **70** for communicating to another data processing system **72** via analog signal waves, digital signal waves, infrared proximity, copper wire, optical fiber, or other wave spectrums described herein. A MS may have multiple communications interfaces **70** (e.g. cellular connectivity, 802.x, etc). Other data processing system **72** may be an MS. Other data processing system **72** may be a service. Other data processing system **72** is a service data processing system when MS **50** communicates to other data processing system **72** by way of service informant code **28**. In any case, the MS and other data processing system are said to be interoperating when communicating.

Data processing system programs (also called control logic) may be completely inherent in the processor(s) **52** being a customized semiconductor, or may be stored in main memory **56** for execution by processor(s) **52** as the result of a read-only memory (ROM) load (not shown), or may be loaded from a secondary storage device into main memory **56** for execution by processor(s) **52**. Such programs, when executed, enable the data processing system **50** to perform features of the present disclosure as discussed herein. Accordingly, such data processing system programs represent controllers of the data processing system.

In some embodiments, the disclosure is directed to a control logic program product comprising at least one processor **52** having control logic (software, firmware, hardware microcode) stored therein. The control logic, when executed by processor(s) **52**, causes the processor(s) **52** to provide functions of the disclosure as described herein. In another embodiment, this disclosure is implemented primarily in hardware, for example, using a prefabricated component state machine (or multiple state machines) in a semiconductor element such as a processor **52**.

Those skilled in the art will appreciate various modifications to the data processing system **50** without departing from the spirit and scope of this disclosure. A data processing system, and more particularly a MS, preferably has capability for many threads of simultaneous processing which provide control logic and/or processing. These threads can be embodied as time sliced threads of processing on a single hardware processor, multiple processors, multi-core processors, Digital Signal Processors (DSPs), or the like, or combinations thereof. Such multi-threaded processing can concurrently serve large numbers of concurrent MS tasks. Concurrent processing may be provided with distinct hardware processing and/or as appropriate software driven time-sliced thread processing. Those skilled in the art recognize that having multiple threads of execution on an MS is accomplished in many different ways without departing from the spirit and scope of this disclosure. This disclosure strives to deploy software to existing MS hardware configurations, but the disclosed software can be deployed as burned-in microcode to new hardware of MSs.

Data processing aspects of drawings/flowcharts are preferably multi-threaded so that many MSs and applicable data processing systems are interfaced with in a timely and optimal manner. Data processing system **50** may also include its own clock mechanism (not shown), if not an interface to an atomic clock or other clock mechanism, to ensure an appropriately accurate measurement of time in order to appropriately carry out processing described below. In some embodiments, Network Time Protocol (NTP) is used to keep a consistent universal time for MSs and other data processing systems in communications with MSs. This is most advantageous to prevent unnecessary round-tripping of data between data processing systems to determine timing (e.g. Time Difference of Arrival (TDOA)) measurements. A NTP synchronized date/time stamp maintained in communications is compared by a receiving data processing system for comparing with its own NTP date/time stamp to measure TOA (time of arrival (i.e. time taken to arrive)). Of course, in the absence of NTP used by the sender and receiver, TOA is also calculated in a bidirectional transmission using correlation. In this disclosure, TOA measurements from one location technology are used for triangulating with TOA measurements from another location technology, not just for determining "how close". Therefore, TDOA terminology is generally used herein to refer to the most basic TOA measurement of a wave spectrum signal being the difference between when it was sent and when it was received. TDOA is also used to describe using the difference of such measurements to locate (triangulate). NTP use among participating systems has the advantage of a single unidirectional broadcast data packet containing all a receiving system requires to measure TDOA, by knowing when the data was sent (date/time stamp in packet) and when the data was received (signal detected and processed by receiving system). A NTP clock source (e.g. atomic clock) used in a network is to be reasonably granular to carry out measurements, and ensures participating MSs are updated timely according to anticipated time drifts of their own clocks. There are many well known methods for accomplishing NTP, some which require dedicated thread(s) for NTP processing, and some which use certain data transmitted to and from a source to keep time in synch.

Those skilled in the art recognize that NTP accuracy depends on participating MS clocks and processing timing, as well as time server source(s). Radio wave connected NTP time server(s) is typically accurate to as granular as 1 millisecond. Global Positioning System (GPS) time servers provide accuracy as granular as 50 microseconds. GPS timing receivers provide accuracy to around 100 nanoseconds, but this may be reduced by timing latencies in time server operating systems. With advancements in hardware, microcode, and software, obvious improvements are being made to NTP. In NTP use embodiments of this disclosure, an appropriate synchronization of time is used for functional interoperability between MSs and other data processing systems using NTP. NTP is not required in this disclosure, but it is an advantage when in use.

LBX Directly Located Mobile Data Processing Systems (DLMs)

FIG. **1**E depicts a network illustration for discussing various deployments of whereabouts processing aspects of the present disclosure. In some embodiments, a cellular network cluster **102** and cellular network cluster **104** are parts of a larger cellular network. Cellular network cluster **102** contains a controller **106** and a plurality of base stations, shown generally as base stations **108**. Each base station covers a single cell of the cellular network cluster, and each base station **108** communicates through a wireless connection with the controller **106** for call processing, as is well known in the art. Wireless devices communicate via the nearest base station (i.e. the cell the device currently resides in), for example base station **108**b. Roaming functionality is provided when a wire-

less device roams from one cell to another so that a session is properly maintained with proper signal strength. Controller **106** acts like a telephony switch when a wireless device roams across cells, and it communicates with controller **110** via a wireless connection so that a wireless device can also roam to other clusters over a larger geographical area. Controller **110** may be connected to a controller **112** in a cellular cluster through a physical connection, for example, copper wire, optical fiber, or the like. This enables cellular clusters to be great distances from each other. Controller **112** may in fact be connected with a physical connection to its base stations, shown generally as base stations **114**. Base stations may communicate directly with the controller **112**, for example, base station **114***e*. Base stations may communicate indirectly to the controller **112**, for example base station **114***a* by way of base station **114***d*. It is well known in the art that many options exist for enabling interoperating communications between controllers and base stations for the purpose of managing a cellular network. A cellular network cluster **116** may be located in a different country. Base controller **118** may communicate with controller **110** through a Public Service Telephone Network (PSTN) by way of a telephony switch **120**, PSTN **122**, and telephony switch **124**, respectively. Telephony switch **120** and telephony switch **124** may be private or public. In one cellular network embodiment of the present disclosure, the services execute at controllers, for example controller **110**. In some embodiments, the MS includes processing that executes at a wireless device, for example mobile laptop computer **126**, wireless telephone **128**, a personal digital assistant (PDA) **130**, an iphone **170**, or the like. As the MS moves about, positional attributes are monitored for determining location. The MS may be handheld, or installed in a moving vehicle. Locating a wireless device using wireless techniques such as Time Difference of Arrival (TDOA) and Angle Of Arrival (AOA) are well known in the art. The service may also execute on a server computer accessible to controllers, for example server computer **132**, provided an appropriate timely connection exists between cellular network controller(s) and the server computer **132**. Wireless devices (i.e. MSs) are preferably known by a unique identifier, for example a phone number, caller id, device identifier, or like appropriate unique handle.

In another embodiment of the present disclosure, GPS satellites such as satellite **134**, satellite **136**, and satellite **138** provide information, as is well known in the art, to GPS devices on earth for triangulation locating of the GPS device. In this embodiment, a MS has integrated GPS functionality so that the MS monitors its positions. The MS is preferably known by a unique identifier, for example a phone number, caller id, device identifier, or like appropriate unique handle.

In yet another embodiment of the present disclosure, a physically connected device, for example, telephone **140**, computer **142**, PDA **144**, telephone **146**, and fax machine **148**, may be newly physically connected to a network. Each is a MS, although the mobility is limited. Physical connections include copper wire, optical fiber, USB, or any other physical connection, by any communications protocol thereon. Devices are preferably known by a unique identifier, for example a phone number, caller id, device identifier, physical or logical network address, or like appropriate unique handle. The MS is detected for being newly located when physically connected. A service can be communicated to upon detecting connectivity. The service may execute at an Automatic Response Unit (ARU) **150**, a telephony switch, for example telephony switch **120**, a web server **152** (for example, connected through a gateway **154**), or a like data processing system that communicates with the MS in any of a variety of ways as well known to those skilled the art. MS detection may be a result of the MS initiating a communication with the service directly or indirectly. Thus, a user may connect his laptop to a hotel network, initiate a communication with the service, and the service determines that the user is in a different location than the previous communication. A local area network (LAN) **156** may contain a variety of connected devices, each an MS that later becomes connected to a local area network **158** at a different location, such as a PDA **160**, a server computer **162**, a printer **164**, an internet protocol telephone **166**, a computer **168**, or the like. Hard copy presentation could be made to printer **164** and fax **148**.

Current technology enables devices to communicate with each other, and other systems, through a variety of heterogeneous system and communication methods. Current technology allows executable processing to run on diverse devices and systems. Current technology allows communications between the devices and/or systems over a plethora of methodologies at close or long distance. Many technologies also exist for automatic locating of devices. It is well known how to have an interoperating communications system that comprises a plurality of individual systems communicating with each other with one or more protocols. As is further known in the art of developing software, executable processing of the present disclosure may be developed to run on a particular target data processing system in a particular manner, or customized at install time to execute on a particular data processing system in a particular manner.

FIG. **2**A depicts an illustration for describing automatic location of a MS, for example a DLM **200**, through the MS coming into range of a stationary cellular tower. A DLM **200**, or any of a variety of MSs, travels within range of a cell tower, for example cell tower **108***b*. The known cell tower location is used to automatically detect the location of the DLM **200**. In fact, any DLM that travels within the cell served by cell tower **108***b* is identified as the location of cell tower **108***b*. The confidence of a location of a DLM **200** is low when the cell coverage of cell tower **108***b* is large. In contrast, the confidence of a location of a DLM **200** is higher when the cell coverage of cell tower **108***b* is smaller. However, depending on the applications locating DLMs using this method, the locating can be quite acceptable. Location confidence is improved with a TDOA measurement for the elapsed time of communication between DLM **200** and cell tower to determine how close the MS is to the cell tower. Cell tower **108***b* can process all locating by itself, or with interoperability to other services as connected to cell tower **108***b* in FIG. **1**E. Cell tower **108***b* can communicate the location of DLM **200** to a service, to the DLM **200**, to other MSs within its coverage area, any combination thereof, or to any connected data processing system, or MS, of FIG. **1**E.

FIG. **2**B depicts an illustration for describing automatic location of a MS, for example a DLM **200**, through the MS coming into range of some stationary antenna. DLM **200**, or any of a variety of MSs, travels within range of a stationary antenna **202** that may be mounted to a stationary object **204**. The known antenna location is used to automatically detect the location of the DLM **200**. In fact, any DLM that travels within the coverage area served by antenna **202** is identified as the location of antenna **202**. The confidence of a location of a DLM **200** is low when the antenna coverage area of antenna **202** is large. In contrast, the confidence of a location of a DLM **200** is higher when the antenna coverage area of antenna **202** is smaller. However, depending on the applications locating DLMs using this method, the locating can be quite acceptable. Location confidence is improved with a TDOA measurement for the elapsed time of communication between

DLM **200** and a particular antenna to determine how close the MS is to the antenna. Antenna **202** can process all locating by itself (with connected data processing system (not shown) as well known to those skilled in the art), or with interoperability to other services as connected to antenna **202**, for example with connectivity described in FIG. **1**E. Antenna **202** can be used to communicate the location of DLM **200** to a service, to the DLM **200**, to other MSs within its coverage area, any combination thereof, or to any connected data processing system, or MS, of FIG. **1**E.

FIG. **2**C depicts an illustration for discussing an example of automatically locating a MS, for example a DLM **200**, through the MS coming into range of some stationary antenna. DLM **200**, or any of a variety of MSs, travels within range of a stationary antenna **212** that may be mounted to a stationary object, such as building **210**. The known antenna location is used to automatically detect the location of the DLM **200**. In fact, any DLM that travels within the coverage area served by antenna **212** is identified as the location of antenna **212**. The confidence of a location of a DLM **200** is low when the antenna coverage area of antenna **212** is large. In contrast, the confidence of a location of a DLM **200** is higher when the antenna coverage area of antenna **212** is smaller. However, depending on the applications locating DLMs using this method, the locating can be quite acceptable. Location confidence is improved with a TDOA measurement as described above. Antenna **212** can process all locating by itself (with connected data processing system (not shown) as well known to those skilled in the art), or with interoperability to other services as connected to antenna **212**, for example with connectivity described in FIG. **1**E. Antenna **212** can be used to communicate the location of DLM **200** to a service, to the DLM **200**, to other MSs within its coverage area, any combination thereof, or to any connected data processing system, or MS, of FIG. **1**E.

Once DLM **200** is within the building **210**, a strategically placed antenna **216** with a desired detection range within the building is used to detect the DLM **200** coming into its proximity. Wall breakout **214** is used to see the antenna **216** through the building **210**. The known antenna **216** location is used to automatically detect the location of the DLM **200**. In fact, any DLM that travels within the coverage area served by antenna **216** is identified as the location of antenna **216**. The confidence of a location of a DLM **200** is low when the antenna coverage area of antenna **216** is large. In contrast, the confidence of a location of a DLM **200** is higher when the antenna coverage area of antenna **216** is smaller. Travels of DLM **200** can be limited by objects, pathways, or other limiting circumstances of traffic, to provide a higher confidence of location of DLM **200** when located by antenna **216**, or when located by any locating antenna described herein which detects MSs coming within range of its location. Location confidence is improved with a TDOA measurement as described above. Antenna **216** can process all locating by itself (with connected data processing system (not shown) as well known to those skilled in the art), or with interoperability to other services as connected to antenna **216**, for example with connectivity described in FIG. **1**E. Antenna **216** can be used to communicate the location of DLM **200** to a service, to the DLM **200**, to other MSs within its coverage area, any combination thereof, or to any connected data processing system, or MS, of FIG. **1**E. Other in-range detection antennas of a FIG. **2**C embodiment may be strategically placed to facilitate warehouse operations such as in Kubler et al.

FIG. **2**D depicts a flowchart for describing a preferred embodiment of a service whereabouts update event of an antenna in-range detected MS, for example a DLM **200**, when MS location awareness is monitored by a stationary antenna, or cell tower (i.e. the service thereof. FIGS. **2**A through **2**C location detection processing are well known in the art. FIG. **2**D describes relevant processing for informing MSs of their own whereabouts. Processing begins at block **230** when a MS signal deserving a response has been received and continues to block **232** where the antenna or cell tower service has authenticated the MS signal. A MS signal can be received for processing by blocks **230** through **242** as the result of a continuous, or pulsed, broadcast or beaconing by the MS (FIG. **13**A), perhaps as part of usual communication protocol in progress for the MS (FIG. **13**A usual data **1302** with embedded Communications Key (CK) **1304**), or an MS response to continuous, or pulsed, broadcast or beaconing via the service connected antenna (FIG. **13**C). MS and/or service transmission can be appropriately correlated for a response (as described above) which additionally facilitates embodiments using TDOA measurements (time of communications between the MS and antenna, or cell tower) to determine at least how close is the MS in range (or use in conjunction with other data to triangulate the MS location). The MS is preferably authenticated by a unique MS identifier such as a phone number, address, name, serial number, or any other unique handle to the MS. In this, and any other embodiments disclosed, an MS may be authenticated using a group identifier handle indicating membership to a supported/known group deserving further processing. Authentication will preferably consult a database for authenticating that the MS is known. Block **232** continues to block **234** where the signal received is immediately responded back to the MS, via the antenna, containing at least correlation along with whereabouts information for a Whereabouts Data Record (WDR) **1100** associated with the antenna (or cell tower). Thereafter, the MS receives the correlated response containing new data at block **236** and completes a local whereabouts data record **1100** (i.e. WDR **1100**) using data received along with other data determined by the MS.

In another embodiment, blocks **232** through **234** are not required. A service connected antenna (or cell tower) periodically broadcasts its whereabouts (WDR info (e.g. FIG. **13**C)) and MSs in the vicinity use that directly at block **236**. The MS can choose to use only the confidence and location provided, or may determine a TDOA measurement for determining how close it is. If the date/time stamp field **1100***b* indicates NTP is in use by the service, and the MS is also using NTP, then a TDOA measurement can be determined using the one unidirectional broadcast via the antenna by using the date/time stamp field **1100***b* received with when the WDR information was received by the MS (subtract time difference and use known wave spectrum for distance). If either the service or MS is not NTP enabled, then a bidirectional correlated data flow between the service and MS is used to assess a TDOA measurement in terms of time of the MS. One embodiment provides the TDOA measurement from the service to the MS. Another embodiment calculates the TDOA measurement at the MS.

Network Time protocol (NTP) can ensure MSs have the same atomic clock time as the data processing systems driving antennas (or cell towers) they will encounter. Then, date/time stamps can be used in a single direction (unidirectional) broadcast packet to determine how long it took to arrive to/from the MS. In an NTP embodiment, the MS (FIG. **13**A) and/or the antenna (FIG. **13**C) sends a date/time stamp in the pulse, beacon, or protocol. Upon receipt, the antenna (or cell tower) service data processing system communicates how long the packet took from an MS to the antenna (or cell tower) by comparing the date/time stamp in the packet and a date/

time stamp of when it was received. The service may also set the confidence value, before sending WDR information to the MS. Similarly, an MS can compare a date/time stamp in the unidirectional broadcast packet sent from a locating service (FIG. **13**C) with when received by the MS. So, NTP facilitates TDOA measurements in a single broadcast communication between systems through incorporation to usual communications data **1302** with a date/time stamp in Communications Key (CK) **1304**, or alternatively in new data **1302**. Similarly, NTP facilitates TDOA measurement in a single broadcast communication between systems through incorporation to usual communications data **1312** with a date/time stamp in Communications Key (CK) **1314**, or alternatively in new data **1312**.

The following template is used in this disclosure to highlight field settings. See FIG. **11**A descriptions. Fields are set to the following upon exit from block **236**:

MS ID field **1100***a* is preferably set with: Unique MS identifier of the MS invoking block **240**. This field is used to uniquely distinguish this MS WDRs on queue **22** from other originated WDRs.

DATE/TIME STAMP field **1100***b* is preferably set with: Date/time stamp for WDR completion at block **236** to the finest granulation of time achievable by the MS. The NTP use indicator is set appropriately.

LOCATION field **1100***c* is preferably set with: Location of stationary antenna (or cell tower) as communicated by the service to the MS.

CONFIDENCE field **1100***d* is preferably set with: The same value (e.g. **76**) for any range within the antenna (or cell tower), or may be adjusted using the TDOA measurement (e.g. amount of time detected by the MS for the response at block **234**). The longer time it takes between the MS sending a signal detected at block **232** and the response with data back received by the MS (block **234**), the less confidence there is for being located because the MS must be a larger distance from the antenna or cell tower. The less time it takes between the MS sending a signal detected at block **232** and the response with data back, the more confidence there is for being located because the MS must be a closer distance to the antenna or cell tower. Confidence values are standardized for all location technologies. In some embodiments of FIG. **2**D processing, a confidence value can be set for 1 through 100 (1 being lowest confidence and 100 being highest confidence) wherein a unit of measurement between the MS and antenna (or cell tower) is used directly for the confidence value. For example, 20 meters is used as the unit of measurement. For each unit of 20 meters distance determined by the TDOA measurement, assign a value of 1, up to a worst case of 100 (i.e. 2000 meters). Round the 20 meter unit of distance such that 0 meters to <25 meters is 20 meters (i.e. 1 unit of measurement), 26 meters to <45 meters is 40 meters (i.e. 2 units of measurement), and so on. Once the number of units is determined, subtract that number from 101 for the confidence value (i.e. 1 unit=confidence value 100, 20 units=confidence value 81; 100 units or greater=confidence value of 1). Yet another embodiment will use a standard confidence value for this "coming in range" technology such as 76 and then further increase or decrease the confidence using the TDOA measurement. Many embodiments exist for quantifying a higher versus lower confidence. In any case, a confidence value (e.g. 76) is determined by the MS, service, or both (e.g. MS uses TDOA measurement to modify confidence sent by service).

LOCATION TECHNOLOGY field **1100***e* is preferably set with: "Server Antenna Range" for an antenna detecting the MS, and is set to "Server Cell Range" for a cell tower detecting the MS. The originator indicator is set to DLM.

LOCATION REFERENCE INFO field **1100***f* is preferably set with: The period of time for communications between the antenna and the MS (a TDOA measurement), if known; a communications signal strength, if available; wave spectrum used (e.g. from MS receive processing), if available; particular communications interface **70**, if available. The TDOA measurement may be converted to a distance using wave spectrum information. The values populated here should have already been factored into the confidence value at block **236**.

COMMUNICATIONS REFERENCE INFO field **1100***g* is preferably set with: Parameters uniquely identifying a/the service (e.g. antenna (or cell tower)) and how to best communicate with it again, if available. May not be set, regardless if received from the service.

SPEED field **1100***h* is preferably set with: Data received by MS at block **234**, if available.

HEADING field **1100***i* is preferably set with: Data received by MS at block **234**, if available.

ELEVATION field **1100***j* is preferably set with: data received by MS at block **234**, if available. Elevation field **1100***j* is preferably associated with the antenna (or cell tower) by the elevation/altitude of the antenna (or cell tower).

APPLICATION FIELDS field **1100***k* is preferably set with: Data received at block **234** by the MS, or set by data available to the MS, or set by both the locating service for the antenna (or cell tower) and the MS itself. Application fields include, and are not limited to, MS navigation APIs in use, social web site identifying information, application information for applications used, accessed, or in use by the MS, or any other information complementing whereabouts of the MS.

CORRELATION FIELD **1100***m* is preferably set with: Not Applicable (i.e. not maintained to queue **22**).

SENT DATE/TIME STAMP field **1100***n* is preferably set with: Not Applicable (i.e. not maintained to queue **22**).

RECEIVED DATE/TIME STAMP field **1100***p* is preferably set with: Not Applicable (i.e. not maintained to queue **22**).

A service connected to the antenna (or cell tower) preferably uses historical information and artificial intelligence interrogation of MS travels to determine fields **1100***h* and **1100***i*. Block **236** continues to block **238** where parameters are prepared for passing to FIG. **2**F processing invoked at block **240**. Parameters are set for: WDRREF=a reference or pointer to the WDR; DELETEQ=FIG. **2**D location queue discard processing; and SUPER=FIG. **2**D supervisory notification processing. Thereafter, block **240** invokes FIG. **2**F processing and FIG. **2**D processing terminates at block **242**. FIG. **2**F processing will insert to queue **22** so this MS knows at least its own whereabouts whenever possible. A single data instance embodiment of WDR queue **22** will cause FIG. **2**F to update the single record of WDR information for being current upon exit from block **240** (this is true for all flowchart blocks invoking FIG. **2**F processing).

With reference now to FIG. **2**F, depicted is a flowchart for describing a preferred embodiment of a procedure for inserting a Whereabouts Data Record (WDR) **1100** to MS WDR queue **22**. Appropriate semaphores are used for variables which can be accessed simultaneously by another thread other than the caller. With reference now to FIG. **2**F, procedure processing starts at block **270** and continues to block **272** where parameters passed from the invoking block of processing, for example block **240**, are determined. The variable WDRREF is set by the caller to a reference or pointer to the WDR so subsequent blocks of FIG. **2**F can access the WDR.

The variable DELETEQ is set by the caller so that block **292** knows how to discard obsolete location queue entries. The DELETEQ variable can be a multi-field record (or reference thereof) for how to prune. The variable SUPER is set by the caller so that block **294** knows under what condition(s), and which data, to contact a supervisory service. The SUPER variable can be a multi-field record (or reference thereof) for instruction.

Block **272** continues to block **274** where the DLMV (see FIG. **12** and later discussions for DLMV (DLM role(s) List Variable)), or ILMV (see FIG. **12** and later discussions for ILMV (ILM role(s) List Variable)), is checked for an enabled role matching the WDR for insertion (e.g. DLM: location technology field **1100***e* (technology and originator indicator) when MS ID=this MS; ILM: DLM or ILM indicator when MS ID not this MS). If no corresponding DLMV/ILMV role is enabled for the WDR to insert, then processing continues to block **294** (the WDR is not inserted to queue **22**). If the ILMV/DLMV role for the WDR is enabled, then processing continues to block **276** where the confidence of the WDR **1100** is validated prior to insertion. An alternate embodiment to FIG. **2**F will not have block **274** (i.e. block **272** continues directly to block **276**) since appropriate DLM and/or ILM processing may be terminated anyway when DLM/ILM role(s) are disabled (see FIG. **14**A/B).

If block **276** determines the data to be inserted is not of acceptable confidence (e.g. field **1100***d*<confidence floor value (see FIG. **14**A/B)), then processing continues to block **294** described below. If block **276** determines the data to be inserted is of acceptable confidence (e.g. field **1100***d*>**70**), then processing continues to block **278** for checking the intent of the WDR insertion.

If block **278** determines the WDR for insert is a WDR describing whereabouts for this MS (i.e. MS ID matching MS of FIG. **2**F processing (DLM: FIGS. **2**A through **9**B, or ILM: FIG. **26**A/B)), then processing continues to block **280**. If block **278** determines the WDR for insert is from a remote ILM or DLM (i.e. MS ID does not match MS of FIG. **2**F processing), then processing continues to block **290**. Block **280** peeks the WDR queue **22** for the most recent highest confidence entry for this MS whereabouts by searching queue **22** for: the MS ID field **1100***a* matching the MS ID of FIG. **2**F processing, and a confidence field **1100***d* greater than or equal to the confidence floor value, and a most recent date/time stamp field **1100***b*. Thereafter, if block **282** determines one was found, then processing continues to block **284**, otherwise processing continues to block **286** where a Last Whereabouts date/Time stamp (LWT) variable is set to field **1100***b* of the WDR for insert (e.g. first MS whereabouts WDR), and processing continues to block **288**.

If block **284** determines the WDR for insertion has significantly moved (i.e. using a movement tolerance configuration (e.g. 3 meters) with fields **1100***c* of the WDR for insert and the WDR peeked at block **280**), then block **286** sets the LWT (Last Whereabouts date/Time stamp) variable (with appropriate semaphore) to field **1100***b* of the WDR for insert, and processing continues to block **288**, otherwise processing continues directly to block **288** (thereby keeping the LWT as its last setting). The LWT is to hold the most recent date/time stamp of when the MS significantly moved as defined by a movement tolerance. The movement tolerance can be system defined or configured, or user configured in FIG. **14** by an option for configuration detected at block **1408**, and then using the Configure Value procedure of FIG. **18** (like confidence floor value configuration).

Block **288** accesses the DLMV and updates it with a new DLM role if there is not one present for it. This ensures a correct list of DLMV roles are available for configuration by FIG. **14**. Preferably, by default an unanticipated DLMV role is enabled (helps inform the user of its availability). Likewise in another embodiment, ILMV roles can be similarly updated, in particular if a more granulated list embodiment is maintained to the ILMV, or if unanticipated results help to identify another configurable role. By default, block **274** should allow unanticipated roles to continue with WDR insertion processing, and then block **288** can add the role, enable it, and a user can decide what to do with it in configuration (FIG. **14**A/B).

Thereafter, the WDR **1100** is inserted to the WDR queue **22** at block **290**, block **292** discards any obsolete records from the queue as directed by the caller (invoker), and processing continues to block **294**. The WDR queue **22** preferably contains a list of historically MS maintained Whereabouts Data Records (WDRs) as the MS travels. When the MS needs its own location, for example from an application access, or to help locate an ILM, the queue is accessed for returning the WDR with the highest confidence value (field **1100***d*) in the most recent time (field **1100***b*) for the MS (field **1100***a*). Block **292** preferably discards by using fields **1100***b* and **1100***d* relative to other WDRs. The queue should not be allowed to get too large. This will affect memory (or storage) utilization at the MS as well as timeliness in accessing a sought queue entry. Block **292** also preferably discards WDRs from queue **22** by moving selected WDRs to LBX History **30**.

As described above, queue interfaces assume an implicit semaphore for properly accessing queue **22**. There may be ILMs requesting to be located, or local applications of the MS may request to access the MS whereabouts. Executable thread(s) at the MS can accesses the queue in a thread-safe manner for responding to those requests. The MS may also have multiple threads of processing for managing whereabouts information from DLMs, ILMs, or stationary location services. The more concurrently executable threads available to the MS, the better the MS is able to locate itself and respond to others (e.g. MSs). There can be many location systems and methods used to keeping a MS informed of its own whereabouts during travel. While the preferred embodiment is to maximize thread availability, the obvious minimum requirement is to have at least 1 executable thread available to the MS. As described above, in operating system environments without proper queue interfaces, queue access blocks are first preceded by an explicit request for a semaphore lock to access queue **22** (waits until obtained), and then followed by a block for releasing the semaphore lock to another thread for use. Also, in the present disclosure it is assumed in blocks which access data accessible to more than 1 concurrent thread (e.g. shared memory access to DLMV or ILMV at block **274**) that an appropriate semaphore (created at block **1220**) protect synchronous access.

If block **294** determines information (e.g. whereabouts) should be communicated by service informant code **28** to a supervisory service, for example a service **1050**, then block **296** communicates specified data to the service and processing terminates at block **298** by returning to the invoker (caller). If block **294** determines a supervisory service is not to be informed, then processing terminates with an appropriate return to the caller at block **298**. Service informant code **28**, at block **296**, can send information as data that is reliably acknowledged on receipt, or as a datagram which most likely (but unreliably) is received.

Depending on the SUPER variable, block **294** may opt to communicate every time a WDR is placed to the queue, or when a reasonable amount of time has passed since last com-

municating to the supervisory service, or when a WDR confidence reaches a certain sought value, or when any WDR field or fields contain certain sought information, or when a reasonably large number of entries exist in WDR queue **22**, or for any processing condition encountered by blocks **270** through **298**, or for any processing condition encountered by caller processing up to the invocation of FIG. **2**F processing. Different embodiments will send a single WDR **1100** at block **296**, a plurality of WDRs **1100**, or any other data. Various SUPER parameter(s) embodiments for FIG. **2**F caller parameters can indicate what, when, where and how to send certain data. Block **296** may send an email, an SMS message, or use other means for conveying data. Service informant code **28** may send LBX history **30**, statistics **14** and/or any other data **8**, data **20**, queue data, data **36** or resources **38**. Service informant code **28** may update data in history **30**, statistics **14** or any other data **8**, data **20**, queue data, data **36** and/or resources **38**, possibly using conditions of this data to determine what is updated. Blocks **294** and **296** may be omitted in some embodiments.

If a single WDR is sent at block **296** as passed to FIG. **2**F processing, then the WDR parameter determined at block **272** is accessed. If a plurality of WDRs is sent at block **296**, then block **296** appropriately interfaces in a thread-safe manner to queue **22**, and sends the WDRs.

Some preferred embodiments do not incorporate blocks **278** through **286**. (i.e. block **276** continues to block **288** if confidence ok). Blocks **278** through **286** are for the purpose of implementing maintaining a date/time stamp of last MS significant movement (using a movement tolerance). Architecture **1900** uses FIG. **2**F, as does DLM processing. FIG. **2**F must perform well for the preferred multithreaded architecture **1900**. Block **280** performs a peek, and block **284** can be quite timely depending on embodiments used for location field **1100***c*. A movement tolerance incorporated at the MS is not necessary, but may be nice to have. Therefore, blocks **278** through **286** are optional blocks of processing.

FIG. **2**F may also maintain (with appropriate semaphore) the most recent WDR describing whereabouts of the MS of FIG. **2**F processing to a single data record every time a new one is to be inserted. This allows applications needing current whereabouts to simply access a current WDR, rather than interface to a plurality of WDRs at queue **22**. For example, there could be a new block **289** for updating the single WDR **1100** oust prior to block **290** such that incoming blocks to block **290** go to new block **289**, and new block **289** continues to block **290**).

With reference now to FIG. **2**E, depicted is a flowchart for describing a preferred embodiment of an MS whereabouts update event of an antenna in-range detected MS, for example a DLM **200**, when MS location awareness is monitored by the MS. FIG. **2**E describes relevant processing for MSs to maintain their own whereabouts. Processing begins at block **250** when the MS receives a signal from an antenna (or cell tower) deserving a response and continues to block **252** where the antenna or cell tower signal is authenticated by the MS as being a legitimate signal for processing. The signal can be received for processing by blocks **250** through **264** as the result of a continuous, or pulsed, broadcast or beaconing by the antenna, or cell tower (FIG. **13**C), or as part of usual communication protocol in progress with at least one MS (FIG. **13**C usual data **1312** is **5** with embedded Communications Key **1314**), or as a response via antenna to a previous MS signal (FIG. **13**A). The signal is preferably authenticated by a data parsed signature deserving further processing. Block **252** continues to block **254** where the MS sends an outbound request for soliciting an immediate response from the antenna (or cell tower) service. The request by the MS is appropriately correlated (e.g. as described above) for a response, which additionally facilitates embodiments using TDOA measurements (time of communications between the MS and antenna, or cell tower) to determine how close is the MS in range. Block **254** waits for a response, or waits until a reasonable timeout, whichever occurs first. There are also multithreaded embodiments to breaking up FIG. **2**E where block **254** does not wait, but rather terminates FIG. **2**E processing and depends on another thread to correlate the response and then continue processing blocks **256** through **260** (like architecture **1900**).

Thereafter, if block **256** determines the request timed out, then processing terminates at block **264**. If block **256** determines the response was received, then processing continues to block **258**. Block **258** completes a WDR **1100** with appropriate response data received along with data set by the MS. See FIG. **11**A descriptions. Fields are set to the following upon exit from block **258**:

MS ID field **1100***a* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

DATE/TIME STAMP field **1100***b* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

LOCATION field **1100***c* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

CONFIDENCE field **1100***d* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

LOCATION TECHNOLOGY field **1100***e* is preferably set with: "Client Antenna Range" for an antenna detecting the MS, and is set to "Client Cell Range" for a cell tower detecting the MS. The originator indicator is set to DLM.

LOCATION REFERENCE INFO field **1100***f* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

COMMUNICATIONS REFERENCE INFO field **1100***g* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

SPEED field **1100***h* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

HEADING field **1100***i* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

ELEVATION field **1100***j* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

APPLICATION FIELDS field **1100***k* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

CORRELATION FIELD **1100***m* is preferably set with: Not Applicable (i.e. not maintained to queue **22**).

SENT DATE/TIME STAMP field **1100***n* is preferably set with: Not Applicable (i.e. not maintained to queue **22**).

RECEIVED DATE/TIME STAMP field **1100***p* is preferably set with: Not Applicable (i.e. not maintained to queue **22**).

The longer time it takes between sending a request and getting a response at block **254**, the less confidence there is for being located because the MS must be a larger distance from the antenna or cell tower. The less time it takes, the more confidence there is for being located because the MS must be a closer distance to the antenna or cell tower. Confidence values are analogously determined as described for FIG. **2**D. FIG. **2**D NTP embodiments also apply here. NTP can be used so no bidirectional communications is required for TDOA measurement. In this embodiment, the antenna (or cell tower) sets a NTP date/time stamp in the pulse, beacon, or protocol. Upon receipt, the MS instantly knows how long the packet took to be received by comparing the NTP date/time stamp in the packet and a MS NTP date/time stamp of when it was received (i.e. no request/response pair required). If location

information is also present with the NTP date/time stamp in data received at block **252**, then block **252** can continue directly to block **258**.

An alternate MS embodiment determines its own (direction) heading and/or speed for WDR completion based on historical records maintained to the WDR queue **22** and/or LBX history **30**.

Block **258** continues to block **260** for preparing parameters for: WDRREF=a reference or pointer to the WDR; DELETEQ=FIG. **2**E location queue discard processing; and SUPER=FIG. **2**E supervisory notification processing. Thereafter, block **262** invokes the procedure (FIG. **2**F processing) to insert the WDR to queue **22**. After FIG. **2**F processing of block **262**, FIG. **2**E processing terminates at block **264**.

In alternative "coming within range" (same as "in range", "in-range", "within range") embodiments, a unique MS identifier, or MS group identifier, for authenticating an MS for locating the MS is not necessary. An antenna emitting signals (FIG. **13**C) will broadcast (in CK **1314** of data **1312**) not only its own location information (e.g. location field **1100***c*), but also an NTP indicated date/time stamp field **1100***b*, which the receiving MS (also having NTP for time synchronization) uses to perform a TDOA measurement upon receipt. This will enable a MS to determine at least how close (e.g. radius **1318** range, radius **1320** range, radius **1322** range, or radius **1316** range) it is located to the location of the antenna by listening for and receiving the broadcast (e.g. of FIG. **13**C). Similarly, in another embodiment, an NTP synchronized MS emits signals (FIG. **13**A) and an NTP synchronized data processing system associated with a receiving antenna can make a TDOA measurement upon signal receipt. In other embodiments, more than a single unidirectional signal may be used while still preventing the requirement to recognize the MS to locate it. For example, an antenna emitting signals (e.g. FIG. **13**C hotspot WiFi 802.x) will contain enough information for a MS to respond with correlation for being located, and visa-versa. In any case, there can be multi-directional exchanged signals for determining a TDOA measurement.

FIG. **3**A depicts a locating by triangulation illustration for discussing automatic location of a MS, for example DLM **200**. DLM **200** is located through triangulation, as is well known in the art. At least three base towers, for example, base tower **108***b*, base tower **108***d*, and base tower **108***f*, are used for locating the MS. A fourth base tower may be used if elevation (or altitude) was configured for use in locating DLM **200**. There are cases where only two base towers are necessary given routes of travel are limited and known, for example, in spread out roadways or limited configured locations. Base towers may also be antennas **108***b*, **108***d*, and **108***f* in similar triangulation embodiments.

FIG. **3**B depicts a flowchart for describing a preferred embodiment of the whereabouts update event of a triangulated MS, for example DLM **200**, when MS location awareness is monitored by some remote service. While FIG. **3**A location determination with TDOA and AOA is well known in the art, FIGS. **3**B and **3**C include relevant processing for MSs to maintain their own whereabouts. Processing begins at block **310** and continues to block **312** where base stations able to communicate to any degree with a MS continue reporting to their controller the MS signal strength with an MS identifier (i.e. a unique handle) and Time Difference of Arrival (TDOA) information, Angle of Arrival (AOA) information, or heterogeneously both TDOA and AOA (i.e. MPT), depending on the embodiment. The MS can pick signals from base stations. In some embodiments, the MS monitors a paging channel, called a forward channel. There can be multiple forward channels. A forward channel is the transmission frequency from the base tower to the MS. Either the MS provides broadcast heartbeats (FIG. **13**A) for base stations, or the base stations provide heartbeats (FIG. **13**C) for a response from the MS, or usual MS use protocol signals are detected and used (incorporating CK **1304** in usual data **1302** by MS, or CK **1314** in "usual data" **1312** by service). Usual data is the usual communications traffic data in carrying out other character **32** processing. Communication from the MS to the base tower is on what is called the reverse channel. Forward channels and reverse channel are used to perform call setup for a created session channel.

TDOA is calculated from the time it takes for a communication to occur from the MS back to the MS via the base tower, or alternatively, from a base tower back to that base tower via the MS. NTP may also be used for time calculations in a unidirectional broadcast from a base tower (FIG. **13**C) to the MS, or from the MS (FIG. **13**A) to a base tower (as described above). AOA is performed through calculations of the angle by which a signal from the MS encounters the antenna. Triangle geometry is then used to calculate a location. The AOA antenna is typically of a phased array type.

See "Missing Part Triangulation (MPT)" section below with discussions for FIGS. **11**A through **11**E for details on heterogeneously locating the MS using both TDOA and AOA (i.e. Missing Part Triangulation (MPT)). Just as high school taught geometry for solving missing parts of a triangle, so to does MPT triangulate an MS location. Think of the length of a side of a triangle as a TDOA measurement—i.e. length of time, translatable to a distance. Think of the AOA of a signal to an antenna as one of the angles of a triangle vertice. Solving with MPT analogously uses geometric and trigonometric formulas to solve the triangulation, albeit at fast processing speeds.

Thereafter, if the MS is determined to be legitimate and deserving of processing (similar to above), then block **314** continues to block **316**. If block **314** determines the MS is not participating with the service, in which case block **312** did little to process it, then processing continues back to block **312** to continue working on behalf of legitimate participating MSs. The controller at block **316** may communicate with other controllers when base stations in other cellular clusters are picking up a signal, for example, when the MS roams. In any case, at block **316**, the controller(s) determines the strongest signal base stations needed for locating the MS, at block **316**. The strongest signals that can accomplish whereabouts information of the MS are used. Thereafter, block **318** accesses base station location information for base stations determined at block **316**. The base station provides stationary references used to (relatively) determine the location of the MS. Then, block **320** uses the TDOA, or AOA, or MPT (i.e. heterogeneously both AOA and TDOA) information together with known base station locations to calculate the MS location.

Thereafter, block **322** accesses historical MS location information, and block **324** performs housekeeping by pruning location history data for the MS by time, number of entries, or other criteria. Block **326** then determines a heading (direction) of the MS based on previous location information. Block **326** may perform Artificial Intelligence (Al) to determine where the MS may be going by consulting many or all of the location history data. Thereafter, block **328** completes a service side WDR **1100**, block **330** appends the WDR information to location history data and notifies a supervisory service if there is one outside of the service processing of FIG. **3**B. Processing continues to block **332** where the service communicates the WDR to the located MS.

Thereafter, the MS completes its own WDR at block **334** for adding to WDR queue **22** to know its own whereabouts whenever possible, and block **336** prepares parameters for invoking WDR insertion processing at block **338**. Parameters are set for: WDRREF=a reference or pointer to the MS WDR; DELETEQ=FIG. **3**B location queue discard processing; and SUPER=FIG. **3**B supervisory notification processing (e.g. no supervisory notification processing because it was already handled at block **330**, or by being in context of the FIG. **3**B service processing). At block **338**, the MS invokes FIG. **2**F processing already described. After block **338**, processing continues back to block **312**. Of course, block **332** continues directly to block **312** at the service(s) since there is no need to wait for MS(s) processing in blocks **334** through **338**. FIG. **3**B processing is continuous for every MS in the wireless network 7 days a week, 24 hours a day.

See FIG. **11**A descriptions. Fields are set to the following upon exit from block **334**:

MS ID field **1100***a* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

DATE/TIME STAMP field **1100***b* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

LOCATION field **1100***c* is preferably set with: The triangulated location of the MS as communicated by the service.

CONFIDENCE field **1100***d* is preferably set with: Confidence of triangulation determined by the service which is passed to the MS at block **332**. The confidence value may be set with the same value (e.g. 85) regardless of how the MS was triangulated. In other embodiments, field **1100***d* will be determined (completely, or adjusting the value of 85) by the service for TDOA measurements used, AOA measurements, signal strengths, wave spectrum involved, and/or the abundance of particular MS signals available for processing by blocks **312** through **320**. Higher confidences are assigned for smaller TDOA measurements (shorter distances), strong signal strengths, and numerous additional data points beyond what is necessary to locate the MS. Lower confidences are assigned for larger TDOA measurements, weak signal strengths, and minimal data points necessary to locate the MS. A reasonable confidence can be assigned using this information as guidelines where 1 is the lowest confidence and 100 is the highest confidence.

LOCATION TECHNOLOGY field **1100***e* is preferably set with: "Server Cell TDOA", "Server Cell AOA", "Server Cell MPT", "Server Antenna TDOA", "Server Antenna AOA", or "Server Antenna MPT", depending on how the MS was located and what flavor of service was used. The originator indicator is set to DLM.

LOCATION REFERENCE INFO field **1100***f* is preferably set with: null (not set) for indicating that all triangulation data was factored into determining confidence, and none is relevant for a single TDOA or AOA measurement in subsequent processing (i.e. service did all the work).

COMMUNICATIONS REFERENCE INFO field **1100***g* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

SPEED field **1100***h* is preferably set with: Service WDR information at block **332**, wherein the service used historical information and artificial intelligence interrogation of MS travels to determine, if available.

HEADING field **1100***i* is preferably set with: Service WDR information at block **332**, wherein the service used historical information and artificial intelligence interrogation of MS travels to determine, if available.

ELEVATION field **1100***j* is preferably set with: Elevation/altitude, if available.

APPLICATION FIELDS field **1100***k* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

CORRELATION FIELD **1100***m* is preferably set with: Not Applicable (i.e. not maintained to queue **22**).

SENT DATE/TIME STAMP field **1100***n* is preferably set with: Not Applicable (i.e. not maintained to queue **22**).

RECEIVED DATE/TIME STAMP field **1100***p* is preferably set with: Not Applicable (i.e. not maintained to queue **22**).

FIG. **3**C depicts a flowchart for describing a preferred embodiment of the whereabouts update event of a triangulated MS, for example a DLM **200**, when MS location awareness is monitored by the MS. Communications between the base stations and MS is similar to FIG. **3**B processing except the MS receives information (FIG. **13**C) for performing calculations and related processing. Processing begins at block **350** and continues to block **352** where the MS continues receiving (FIG. **13**C) pulse reporting from base stations (or antennas). AOA, TDOA, and MPT (See "Missing Part Triangulation (MPT)" section below with discussions for FIGS. **11**A through **11**E for details on heterogeneously locating the MS using both TDOA and AOA) can be used to locate the MS, so there are many possible signal types received at block **352**. Then, block **354** determines the strongest signals which can accomplish a completed WDR, or at least a location, of the MS. Thereafter, block **356** parses base station location information from the pulse messages that are received by the MS. Block **358** communicates with base stations to perform TDOA and/or AOA measurements and calculations. The time it takes for a communication to occur from the MS back to the MS for TDOA, or alternatively, from a base tower back to that base tower can be used. NTP may also be used, as described above, so that base towers (or antennas) broadcast signals (FIG. **13**C) picked up by the MS which already contain the base tower locations and NTP date/time stamps for TDOA calculations. Block **358** uses the TDOA and/or AOA information with the known base station information to determine the MS location. While AOA information from the base stations (or antennas) is used by the MS, various MS embodiments can use AOA information detected at an MS antenna provided the heading, yaw, pitch, and roll is known at the MS during the same time as signal reception by the MS. A 3-axis accelerometer (e.g. in iPhone) may also provide yaw, pitch and roll means for proper AOA calculation.

Thereafter, block **360** accesses historical MS location information (e.g. WDR queue **22** and/or LBX history **30**) to prevent redundant information kept at the MS, and block **362** performs housekeeping by pruning the LBX history **30** for the MS by time, number of entries, or other criteria. Block **364** then determines a heading (direction) of the MS based on previous location information (unless already known from block **358** for AOA determination). Block **364** may perform Artificial Intelligence (AI) to determine where the MS may be going by consulting queue **22** and/or history **30**. Thereafter, block **366** completes a WDR **1100**, and block **368** prepares parameters for FIG. **2**F processing: WDRREF=a reference or pointer to the MS WDR; DELETEQ=FIG. **3**C location queue discard processing; and SUPER=FIG. **3**B supervisory notification processing. Block **368** continues to block **370** for invoking FIG. **2**F processing already described above. After block **370**, processing continues back to block **352**. FIG. **3**C processing is continuous for the MS as long as the MS is enabled. In various multithreaded embodiments, many threads at the MS work together for high speed processing at blocks **352** through **358** for concurrently communicating to many stationary references.

See FIG. **11**A descriptions. Fields are set to the following upon exit from block **366**:

MS ID field **1100***a* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

DATE/TIME STAMP field **1100***b* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

LOCATION field **1100***c* is preferably set with: The triangulated location of the MS as determined by the MS.

CONFIDENCE field **1100***d* is preferably set with: The confidence of triangulation as determined by the MS. Confidence may be set with the same value (e.g. 80 since MS may be moving during triangulation) regardless of how the MS was triangulated. In other embodiments, field **1100***d* will be determined (completely, or adjusting the value of 80) by the MS for TDOA measurements used, AOA measurements, signal strengths, wave spectrum involved, and/or the abundance of particular service signals available for processing. Higher confidences are assigned for smaller TDOA measurements (shorter distances), strong signal strengths, and numerous additional data points beyond what is necessary to locate the MS. Lower confidences are assigned for larger TDOA measurements, weak signal strengths, and minimal data points necessary to locate the MS. A reasonable confidence can be assigned using this information as guidelines where 1 is the lowest confidence and 100 is the highest confidence.

LOCATION TECHNOLOGY field **1100***e* is preferably set with: "Client Cell TDOA", "Client Cell AOA", "Client Cell MPT", "Client Antenna TDOA", "Client Antenna AOA", or "Client Antenna MPT", depending on how the MS located itself. The originator indicator is set to DLM.

LOCATION REFERENCE INFO field **1100***f* is preferably set with: Data associated with selected best stationary reference(s) used by the MS: the selection location/whereabouts, TDOA measurement to it, and wave spectrum (and/or particular communications interface **70**) used, if reasonable. The TDOA measurement may be converted to a distance using wave spectrum information. Also, preferably set herein is data associated with a selected best stationary reference used by the MS (may be same or different than for TDOA measurement): the selection location, AOA measurement to it, and heading, yaw, pitch, and roll values (or accelerometer readings), if reasonable. Values that may be populated here should have already been factored into the confidence value. There may be one or more stationary reference whereabouts with useful measurements maintained here for FIG. **26**B processing of block **2652**.

COMMUNICATIONS REFERENCE INFO field **1100***g* is preferably set with: Parameters referencing MS internals, if desired.

SPEED field **1100***h* is preferably set with: Speed determined by the MS using historical information (queue **22** and/or history **30**) and artificial intelligence interrogation of MS travels to determine, if reasonable.

HEADING field **1100***i* is preferably set with: Heading determined by the MS using historical information (queue **22** and/or history **30**) and artificial intelligence interrogation of MS travels to determine, if reasonable.

ELEVATION field **1100***j* is preferably set with: Elevation/altitude, if available.

APPLICATION FIELDS field **1100***k* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

CORRELATION FIELD **1100***m* is preferably set with: Not Applicable (i.e. not maintained to queue **22**).

SENT DATE/TIME STAMP field **1100***n* is preferably set with: Not Applicable (i.e. not maintained to queue **22**).

RECEIVED DATE/TIME STAMP field **1100***p* is preferably set with: Not Applicable (i.e. not maintained to queue **22**).

In alternative triangulation embodiments, a unique MS identifier, or MS group identifier, for authenticating an MS for locating the MS is not necessary. An antenna emitting signals (FIG. **13**C) will broadcast (CK **1314** of data **1312**) not only its own location information, but also an NTP date/time stamp, which the receiving MS (also having NTP for time synchronization) uses to perform TDOA measurements upon receipt. This will enable a MS to determine how close (e.g. radius **1318** range, radius **1320** range, radius **1322** range, or radius **1316** range) it is located to the location of the antenna by listening for and receiving the broadcast (e.g. of FIG. **13**C). Similarly, in another embodiment, an NTP synchronized MS emits signals (FIG. **13**A) and an NTP synchronized data processing system associated with a receiving antenna can determine a TDOA measurement upon signal receipt. In other embodiments, more than a single unidirectional signal may be used while still preventing the requirement to recognize the MS to locate it. For example, an antenna emitting signals will contain enough information for a MS to respond with correlation for being located. Alternatively, an MS emitting signals will contain enough information for a service to respond with correlation for being located. In any case, there can be multi-directional exchanged signals for determining TDOA. Similarly, a service side data processing system can interact with a MS for AOA information without requiring a known identifier of the MS (use request/response correlation).

FIG. **4**A depicts a locating by GPS triangulation illustration for discussing automatic location of a MS, for example a DLM **200**. A MS, for example DLM **200**, is located through GPS triangulation as is well known in the art. At least three satellites, for example, satellite **134**, satellite **136**, and satellite **138**, are necessary for locating the MS. A fourth satellite would be used if elevation, or altitude, was configured for use by the present disclosure. Ground based stationary references can further enhance whereabouts determination.

FIG. **4**B depicts a flowchart for describing a preferred embodiment of the whereabouts update event of a GPS triangulated MS, for example a DLM **200**. Repeated continuous GPS location processing begins at block **410** and continues to block **412** where the MS initializes to the GPS interface, then to block **414** for performing the conventional locating of the GPS enabled MS, and then to block **416** for calculating location information. In some embodiments, block **412** may only be necessary a first time prior to repeated invocations of FIG. **4**B processing. Block **414** may be an implicit wait for pulses from satellites, or an event driven mechanism when GPS satellite pulses are received for synchronized collection, or a multithreaded implementation concurrently listening for, and processing collaboratively, the signals. Block **414** and block **416** processing is well known in the art. Thereafter, the MS completes a WDR **1100** at block **418**, block **420** prepares parameters for FIG. **2**F invocation, and block **422** invokes, with the WDR, the FIG. **2**F processing (described above). Processing then terminates at block **424**. Parameters prepared at block **420** are: WDRREF=a reference or pointer to the WDR; DELETEQ=FIG. **4**B location queue discard processing; and SUPER=FIG. **4**B supervisory notification processing. GPS location processing is preferably continuous for the MS as long as the MS is enabled.

See FIG. **11**A descriptions. Fields are set to the following upon exit from block **418**:

MS ID field **1100***a* is preferably set with: Same, as was described for FIG. **2**D (block **236**) above.

DATE/TIME STAMP field **1100***b* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

LOCATION field **1100***c* is preferably set with: The GPS location of the MS.

CONFIDENCE field **1100***d* is preferably set with: Confidence of GPS variety (usually high) which may be set with the same value (e.g. 95 for DGPS, 93 for AGPS, and 90 for GPS).

In other embodiments, field **1100***d* will be determined (completely, or amending the defaulted value) by the MS for timing measurements, signal strengths, and/or the abundance of particular signals available for processing, similarly to as described above. An MS may not be aware of the variety of GPS, in which case straight GPS is assumed.

LOCATION TECHNOLOGY field **1100***e* is preferably set with: "GPS", "A-GPS", or "D-GPS", depending on (if known) flavor of GPS. The originator indicator is set to DLM.

LOCATION REFERENCE INFO field **1100***f* is preferably set with: null (not set) for indicating that data was factored into determining confidence, and none is relevant for a single TDOA or AOA measurement in subsequent processing.

COMMUNICATIONS REFERENCE INFO field **1100***g* is preferably set with: Parameters referencing MS internals, if desired.

SPEED field **1100***h* is preferably set with: Speed determined by the MS using a suitable GPS interface, or historical information (queue **22** and/or history **30**) and artificial intelligence interrogation of MS travels to determine, if reasonable.

HEADING field **1100***i* is preferably set with: Heading determined by the MS using a suitable GPS interface, or historical information (queue **22** and/or history **30**) and artificial intelligence interrogation of MS travels to determine, if reasonable.

ELEVATION field **1100***j* is preferably set with: Elevation/altitude, if available.

APPLICATION FIELDS field **1100***k* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

CORRELATION FIELD **1100***m* is preferably set with: Not Applicable (i.e. not maintained to queue **22**).

SENT DATE/TIME STAMP field **1100***n* is preferably set with: Not Applicable (i.e. not maintained to queue **22**).

RECEIVED DATE/TIME STAMP field **1100***p* is preferably set with: Not Applicable (i.e. not maintained to queue **22**).

FIG. **5**A depicts a locating by stationary antenna triangulation illustration for discussing automatic location of a MS, for example DLM **200**. There may be communication/transmission issues when an MS is taken indoors. Shown is a top view of an indoor floor plan **502**. Antenna stations **504** (shown generally as **504**) are strategically placed over the area so that an MS can be located. Triangulation techniques again apply. At least three antenna stations, for example, station **504***f*, station **504***h*, and station **504***i* are used to locate the MS, for example DLM **200**. In floor plan embodiments where aisles delimit travel, only two antenna stations may be necessary, for example at either end of the particular aisle. While most stations **504** may receive signals from the MS, only the strongest stations are used. FIG. **5**A and associated discussions can also be used for an outside triangulation embodiment using a similar strategic antenna placement scheme. Processing described for FIGS. **3**A to **3**C can also be used for an indoor embodiment as described by FIG. **5**A.

FIG. **5**B depicts a flowchart for describing a preferred embodiment of the whereabouts update event of a stationary antenna triangulated MS, for example a DLM **200**. In one embodiment, indoor location technology of Pinpoint corporation (Pinpoint is a trademark of Pinpoint Corporation) is utilized to locate any MS that moves about the indoor location. The Pinpoint corporation methodology begins at block **510** and continues to block **512**. A cell controller drives antenna stations to emit a broadcast signal from every station. Any MS within range (i.e. indoors) will phase modulate its unique identifier onto a return signal it transmits, at block **514**. Stations at block **516** receive the transmission and strength of signal. The cell controller that drives stations sorts out and selects the strongest (e.g. 3) signals. The cell controller, at block **518**, also extracts the unique MS identifier from the return signal, and TDOA is used to calculate distances from the stations receiving the strongest signals from the MS at block **520**. Alternative embodiments can use AOA or MPT to determine locations. The locations of the controller selected stations are registered in an overlay map in an appropriate coordinate system, landmark system, or grid of cells. Block **522** locates the MS using the overlay map, locations of the (e.g. 3) selected stations, and the calculated distances triangulated from the selected stations, using TDOA, AOA, or MPT in various embodiments. Thereafter, block **524** calculates location information of the MS. Processing continues with repeated broadcast at block **512** and subsequent processing for every MS within range.

Thereafter, block **526** accesses historical MS location information, performs housekeeping by pruning location history data for the MS by time, number of entries, or other criteria, and determines a heading (direction) of the MS based on previous-location information. Block **526** may perform Artificial Intelligence (Al) to determine where the MS may be going by consulting many or all of the location history data. Thereafter, block **528** completes a service side WDR **1100**, block **530** appends the WDR information to location history data and notifies a supervisory service if there is one outside of the service processing of FIG. **5**B. Processing continues to block **532** where the service communicates the WDR to the located MS.

Thereafter, the MS completes the WDR at block **534** for adding to WDR queue **22**. Thereafter, block **536** prepares parameters passed to FIG. **2**F processing for: WDRREF=a reference or pointer to the MS WDR; DELETEQ=FIG. **5**B location queue discard processing; and SUPER=FIG. **5**B supervisory notification processing (e.g. no supervisory notification processing because it was already handled at block **530**, or by being in context of the FIG. **5**B service processing). Block **536** continues to block **538** where the MS invokes FIG. **2**F processing already described above. After block **538**, processing continues back to block **514**. Of course, block **532** continues directly to block **514** at the service(s) since there is no need to wait for MS(s) processing in blocks **534** through **538**. FIG. **5**B processing is continuous for every MS in the wireless network 7 days a week, 24 hours a day.

See FIG. **11**A descriptions. Fields are set to the following upon exit from block **534**:

MS ID field **1100***a* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

DATE/TIME STAMP field **1100***b* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

LOCATION field **1100***c* is preferably set with: The triangulated location of the MS as communicated by the service.

CONFIDENCE field **1100***d* is preferably set with: Confidence of triangulation determined by the service which is passed to the MS at block **532**. The confidence value may be set with the same value (e.g. 95 (normally high for triangulation using densely positioned antennas)) regardless of how the MS was triangulated. In other embodiments, field **1100***d* will be determined (completely, or adjusting the value of 95) by the service for TDOA mea-

surements used, AOA measurements, signal strengths, wave spectrum involved, and/or the abundance of particular MS signals available for processing. Higher confidences are assigned for smaller TDOA measurements (shorter distances), strong signal strengths, and numerous additional data points beyond what is necessary to locate the MS. Lower confidences are assigned for larger TDOA measurements, weak signal strengths, and minimal data points necessary to locate the MS. A reasonable confidence can be assigned using this information as guidelines where 1 is the lowest confidence and 100 is the highest confidence.

LOCATION TECHNOLOGY field **1100***e* is preferably set with: "Server Antenna TDOA", "Server Antenna AOA", or "Server Antenna MPT", depending on how the MS was located and what flavor of service was used. The originator indicator is set to DLM.

LOCATION REFERENCE INFO field **1100***f* is preferably set with: null (not set) for indicating that all triangulation data was factored into determining confidence, and none is relevant for a single TDOA or AOA measurement in subsequent processing (i.e. service did all the work).

COMMUNICATIONS REFERENCE INFO field **1100***g* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

SPEED field **1100***h* is preferably set with: Service WDR information at block **532**, wherein the service used historical information and artificial intelligence interrogation of MS travels to determine, if available.

HEADING field **1100***i* is preferably set with: Service WDR information at block **532**, wherein the service used historical information and artificial intelligence interrogation of MS travels to determine, if available.

ELEVATION field **1100***j* is preferably set with: Elevation/altitude, if available.

APPLICATION FIELDS field **1100***k* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

CORRELATION FIELD **1100***m* is preferably set with: Not Applicable (i.e. not maintained to queue **22**).

SENT DATE/TIME STAMP field **1100***n* is preferably set with: Not Applicable (i.e. not maintained to queue **22**).

RECEIVED DATE/TIME STAMP field **1100***p* is preferably set with: Not Applicable (i.e. not maintained to queue **22**).

FIG. **6**A depicts a flowchart for describing a preferred embodiment of a service whereabouts update event of a physically, or logically, connected MS, for example a DLM **200**. A MS may be newly located and physically, or logically, connected, whereby communications between the MS and service is over a physical/logical connection. Physical connections may occur by connecting a conduit for communications to the MS, or from the MS to a connection point. Conduits include ethernet cables, optical fiber, firewire, USB, or any other means for conduit for communications through a physical medium. Conduits also include wireless mediums (air) for transporting communications, such as when an MS comes into physical wireless range eligible for sending and receiving communications. Logical connections may occur, after a physical connection already exists, for example through a successful communication, or authenticated, bind between a MS and other MS, or MS and service. Logical connections also include the result of: successfully logging into an application, successfully authenticated for access to some resource, successfully identified by an application, or any other logical status upon a MS being certified, registered, signed in, authenticated, bound, recognized, affirmed, or the like.

Relevant processing begins at block **602** and continues to block **604** where an MS device is physically/logically connected to a network. Thereafter, the MS accesses a service at block **606**. Then, at block **608**, the service accesses historical MS location history, and block **610** performs housekeeping by pruning the location history data maintained for the MS by time, number of entries, or other criteria. Block **610** may perform Artificial Intelligence (Al) to determine where the MS may be going (e.g. using heading based on previous locations) by consulting much or all of the location history data. Thereafter, service processing at block **612** completes a service side WDR **1100**, then the service appends WDR information to location history data at block **614**, and may notify a supervisory service if there is one outside of the service processing of FIG. **6**A. Processing continues to block **616** where the service communicates WDR information to the newly physically/logically connected MS. There are many embodiments for determining a newly connected MS location using a physical or logical address, for example consulting a database which maps locations to network addresses (e.g. location to logical ip address; location to physical wall jack/port; etc). Then, at block **618** the MS completes its own WDR using some information from block **616**, FIG. **2**F parameters are prepared at block **620**, block **622** invokes FIG. **2**F processing already described above, and processing terminates at block **624**. Parameters are set at block **620** for: WDRREF=a reference or pointer to the MS WDR; DELETEQ=FIG. **6**A location queue discard processing; and SUPER=FIG. **6**A supervisory notification processing (e.g. no supervisory notification processing because it was already handled at block **614**, or by being in context of the FIG. **6**A service processing). Of course, block **616** continues directly to block **624** at the service(s) since there is no need to wait for MS processing in blocks **618** through **622**. FIG. **6**A processing is available at any appropriate time in accordance with the underlying service.

See FIG. **11**A descriptions. Fields are set to the following upon exit from block **618**:

MS ID field **1100***a* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

DATE/TIME STAMP field **1100***b* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

LOCATION field **1100***c* is preferably set with: The location of the MS as communicated by the service.

CONFIDENCE field **1100***d* is preferably set with: Confidence (determined by the service) according to how the MS was connected, or may be set with the same value (e.g. 100 for physical connect, 77 for logical connect (e.g. short range wireless)) regardless of how the MS was located. In other embodiments, field **1100***d* will be determined by the service for anticipated physical conduit range, wireless logical connect range, etc. The resulting confidence value can be adjusted based on other parameters analogously to as described above.

LOCATION TECHNOLOGY field **1100***e* is preferably set with "Service Physical Connect" or "Service Logical Connect", depending on how the MS connected. The originator indicator is set to DLM.

LOCATION REFERENCE INFO field **1100***f* is preferably set with: null (not set), but if a TDOA measurement can be made (e.g. short range logical connect, and using methodologies described above), then a TDOA measurement, a communications signal strength, if available; and wave spectrum (and/or particular communications interface **70**) used, if available. The TDOA measurement may be converted to a distance using wave spectrum information. Pos-

sible values populated here should have already been factored into the confidence value.

COMMUNICATIONS REFERENCE INFO field **1100***g* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

SPEED field **1100***h* is preferably set with: null (not set), but can be set with speed required to arrive to the current location from a previously known location, assuming same time scale is used.

HEADING field **1100***i* is preferably set with: null (not set), but can be set to heading determined when arriving to the current location from a previously known location.

ELEVATION field **1100***j* is preferably set with: Elevation/altitude (e.g. of physical connection, or place of logical connection detection), if available.

APPLICATION FIELDS field **1100***k* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

CORRELATION FIELD **1100***m* is preferably set with: Not Applicable (i.e. not maintained to queue **22**).

SENT DATE/TIME STAMP field **1100***n* is preferably set with: Not Applicable (i.e. not maintained to queue **22**).

RECEIVED DATE/TIME STAMP field **1100***p* is preferably set with: Not Applicable (i.e. not maintained to queue **22**).

FIG. **6**B depicts a flowchart for describing a preferred embodiment of a MS whereabouts update event of a physically, or logically, connected MS, for example a DLM **200**. A MS may be newly located and physically/logically connected, whereby communications between the MS and service is over a physical/logical connection as described in FIG. **6**A above. Relevant processing begins at block **640** and continues to block **642** where an MS device is physically/logically connected. Thereafter, at block **644** the MS accesses the connectivity service and waits for an acknowledgement indicating a successful connection. Upon acknowledgement receipt, processing continues to block **646** where the MS requests WDR information via the connectivity service and waits for the data (i.e. connectivity service may be different than the location service, or may be one in the same). As part of connectivity, location service pointer(s) (e.g. ip address for http://112.34.323.18 referencing or a Domain Name Service (DNS) name like http://www.servicename.com) are provided with the connectivity acknowledgement from the connectivity service at block **644**, so the MS knows how to proceed at block **646** for retrieving location information. There are various embodiments for the location service determining a MS location as described above-for FIG. **6**A. In an alternative embodiment, the MS already knows how to locate itself wherein block **644** continues directly to block **648** (no block **646**) because the MS maintains information for determining its own whereabouts using the physical or logical address received in the acknowledgement at block **644**. Similar mapping of a network address to the MS location can be in MS data, for example data **36**, data **8**, or data **20**. At block **648**, the MS completes its WDR **1100**. Thereafter, block **650** prepares FIG. **2**F parameters, block **652** invokes FIG. **2**F processing already described above, and processing terminates at block **654**. Parameters set at block **650** are: WDRREF=a reference or pointer to the MS WDR; DELETEQ=FIG. **6**B location queue discard processing; and SUPER=FIG. **6**B supervisory notification processing. FIG. **6**B processing is available at any appropriate time to the MS.

See FIG. **11**A descriptions. Fields are set to the following upon exit from block **648**:

MS ID field **1100***a* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

DATE/TIME STAMP field **1100***b* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

LOCATION field **1100***c* is preferably set with: The location determined for the MS.

CONFIDENCE field **1100***d* is preferably set with: Confidence (determined by the service) according to how the MS was connected, or may be set with the same value (e.g. 100 for physical connect, 77 for logical connect (e.g. short range wireless)) regardless of how the MS was located. In other embodiments, field **1100***d* will be determined by the service for anticipated physical conduit range, wireless logical connect range, etc. The resulting confidence value can be adjusted based on other parameters analogously to as described above.

LOCATION TECHNOLOGY field **1100***e* is preferably set with "Client Physical Connect" or "Client Logical Connect", depending on how the MS connected. The originator indicator is set to DLM.

LOCATION REFERENCE INFO field **1100***f* is preferably set with: null (not set), but if a TDOA measurement can be made (e.g. short range logical connect, and using methodologies described above), then a TDOA measurement, a communications signal strength, if available; and wave spectrum (and/or particular communications interface **70**) used:, if available. The TDOA measurement may be converted to a distance using wave spectrum information. Possible values populated here should have already been factored into the confidence value.

COMMUNICATIONS REFERENCE INFO field **1100***g* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

SPEED field **1100***h* is preferably set with: null (not set), but can be set with speed required to arrive to the current location from a previously known location using, assuming same time scale is used.

HEADING field **1100***i* is preferably set with: null (not set), but can be set to heading determined when arriving to the current location from a previously known location.

ELEVATION field **1100***j* is preferably set with: Elevation/altitude (e.g. of physical connection, or place of logical connection detection), if available.

APPLICATION FIELDS field **1100***k* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

CORRELATION FIELD **1100***m* is preferably set with: Not Applicable (i.e. not maintained to queue **22**).

SENT DATE/TIME STAMP field **1100***n* is preferably set with: Not Applicable (i.e. not maintained to queue **22**).

RECEIVED DATE/TIME STAMP field **1100***p* is preferably set with: Not Applicable (i.e. not maintained to queue **22**).

FIGS. **7**A, **7**B and **7**C depict a locating by image sensory illustration for discussing automatic location of a MS, for example a DLM **200**. With reference now to FIG. **7**A, an image capture device **702** is positioned for monitoring MSs that come into the field of view **704** of device **702**. Device **702** may be a camcorder, video camera, image camera that takes at least one snapshot, timely snapshots, or motion/presence detection snapshots, or any other device capable of producing at least a snapshot image at some point in time containing objects in the field of view **704**. In one preferred embodiment, DLM **200** is sensed within the vicinity of device **702**, perhaps by antenna (or cell tower) **701**, prior to being photographed by device **702**. In another embodiment, DLM **200** is sensed by movement within the vicinity of device **702** with well know motion detection means. In yet another embodiment, device **702** periodically or continually records. Device **702** is connected to a locating service **700** for processing as described by FIG. **7**D. Locating service **700** has means for communicating wirelessly to DLM **200**, for example through a connected antenna (or cell tower) **701**. FIG. **7**A illustrates that device

702 participates in pattern recognition for identifying the location of a MS. The MS can have on its exterior a string of characters, serial number, barcode, license plate, graphic symbol(s), textual symbols, combinations thereof, or any other visually perceptible, or graphical, identification **708** that can be recognized optically, or in a photograph. Device **702** is to have graphical/pixel resolution capability matching the requirements for identifying a MS with the sought graphical identification. Graphical identification **708** can be formed on the perceptible exterior of DLM **200**, or can be formed as part of a housing/apparatus **706** which hosts DLM **200**. Graphical identification **708** can be automatically read from an image using well known barcode reader technology, an Optical Character Recognition (OCR) process, a license tag scanner, general pattern recognition software, or the like. Housing **706** is generally shown for representing an automobile (license plate recognition, for example used in prior art toll tag lanes), a shopping cart, a package, or any other hosting article of manufacture which has a DLM **200** as part of it. Upon recognition, DLM **200** is associated with the location of device **702**. Error in locating an MS will depend on the distance within the field of view **704** from device **702**. A distance may be estimated based on the anticipated size of identification **708**, relative its size determined within the field of view **704**.

With reference now to FIG. **7**B, image capture device **702** is positioned for monitoring MSs that come into the field of view **704** of device **702**. MSs are preferably distinguishable by appearance (e.g. color, shape, markings, labels, tags, etc), or as attached (e.g. recognized mount to host) or carried (e.g. recognized by its recognized user). Such techniques are well known to those skilled in the art. Device **702** is as described above with connectivity to locating service **700** and antenna (or cell tower) **701**. FIG. **7**B illustrates that device **702** uses known measurements within its field of view for determining how large, and where located, are objects that come into the field of view **704**. For example, a well placed and recognizable vertical line **710***a* and horizontal line **710***b*, which are preferably perpendicular to each other, have known lengths and positions. The objects which come into the field of view are measured based on the known lengths and positions of the lines **710***a* and **710***b* which may be landscape markings (e.g. parking lot lines) for additional purpose. Field of view **704** may contain many lines and/or objects of known dimensions strategically placed or recognized within the field of view **704** to facilitate image processing by service **700**. Building **714** may serve as a reference point having known dimension and position in measuring objects such as a person **716** or DLM **200**. A moving object such as a shopping cart **712** can have known dimensions, but not a specific position, to facilitate service **700** in locating an MS coming into the field of view **704**. Those skilled in the art recognize that known dimensions and/or locations of anticipated objects in field of view **704** have measurements facilitating discovering positions and measurements of new objects that may travel into the field of view **704**. Using FIG. **7**B techniques with FIG. **7**A techniques provides additional locating accuracy. A distance may be estimated based on the anticipated sizes of references in the field of view, relative size of the recognized MS.

With reference now to FIG. **7**C, image capture device **702** is positioned for monitoring MSs that come into the field of view **704** of device **702**. Device **702** is as described above with connectivity to locating service **700** and antenna (or cell tower) **701**. MSs are preferably distinguishable by appearance (e.g. color, shape, markings, labels, tags, etc), or as attached (e.g. recognized mount to host) or carried (e.g. recognized by its user), or as identified by FIG. **7**A and/or FIG. **7**B methodologies. FIG. **7**C illustrates that device **702** uses known locations within its field of view for determining how large, and where located, are objects that come into the field of view **704**. For example, building **714**, tree **720**, and traffic sign **722** have its locations known in field of view **704** by service **700**. Solving locations of objects that move into the field of view is accomplished with graphical triangulation measurements between known object reference locations (e.g. building **714**, tree **720**, and sign **722**) and the object to be located. Timely snapshots by device **702** provide an ongoing locating of an MS, for example DLM **200**. Line segment distances **724** (*a, b, c*) can be measured using references such as those of FIG. **7**B. Whereabouts are determined by providing known coordinates to anticipated objects such as building **714**, tree **720**, and sign **722**. Similarly, graphical AOA measurements (i.e. graphical angle measurements) and graphical MPT measurements can be used in relation to anticipated locations of objects within the field of view **704**. There may be many anticipated (known) object locations within field of view **704** to further facilitate locating an MS. Being nearby an object may also be enough to locate the MS by using the object's location for the location of the MS. Using FIG. **7**C techniques with FIG. **7**A and/or FIG. **7**B techniques provides additional locating accuracy.

The system and methodologies illustrated by FIGS. **7**A through **7**C are preferably used in optimal combination by locating service **700** to provide a best location of an MS. In some embodiments, MS whereabouts is determined as the location of a device **702** by simply being recognized by the device **702**. In other embodiments, multiple devices **702** can be strategically placed within a geographic area for being used in combination to a common locating service **700** for providing a most accurate whereabouts of an MS. Multiple field of views **704** from difference angles of different devices **702** enable more precise locating within three dimensional space, including precise elevations.

FIG. **7**D depicts a flowchart for describing a preferred embodiment of graphically locating a MS in accordance with locating service **700** described above, for example as illustrated by FIGS. **7**A through **7**C. Locating service **700** may be a single capable data processing system, or many connected data processing systems for enhanced parallel processing. Locating service **700** may be connected to services involved with any other locating technology described in this application for synergistic services as an MS is mobile. Locating service **700** begins at block **732** and continues to block **734** where the service **700** is initialized in preparation of MS whereabouts analysis. Block **734** initializes its table(s) of sought identifying criteria which can be pattern recognized. In one preferred embodiment, color/shade, shape, appearance and applicable sought information is initialized for each sought identifying criteria. Pattern recognition is well known in the art and initialization is specific for each technology discussed above for FIGS. **7**A through **7**C. For FIGS. **7**B and **7**C discussions, positions, measurements, and reference points of known landmarks are additionally accounted. Thereafter, block **736** gets the next snapshot from device(s) **702**. If there is none waiting to get, block **736** waits for one. If there is one queued up for processing, then block **736** continues to block **738**. FIG. **7**D is processing of a service, and is preferably multi-threaded. For example, blocks **736** through **754** can occur concurrently in many threads for processing a common queue of snapshots received from a device **702**, or many devices **702**. Each thread may process all sought criteria, or may specialize in a subset of sought criteria wherein if nothing is found, the thread can place the snapshot back on a queue for thread processing for another sought criteria after

marking the queue entry as having been processed for one particular subset. So, threads may be specialized and work together in seeking all criteria, or may each work in parallel seeking the same criteria. In preferred embodiments, there is at least one queue of snapshots received by block(s) **736**. Block **736** continues to block **738** which attempts to detect an MS having sought criteria using pattern recognition techniques of FIGS. **7**A through **7**C, in particular, or in combination. In one example embodiment, as device **702** provides service **700** with at least one timely snapshot to block **736**, the snapshot graphic is scanned at block **738** for identifying characters/symbols/appearance of sought criteria. Block **738** continues with its search result to block **740**. If block **740** determines no MS was detected, then processing continues back to block **736**. If block **738** detected at least one MS (as determined at block **740**), then block **742** calculates WDR information for the MS(s) detected, block **744** notifies a supervisory service of MS whereabouts if applicable, block **746** communicates the WDR information to MS(s) detected (for example via antenna **701**), and processing continues to block **748**.

There may be a plurality of MSs in the field of view, so communications at block **746** targets each MS recognized. A MS should not rely on the service to have done its job correctly. At a MS, block **748** checks the MS ID communicated for validation. If block **748** determines the MS ID is incorrect, then processing continues back to block **736** (for the particular MS). If block **748** determines the MS ID is correct, then processing continues to block **750** where the particular MS completes its WDR **1100** received from service **700**. Thereafter, MS(s) prepare parameters at block **752**, invoke local FIG. **2**F processing already described above (at block **754**), and processing continues for service **700** back to block **736**. Of course, block **746** continues directly to block **736** at the service(s) since there is no need to wait for MS(s) processing in blocks **748** through **754**. Parameters set at block **752** are: WDRREF=a reference or pointer to the MS WDR; DELETEQ=FIG. **7**D location queue discard processing; and SUPER=FIG. **7**D supervisory notification (e.g. no supervisory notification processing because it was already handled at block **744**, or by being in context of the FIG. **7**D service processing). No snapshots from device **702** are to be missed at block **736**.

See FIG. **11**A descriptions. Fields are set to the following upon exit from block **750**:

MS ID field **1100***a* is preferably set with: Unique MS identifier of the MS, after validating at the MS that the service **700** has correctly identified it. This field is used to uniquely distinguish this MS WDRs on queue **22** from other originated WDRs. The service **700** may determine a MS ID from a database lookup using above appearance criteria. Field **1100***a* may also be determined using the transmission methods as described for FIGS. **2**A through **2**E, for example by way of antenna **701**. For example, when the MS comes within range of antenna **701**, FIG. **7**D processing commences. Another embodiment prevents recognizing more than one MS within the field of view **704** at any time (e.g. a single file entryway), in which case the service can solicit a "who are you" transmission to identify the MS and then send back its whereabouts (in which case the MS sets its own MS ID here).

DATE/TIME STAMP field **1100***b* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

LOCATION field **1100***c* is preferably set with: The location determined for the MS by the service.

CONFIDENCE field **1100***d* is preferably set with: same value (e.g. **76**) regardless of how the MS location was determined. In other embodiments, field **1100***d* will be determined by the number of distance measurements and/or the abundance of particular objects used in the field of view **704**. The resulting confidence value can be adjusted based on other graphical parameters involved, analogously to as described above.

LOCATION TECHNOLOGY field **1100***e* is preferably set with: "Server Graphic-Patterns" "Server Graphic-Distances", "Server Graphic Triangulate", or a combination field value depending on how the MS was located and what flavor of service was used. The originator indicator is set to DLM.

LOCATION REFERENCE INFO field **1100***f* is preferably set with: null (not set) for indicating that all whereabouts determination data was factored into the confidence, and none is relevant for a single TDOA or AOA measurement in subsequent processing (i.e. service did all the work).

COMMUNICATIONS REFERENCE INFO field **1100***g* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

SPEED field **1100***h* is preferably set with: null (not set), but can be set with speed required to arrive to the current location from a previously known time at a location (e.g. using previous snapshots processed), assuming the same time scale is used.

HEADING field **1100***i* is preferably set with: null (not set), but can be set to heading determined when arriving to the current location from a previously known location (e.g. using previous snapshots processed).

ELEVATION field **1100***j* is preferably set with: Elevation/altitude, if available, if available.

APPLICATION FIELDS field **1100***k* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

CORRELATION FIELD **1100***m* is preferably set with: Not Applicable (i.e. not maintained to queue **22**).

SENT DATE/TIME STAMP field **1100***n* is preferably set with: Not Applicable (i.e. not maintained to queue **22**).

RECEIVED DATE/TIME STAMP field **1100***p* is preferably set with: Not Applicable (i.e. not maintained to queue **22**).

In an alternative embodiment, MS **2** may be equipped (e.g. as part of resources **38**) with its own device **702** and field of view **704** for graphically identifying recognizable environmental objects or places to determine its own whereabouts. In this embodiment, the MS would have access to anticipated objects, locations and dimensions much the same way described for FIGS. **7**A through **7**D, either locally maintained or verifiable with a connected service. Upon a successful recognition of an object, place, or other graphically perceptible image which can be mapped to a location, the MS would complete a WDR similarly to above. The MS may recognize addresses, buildings, landmarks, of other pictorial data. Thus, the MS may graphically determine its own location. The MS would then complete a WDR **1100** for FIG. **2**F processing exactly as described for FIG. **7**D with the exceptions of fields that follow:

MS ID field **1100***a* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

LOCATION field **1100***c* is preferably set with: The location determined for the MS by the MS.

LOCATION TECHNOLOGY field **1100***e* is preferably set with: "Client Graphic-Patterns" "Client Graphic-Distances", "Client Graphic Triangulate", or a combination field value depending on how the MS located itself. The originator indicator is set to DLM.

COMMUNICATIONS REFERENCE INFO field **1100***g* is preferably set with: null (not set).

FIG. **8**A heterogeneously depicts a locating by arbitrary wave spectrum illustration for discussing automatic location of a MS. In the case of acoustics or sound, prior art has shown that a noise emitting animal or object can be located by triangulating the sound received using TDOA by strategically placed microphones. It is known that by figuring out time delay between a few strategically spaced microphones, one can infer the location of the sound. In a preferred embodiment, an MS, for example DLM **200**, emits a pulsed or constant sound (preferably beyond the human hearing range) which can be sensed by microphones **802** though **806**. Data is superimposed on the sound wave spectrum with variations in pitch or tone, or data occurs in patterned breaks in sound transmission. Data may contain a unique identifier of the MS so service(s) attached to microphones **802** through **806** can communicate uniquely to an MS. In some embodiments, sound used by the MS is known to repel certain pests such as unwanted animals, rodents, or bugs in order to prevent the person carrying the MS from encountering such pests during travel, for example during outdoor hiking or mountain climbing. In submarine acoustics, AOA is a method to locate certain objects. The FIGS. **3**B and **3**C flowcharts occur analogously for sound signals received by microphones **802** through **806** which are connected to service processing of FIGS. **3**B and **3**C. The only difference is wave spectrum used.

It has been shown that light can be used to triangulate position or location information (e.g. U.S. Pat. No. 6,549,288 (Migdal et al) and U.S. Pat. No. 6,549,289 (Ellis)). Optical sensors **802** through **806** detect a light source of, or illumination of, an MS, for example DLM **200**. Data is superimposed on the light wave spectrum with specified frequency/wavelength and/or periodicity, or data occurs in patterned breaks in light transmission. Data may contain a unique identifier of the MS so service(s) attached to sensors **802** through **806** can communicate uniquely to an MS. Mirrors positioned at optical sensors **802** through **806** may be used to determine an AOA of light at the sensor, or alternatively TDOA of recognizable light spectrum is used to position an MS. The FIGS. **3**B and **3**C flowcharts occur analogously for light signals received by sensors **802** through **806** which are connected to service processing of FIGS. **3**B and **3**C. The only difference is wave spectrum used.

Heterogeneously speaking, FIG. **8**A illustrates having strategically placed sensors **802** through **806** for detecting a wave spectrum and using TDOA, AOA, or MPT. Those skilled in the art appreciate that a wave is analogously dealt with by FIGS. **3**B and **3**C regardless of the wave type, albeit with different sensor types **802** through **806** and different sensor interface to service(s) of FIGS. **3**B and **3**C. Wave signal spectrums for triangulation by analogous processing to FIGS. **3**B and **3**C include microwaves, infrared, visible light, ultraviolet light, X-rays, gamma rays, longwaves, magnetic spectrum, or any other invisible, visible, audible, or inaudible wave spectrum. Sensors **802** through **806** are appropriately matched according-to the requirements. Alternatively, a MS may be sensing wave spectrums emitted by transmitters **802** through **806**.

Those skilled in the relevant arts appreciate that the point in all this discussion is all the wave forms provide methods for triangulating whereabouts information of an MS. Different types of wave forms that are available for an MS can be used solely, or in conjunction with each other, to determine MS whereabouts. MSs may be informed of their location using the identical wave spectrum used for whereabouts determination, or may use any other spectrum available for communicating WDR information back to the MS. Alternatively, the MS itself can determine WDR information relative applicable sensors/transmitters. In any case, a WDR **1100** is completed analogously to FIGS. **3**B and **3**C.

FIG. **8**B depicts a flowchart for describing a preferred embodiment of locating a MS through physically sensing a MS, for example a DLM **200**. Processing begins at block **810** upon contact with a candidate MS and continues to block **812** where initialization takes place. Initialization includes determining when, where, and how the contact was made. Then, block **814** takes the contact sample and sets it as input containing a unique identifier or handle of the MS which was sensed. There are various known embodiments of how the MS is sensed:

a) Touching sensors contact the MS (or host/housing having MS) to interpret physical characteristics of the MS in order to uniquely identify it (e.g. Braille, embossed/raised/depressed symbols or markings, shape, temperature, depressions, size, combinations thereof, etc);

b) Purchase is made with MS while in vicinity of device accepting purchase, and as part of that transaction, the MS is sensed as being at the same location as the device accepting purchase, for example using a cell phone to purchase a soft drink from a soft drink dispensing machine;

c) Barcode reader is used by person to scan the MS (or host/housing having MS), for example as part of shipping, receiving, or transporting;

d) The MS, or housing with MS, is sensed by its odor (or host/housing having MS), perhaps an odor indicating where it had been, where it should not be, or where it should be. Various odor detection techniques may be used;

e) Optical sensing wherein the MS is scanned with optical sensory means, for example to read a serial number; and/or

f) Any sensing means which can identify the MS through physical contact, or by nearby/close physical contact with some wave spectrum.

Block **814** continues to block **816** where a database is accessed for recognizing the MS identifier (handle) by mapping sensed information with an associated MS handle. If a match is found at block **818**, then block **822** determines WDR **1100** information using the location of where sensing took place. If block **818** determines no match was found, then data is saved at block **820** for an unrecognized entity such as is useful when an MS should have been recognized, but was not. In another embodiment, the MS handle is directly sensed so block **814** continues directly to block **818** (no block **816**). Block **820** continues to block **834** where processing terminates. Block **816** may not use the entire MS identifier for search, but some portion of it to make sure it is a supported MS for being located by sensing. The MS identifier is useful when communicating wirelessly the WDR information to the MS (at block **826**).

Referring now back to block **822**, processing continues to block **824** where a supervisory service may be updated with the MS whereabouts (if applicable), and block **826** communicates the WDR information to the MS. Any available communication method can be used for communicating the WDR information to the MS, as described above. Thereafter, the MS completes the WDR at block **828**, block **830** prepares FIG. **2**F parameters, and block **832** invokes FIG. **2**F processing already described above. Processing terminates thereafter at block **834**. Parameters set at block **830** are: WDRREF=a reference or pointer to the MS WDR; DELETEQ=FIG. **8**B location queue discard processing; and SUPER=FIG. **8**B supervisory notification (e.g. no supervisory notification processing because it was already handled at block **824**, or by

being in context of the FIG. **8**B service processing). FIG. **8**B processing is available at any appropriate time for the MS. In an alternate embodiment, the MS senses its environment to determine whereabouts.

See FIG. **11**A descriptions. Fields are set to the following upon exit from block **828**:

MS ID field **1100***a* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

DATE/TIME STAMP field **1100***b* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

LOCATION field **1100***c* is preferably set with: Location of the sensor sensing the MS.

CONFIDENCE field **1100***d* is preferably set with: Should be high confidence (e.g. 98) for indisputable contact sensing and is typically set with the same value.

LOCATION TECHNOLOGY field **1100***e* is preferably set with: "Contact", or a specific type of Contact. The originator indicator is set to DLM.

LOCATION REFERENCE INFO field **1100***f* is preferably set with: null (not set).

COMMUNICATIONS REFERENCE INFO field **1100***g* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

SPEED field **1100***h* is preferably set with: null (not set), but can be set with speed required to arrive to the current location from a previously known time at a location, assuming the same time scale is used.

HEADING field **1100***i* is preferably set with: null (not set), but can be set to heading determined when arriving to the current location from a previously known location.

ELEVATION field **1100***j* is preferably set with: Elevation/altitude, if available.

APPLICATION FIELDS field **1100***k* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

CORRELATION FIELD **1100***m* is preferably set with: Not Applicable (i.e. not maintained to queue **22**).

SENT DATE/TIME STAMP field **1100***n* is preferably set with: Not Applicable (i.e. not maintained to queue **22**).

RECEIVED DATE/TIME STAMP field **1100***p* is preferably set with: Not Applicable (i.e. not maintained to queue **22**).

FIG. **8**C depicts a flowchart for describing a preferred embodiment of locating a MS, for example a DLM **200**, through a manually entered location of the MS. MS user interface processing begins at block **850** when a user starts the user interface from code **18** and continues to block **852**. Any of a variety of user interfaces, dependent on the type of MS, is used for manually entering the location of the MS. A user interfaces with the MS at block **852** until one of the monitored actions relevant to this disclosure are detected. Thereafter, if block **854** determines the user has selected to set his location manually, then processing continues to block **860**. If block **854** determines the user did not select to manually set his location, then block **856** determines if the user selected to force the MS to determine its location. If the user did select to force the MS to get its own location, then block **856** continues to block **862**. If the user did not select to force the MS to get its own location as determined by block **856**, then processing continues to block **858**. If block **858** determines the user wanted to exit the user interface, then block **880** terminates the interface and processing terminates at block **882**. If block **858** determines the user did not want to exit the user interface, then block **884** handles any user interface actions which caused exit from block **852** yet were not handled by any action processing relevant to this disclosure.

With reference back to block **860**, the user interfaces with the MS user interface to manually specify WDR information. The user can specify:

1) An address or any address subset such as a zip code;
2) Latitude, longitude, and elevation;
3) MAPSCO identifier;
4) FEMA map identifier;
5) USDA map identifier;
6) Direct data entry to a WDR **1100**; or
7) Any other method for user specified whereabouts of the MS.

The user can specify a relevant confidence value for the manually entered location, however, processing at block **860** preferably automatically defaults a confidence value for the data entered. For example, a complete address, validated at block **860**, will have a high confidence. A partial address such as city and state, or a zip code will have a low confidence value. The confidence value will reflect how large an area is candidate for where the MS is actually located. To prevent completely relying on the user at block **860** for accurate WDR information, validation embodiments may be deployed. Some examples:

Upon specification (e.g. FEMA), the MS will access connected service(s) to determine accuracy (FEMA conversion tables);

Upon specification (e.g. MAPSCO), the MS will access local resources to help validate the specification (e.g. MAPSCO conversion tables); and/or

Upon specification (e.g. address), the MS can access queue **22** and/or history **30** for evidence proving likelihood of accuracy. The MS may also access services, or local resources, for converting location information for proper comparisons.

In any case, a confidence field **1100***d* value can be automatically set based on the validation results, and the confidence may, or may not, be enabled for override by the user.

After WDR information is specified at block **860**, the MS completes the WDR at block **874**, block **876** prepares parameters for FIG. **2**F processing, and (at block **878**) the MS invokes FIG. **2**F processing already described above before returning back to block **852**. Parameters set at block **876** are: WDRREF=a reference or pointer to the MS WDR; DELETEQ=FIG. **8**C location queue discard processing; and SUPER=FIG. **8**C supervisory notification processing. Various embodiments permit override of the confidence floor value by the user, or by FIG. **8**C processing. Block **874** may convert the user specified information into a standardized more usable form in an LN-expanse (e.g. convert to latitude and longitude if possible, truncated precision for more area coverage). WDR **1100** fields (see FIG. **11**A) are set analogously in light of the many variations already described above.

With reference back to block **862**, if it is determined that the MS is equipped with capability (e.g. in range, or in readiness) to locate itself, then processing continues-to block **864** where the MS locates itself using MS driven capability described by FIGS. **2**E, **3**C, **4**B, **6**B, and **8**A or MS driven alternative embodiments to FIGS. **2**D, **3**B, **5**B, **6**A, **7**D, **8**A, and **8**B, or any other MS capability for determining its own whereabouts with or without help from other data processing systems or services. Interfacing -to locating capability preferably involves a timeout in case there is no, or slow, response, therefore block **864** continues to block **868** where it determined whether or not block **864** timed out prior to determining a location. If block **868** determines a timeout was encountered, then block **872** provides the user with an error to the user interface, and processing continues back to block **852**. Block **872** preferably requires use acknowledgement prior-to continuing to block **852**.

If block **868** determines there was no timeout (i.e. whereabouts successfully determined), then block **870** interfaces to the locating interface to get WDR information, block **874** completes a WDR, and blocks **876** and **878** do as described above. If block **862** determines the MS cannot locate itself and needs help, then block **866** emits at least one broadcast request to any listening service which can provide the MS its location. Appropriate correlation is used for an anticipated response. Example services listening are service driven capability described by FIGS. **2**D, **3**B, **5**B, **6**A, **7**D, **8**A, and **8**B, or service side alternative embodiments of FIGS. **2**E, **3**C, **4**B, **6**B, and **8**A, or any other service capability for determining MS whereabouts with or without help from the MS or other data processing systems or services. Block **866** then continues to block **868**.

If block **868** determines a timeout was encountered from the service broadcast request, then block **872** provides the user with an error to the user interface, and processing continues back to block **852**. If block **868** determines there was no timeout (i.e. whereabouts successfully determined), then block **870** receives WDR information from the locating interface of the responding service, block **874** completes a WDR, and blocks **876** and **878** do as already described above.

See FIG. **11**A descriptions. Depending how the MS was located via processing started at block **856** to block **862**, a WDR is completed analogous to as described in Figures above. If the user manually specified whereabouts at block **860**, fields are set to the following upon exit from block **874**:

MS ID field **1100***a* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

DATE/TIME STAMP field **1100***b* is preferably set with: Same as was described for FIG. **2**D (block **236**) above.

LOCATION field **1100***c* is preferably set with: Location entered by the user, or converted from entry by the user; preferably validated.

CONFIDENCE field **1100***d* is preferably set with: User specified confidence value, or a system assigned value per a validated manual specification. Confidence should reflect confidence of location precision (e.g. validated full address high; city and zip code low, etc). Manually specified confidences are preferably lower than other location technologies since users may abuse or set incorrectly, unless validated. Specifying lower confidence values than technologies above, for completely manual WDR specifications (i.e. no validation), ensures that manual specifications are only used by the MS in absence of other technologies.

LOCATION TECHNOLOGY field **1100***e* is preferably set with: "Manual", or "Manual Validated". Types of validations may further be elaborated. The originator indicator is set to DLM.

LOCATION REFERENCE INFO field **1100***f* is preferably set with: null (not set).

COMMUNICATIONS REFERENCE INFO field **1100***g* is preferably set with: null (not set).

SPEED field **1100***h* is preferably set with: null (not set).

HEADING field **1100***i* is preferably set with: null (not set).

ELEVATION field **1100***j* is preferably set with: null (not set).

APPLICATION FIELDS field **1100***k* is preferably set with: Same as was described for FIG. **2**D (block **236**) above; or as decided by the user.

CORRELATION FIELD **1100***m* is preferably set with: Not Applicable (i.e. not maintained to queue **22**).

SENT DATE/TIME STAMP field **1100***n* is preferably set with: Not Applicable (i.e. not maintained to queue **22**).

RECEIVED DATE/TIME STAMP field **1100***p* is preferably set with: Not Applicable (i.e. not maintained to queue **22**).

FIG. **9**A depicts a table for illustrating heterogeneously locating a MS, for example a DLM **200**. While many location methods and systems have been exhausted above, there may be other system and methods for locating an MS which apply to the present disclosure. The requirement for LBX is that the MS be located, regardless of how that occurs. MSs disclosed herein can be located by one or many location technologies discussed. As MS prices move lower, and capabilities increase, an affordable MS will contain multiple abilities for being located. GPS, triangulation, in-range detection, and contact sensory may all be used in locating a particular MS as it travels. Equipping the MS with all techniques is straightforward and is compelling when there are competing, or complementary, technologies that the MS should participate in.

The FIG. **9**A table has DLM location methods for rows and a single column for the MS (e.g. DLM **200**). Each location technology can be driven by the client (i.e. the MS), or a service (i.e. the location server(s)) as denoted by a row qualifier "C" for client or "S" for service. An MS may be located by many technologies. The table illustrated shows that the MS with unique identifier 0A12:43EF:985B:012F is able to be heterogeneously located, specifically with local MS GPS capability, service side cell tower in-range detection, service side cell tower TDOA, service side cell tower MPT (combination of TDOA and AOA), service side antenna in-range detection, service side antenna AOA, service side antenna TDOA, service side antenna MPT, service side contact/sensory, and general service side MPT. The unique identifier in this example is a universal product identifier (like Host Bus Adapter (HBA) World Wide Name (WWN) identifiers are generated), but could be in other form as described above (e.g. phone #214-403-4071). An MS can have any subset of technologies used to locate it, or all of the technologies used to locate it at some time during its travels. An MS is heterogeneously located when two or more location technologies are used to locate the MS during MS travels and/or when two or more location technologies with incomplete results are used in conjunction with each other to locate the MS during MS travels, such as MPT. MPT is a heterogeneous location technology because it uses at least two different methods to accomplish a single location determination. Using combinations of different location technologies can be used, for example a TDOA measurement from an in-range antenna with a TDOA measurement relative a cell tower (e.g. as accomplished in MS processing of FIG. **26**B), using completely different services that have no knowledge of each other. Another combination is to use a synergy of whereabouts data from one technology with whereabouts data from another technology. For example, in-range detection is used in combination with graphical identification to provide better whereabouts of a MS. In another example, a GPS equipped MS travels to an area where GPS does not work well (e.g. downtown amidst large and tall buildings). The DLM becomes an ILM, and is triangulated relative other MSs. So, an MS is heterogeneously located using two or more technologies to determine a single whereabouts, or different whereabouts of the MS during travel.

FIG. **9**B depicts a flowchart for describing a preferred embodiment of heterogeneously locating a MS, for example DLM **200**. While heterogeneously locating an MS can occur by locating the MS at different times using different location technologies, flowchart **9**B is shown to discuss a generalization of using different location technologies with each other at the same time to locate an MS. Processing begins at block **950** and continues to block **952** where a plurality of parameters from more than one location technology are examined for

locating an MS. Processing begins at block **950** by a service (or the MS) when a location technology by itself cannot be used to confidently locate the MS. Data deemed useful at block **952**, when used in conjunction with data from a different location technology to confidently locate the MS, is passed for processing to block **954**. Block **954** heterogeneously locates the MS using data from at least two location technologies to complement each other and to be used in conjunction with each other in order to confidently locate the MS. Once the MS whereabouts are determined at block **954**, WDR information is communicated to the MS for further processing at block **956**. In some embodiments where a service is heterogeneously locating the MS, block **956** communicates WDR information wirelessly to the MS before processing begins at block **958**. In another embodiment where the MS is heterogeneously locating itself, block **956** communicates WDR information internally to WDR completion processing at block **958**. In preferred embodiments, the MS completes its WDR information at block **958**, FIG. **2**F parameters are prepared at block **960**, and the MS invokes FIG. **2**F processing already described above (at block **962**), before processing terminates at block **964**. Parameters set at block **960** are: WDRREF=a reference or pointer to the MS WDR; DELETEQ=FIG. **9**B location queue discard processing; and SUPER=FIG. **9**B supervisory notification processing. WDR **1100** fields (see FIG. **11**A) are set analogously in light of many variations already described above.

In some embodiments of FIG. **9**B processing, Missing Part Triangulation (MPT) is used to heterogeneously locate an MS. For a service side embodiment example, block **950** begins service processing when TDOA information itself cannot be used to confidently locate the MS, or AOA information itself cannot be used to confidently locate the MS, however using angles and distances from each in conjunction with each other enables solving whereabouts confidently. See "Missing Part Triangulation (MPT)" section below with discussions for FIGS. **11**A through **11**E for MPT processing of blocks **952** and **954**. Data discovered at block **952** and processed by block **954** depends on the embodiment, what stationary reference point locations are known at the time of blocks **952** and **954** processing, and which parts are missing for triangulating the MS. Having three (3) sides (all TDOA) with known stationary vertices location(s) solves the triangle for locating the MS. Three (3) angles (all AOA) with known stationary vertices location(s) solves the triangle for locating the MS. Those skilled in the art appreciate that solving triangulation can make complementary use of different distances (time used to determine length in TDOA) and angles (from AOA) for deducing a MS location confidently (e.g. MPT). Those skilled in the art recognize that having stationary reference locations facilitates requiring less triangular information for deducing a MS location confidently.

While MPT has been discussed by example, flowchart **9**B is not to be interpreted in a limiting sense. Any location technologies, for example as shown in FIG. **9**A, can be used in conjunction with each other when not all information required is available in a single location technology to confidently deduce an MS location. Data available from the different location technologies available will be examined on its own merits, and optionally used in conjunction to deduce a confident location. For example, a TDOA (difference between when signal sent and when received) measurement from "coming within range" technology can be used to distinguish how close, or how far, is an MS in the vicinity. That measurement may be used to more confidently locate the MS using other TDOA measurements from other unrelated "coming within range" whereabouts information.

With the many DLM examples above, it should be clear now to the reader how to set the WDR **1100** for DLM invoked FIG. **2**F processing. There can be other location technologies that will set WDR **1100** fields analogously. Locating methodologies of FIGS. **2**A through **9**B can be used in any combination, for example for more timely or accurate locating. Furthermore, a MS automatically takes on a role of a DLM or ILM depending on what capability is available at the time, regardless of whether or not the MS is equipped for being directly located. As a DLM roams to unsupported areas, it can remain a DLM using different DLM technologies, and it can become an ILM to depend on other MSs (ILMs or DLMs) in the vicinity to locate it.

LBX Indirectly Located Mobile Data Processing Systems (ILMS)

FIGS. **10**A and **10**B depict an illustration of a Locatable Network expanse (LN-Expanse) **1002** for describing locating of an ILM with all DLMs. With reference now to FIG. **10**A, DLM **200***a*, DLM **200***b*, DLM **200***c*, DLM **200***d*, and DLM **200***e* (referred to generally in FIGS. **10**A and **10**B discussions as DLMs **200**) are each automatically and directly located, for example using any of the automatic location technologies heretofore described. ILM **1000***b* is automatically located using the reference locations of DLM **200***b*, DLM **200***c*, and DLM **200***e*. DLMs **200** can be mobile while providing reference locations for automatically determining the location of ILM **1000***b*. Timely communications between MSs is all that is required for indirectly locating MSs. In some embodiments, DLMs **200** are used to triangulate the position of ILM **1000***b* using aforementioned wave spectrum(s) reasonable for the MSs. Different triangulation embodiments can triangulate the location of ILM **1000***b* using TDOA, AOA, or MPT, preferably by the ILM **1000***b* seeking to be located. In other embodiments, TDOA information is used to determine how close ILM **1000***b* is to a DLM for associating the ILM at the same location of a DLM, but with how close nearby. In other embodiments, an ILM is located by simply being in communications range to another MS. DLMs **200** can be referenced for determining elevation of an ILM. The same automatic location technologies used to locate a DLM can be used to automatically locate an ILM, except the DLMs are mobile and serve as the reference points. It is therefore important that DLM locations be timely known when references are needed for locating ILMs. Timely ILM interactions with other MSs, and protocol considerations are discussed in architecture **1900** below. DLMs **200***b*, **200***c*, and **200***e* are preferably selected for locating ILM **1000***b* by their WDR high confidence values, however any other WDR data may be used whereby wave spectrum, channel signal strength, time information, nearness, surrounded-ness, etc is considered for generating a confidence field **1100***d* of the WDR **1100** for the located ILM. Preferably, those considerations are factored into a confidence value, so that confidence values can be completely relied upon.

With reference now to FIG. **10**B, ILM **1000***c* has been located relative a plurality of DLMs, namely DLM **200***b*, DLM **200***d*, and DLM **200***e*. ILM **1000***c* is located analogously to ILM **1000***b* as described for FIG. **10**A, except there are different DLMs involved with doing the locating of ILM **1000***c* because of a different location of ILM **1000***c*. FIGS. **10**A and **10**B illustrate that MSs can be located using other MSs, rather than fixed stationary references described for FIGS. **2**A through **9**B. ILM **1000***b* and ILM **1000***c* are indirectly located using DLMs **200**.

FIG. **10**C depicts an illustration of a Locatable Network expanse (LN-Expanse) **1002** for describing locating of an ILM with an ILM and DLM. ILM **1000***a* is automatically located using the reference locations of DLM **200***c*, DLM **200***b*, and ILM **1000***b*. DLM **200***b*, DLM **200***c* and ILM **1000***b* can be mobile while providing reference locations for automatically determining the location of ILM **1000***a*. In some embodiments, MSs are used to triangulate the position of ILM **1000***a* using any of the aforementioned wave spectrum(s) (e.g. WiFi 802.x, cellular radio, etc) reasonable for the MSs. Different triangulation embodiments can triangulate the location of ILM **1000***a* using TDOA, AOA, or MPT, preferably by the ILM **1000***a* seeking to be located. In other embodiments, TDOA information is used to determine how close ILM **1000***a* is to a MS (DLM or ILM) for associating the ILM at the same location of a MS, but with how close nearby. In other embodiments, an ILM is located by simply being in communications range to another MS. DLMs or ILMs can be referenced for determining elevation of ILM **1000***a*. The same automatic location technologies used to locate a MS (DLM or ILM) are used to automatically locate an ILM, except the MSs are mobile and serve as the reference points. It is therefore important that MS (ILM and/or DLM) locations be timely known when references are needed for locating ILMs. Timely ILM interactions with other MSs, and protocol, considerations are discussed in architecture **1900** below. DLM **200***b*, DLM **200***c*, and ILM **1000***b* are preferably selected for locating ILM **1000***a* by their WDR high confidence values, however any other WDR data may be used whereby wave spectrum, channel signal strength, time information, nearness, surrounded-ness, etc is considered for generating a confidence field **1100***d* of the WDR **1100** for the located ILM. Preferably, those considerations were already factored into a confidence value so that confidence values can be completely relied upon. ILM **1000***a* is indirectly located using DLM(s) and ILM(s).

FIGS. **10**D, **10**E, and **10**F depict an illustration of a Locatable Network expanse (LN-Expanse) **1002** describing locating of an ILM with all ILMs. With reference now to FIG. **10**D, ILM **1000***e* is automatically located using the reference locations of ILM **1000***a*, ILM **1000***b*, and ILM **1000***c*. ILM **1000***a*, ILM **1000***b* and ILM **1000***c* can be mobile while providing reference locations for automatically determining the location of ILM **1000***e*. Timely communications between MSs is all that is required. In some embodiments, MSs are used to triangulate the position of ILM **1000***e* using any of the aforementioned wave spectrum(s) reasonable for the MSs. Different triangulation embodiments can triangulate the location of ILM **1000***e* using TDOA, AOA, or MPT processing (relative ILMs **1000***a* through **1000***c*), preferably by the ILM **1000***e* seeking to be located. ILMs can be referenced for determining elevation of ILM **1000***e*. The same automatic location technologies used to locate a MS (DLM or ILM) are used to automatically locate an ILM, except the MSs are mobile and serve as the reference points. It is therefore important that ILM locations be timely known when references are needed for locating ILMs. Timely ILM interactions with other MSs, and protocol considerations are discussed in architecture **1900** below. ILM **1000***a*, ILM **1000***b*, and ILM **1000***c* are preferably selected for locating ILM **1000***e* by their WDR high confidence values, however any other WDR data may be used whereby wave spectrum, channel signal strength, time information, nearness, surrounded-ness, etc is considered for generating a confidence field **1100***d* of the WDR **1100** for the located ILM. Preferably, those considerations were already factored into a confidence value so that confidence values can be completely relied upon. ILM **1000***e* is indirectly located using ILM **1000***a*, ILM **1000***b*, and ILM **1000***c*.

With reference now to FIG. **10**E, ILM **1000***g* is automatically located using the reference locations of ILM **1000***a*, ILM **1000***c*, and ILM **1000***e*. ILM **1000***a*, ILM **1000***c* and ILM **1000***e* can be mobile while providing reference locations for automatically determining the location of ILM **1000***g*. ILM **1000***g* is located analogously to ILM **1000***e* as described for FIG. **10**D, except there are different ILMs involved with doing the locating of ILM **1000***g* because of a different location of ILM **1000***g*. Note that as ILMs are located in the LN-expanse **1002**, the LN-expanse expands with additionally located MSs.

With reference now to FIG. **10**F, ILM **1000***i* is automatically located using the reference locations of ILM **1000***f*, ILM **1000***g*, and ILM **1000***h*. ILM **1000***f*, ILM **1000***g* and ILM **1000***h* can be mobile while providing reference locations for automatically determining the location of ILM **1000***i*. ILM **1000***i* is located analogously to ILM **1000***e* as described for FIG. **10**D, except there are different ILMs involved with doing the locating of ILM **1000***i* because of a different location of ILM **1000***i*. FIGS. **10**D through **10**F illustrate that an MS can be located using all ILMs, rather than all DLMs (FIGS. **10**A and **10**B), a mixed set of DLMs and ILMs (FIG. **10**C), or fixed stationary references (FIGS. **2**A through **9**B). ILMs **1000***e*, **1000***g*, and **1000***i* are indirectly located using ILMs. Note that in the FIG. **10** illustrations the LN-expanse **1002** has expanded down and to the right from DLMs directly located up and to the left. It should also be noted that locating any MS can be done with at least one other MS. Three are not required as illustrated. It is preferable that triangulation references used surround an MS.

FIGS. **10**G and **10**H depict an illustration for describing the reach of a Locatable Network expanse (LN-Expanse) according to MSs. Location confidence will be dependent on the closest DLMs, how stale an MS location becomes for serving as a reference point, and how timely an MS refreshes itself with a determined location. An MS preferably has highest available processing speed with multithreaded capability in a plurality of hardware processors and/or processor cores. A substantially large number of high speed concurrent threads of processing that can occur within an MS provides for an optimal capability for being located quickly among its peer MSs, and for serving as a reference to its peer MSs. MS processing described in flowcharts herein assumes multiple threads of processing with adequate speed to accomplish an optimal range in expanding the LN-Expanse **1002**.

With reference now to FIG. **10**G, an analysis of an LN-Expanse **1002** will contain at least one DLM region **1022** containing a plurality of DLMs, and at least one DLM indirectly located region **1024** containing at least one ILM that has been located with all DLMs. Depending on the range, or scope, of an LN-Expanse **1002**, there may be a mixed region **1026** containing at least one ILM that has been indirectly located by both an ILM and DLM, and there may be an exclusive ILM region **1028** containing at least one ILM that has been indirectly located by all ILMs. The further in distance the LN-Expanse has expanded from DLM region **1022** with a substantial number of MSs, the more likely there will an exclusive ILM region **1028**. NTP may be available for use in some regions, or some-subset of a region, yet not available for use in others. NTP is preferably used where available to minimize communications between MSs, and an MS and service(s). An MS has the ability to make use of NTP when available.

With reference now to FIG. **10**H, all MSs depicted know their own locations. The upper left-hand portion of the illus-

tration consists of region **1022**. As the reader glances more toward the rightmost bottom portion of the illustration, there can be regions **1024** and regions **1026** in the middle of the illustration. At the very rightmost bottom portion of the illustration, remaining ILMs fall in region **1028**. An ILM is indirectly located relative all DLMs, DLMs and ILMs, or all ILMs. An "Affirmifier" in a LN-expanse confidently knows its own location and can serve as a reference MS for other MSs. An affirmifier is said to "affirmify" when in the act of serving as a reference point to other MSs. A "Pacifier" can contribute to locating other systems, but with a low confidence of its own whereabouts. The LN-Expanse is a network of located/locatable MSs, and is preferably expanded by a substantial number of affirmifiers.

FIG. **10**I depicts an illustration of a Locatable Network expanse (LN-Expanse) for describing a supervisory service, for example supervisory service **1050**. References in flowcharts for communicating information to a supervisory service can refer to communicating information to supervisory service **1050** (e.g. blocks **294** and **296** from parameters passed to block **272** for many processing flows). The only requirement is that supervisory service **1050** be contactable from an MS (DLM or ILM) that reports to it. An MS reporting to service **1050** can communicate directly to it, through another MS (i.e. a single hop), or through a plurality of MSs (i.e. a plurality of hops). Networks of MSs can be preconfigured, or dynamically reconfigured as MSs travel to minimize the number of hops between a reporting MS and service **1050**. A purely peer to peer preferred embodiment includes a peer to peer network of located/locatable MSs that interact with each other as described herein. The purely peer to peer preferred embodiment may have no need to include a service **1050**. Nevertheless, a supervisory service may be warranted to provide certain processing centralization, or for keeping information associated with MSs. In some embodiments, supervisory service **1050** includes at least one database to house data (e.g. data **8**; data **20**; data **36**; data **38**, queue data **22**, **24**, **26**; and/or history **30**) for any subset of MSs which communicate with it, for example to house MS whereabouts information.

FIG. **11**A depicts a preferred embodiment of a Whereabouts Data Record (WDR) **1100** for discussing operations of the present disclosure. A WDR takes on a variety of formats depending on the context of use. There are several parts to a WDR depending on use. There is an identity section which contains a MS ID field **1100***a* for identifying the WDR. Field **1100***a* can contain a null value if the WDR is for whereabouts information received from a remote source which has not identified itself. MSs do not require identities of remote data processing systems in order to be located. There is a core section which is required in WDR uses. The core section includes date/time stamp field **1100***b*, location field **1100***c*, and confidence field **1100***d*. There is a transport section of fields wherein any one of the fields may be used when communicating WDR information between data processing systems. Transport fields include correlation field **1100***m*, sent date/time stamp field **1100***n*, and received date/time stamp field **1100***p*. Transport fields may also be communicated to send processing (e.g. queue **24**), or received from receive processing (e.g. queue **26**). Other fields are of use depending on the MS or applications thereof, however location technology field **1100***e* and location reference info field **1100***f* are of particular interest in carrying out additional novel functionality of the present disclosure. Communications reference information field **1100***g* may be valuable, depending on communications embodiments in the LN-expanse.

Some fields are multi-part fields (i.e. have sub-fields). Whereabouts Data Records (WDRs) **1100** may be fixed length records, varying length records, or a combination with field(s) in one form or the other. Some WDR embodiments will use anticipated fixed length record positions for subfields that can contain useful data, or a null value (e.g. −1). Other WDR embodiments may use varying length fields depending on the number of sub-fields to be populated. Other WDR embodiments will use varying length fields and/or sub-fields which have tags indicating their presence. Other WDR embodiments will define additional fields to prevent putting more than one accessible data item in one field. In any case, processing will have means for knowing whether a value is present or not, and for which field (or sub-field) it is present. Absence in data may be indicated with a null indicator (−1), or indicated with its lack of being there (e.g. varying length record embodiments).

When a WDR is referenced in this disclosure, it is referenced in a general sense so that the contextually reasonable subset of the WDR of FIG. **11**A is used. For example, when communicating WDRs (sending/receiving data **1302** or **1312**) between data processing systems, a reasonable subset of WDR **1100** is communicated in preferred embodiments as described with flowcharts. When a WDR is maintained to queue **22**, preferably most (if not all) fields are set for a complete record, regardless if useful data is found in a particular field (e.g. some fields may be null (e.g. −1)). Most importantly, Whereabouts Data Records (WDRs) are maintained to queue **22** for maintaining whereabouts of the MS which owns queue **22**. LBX is most effective the more timely (and continuous) a MS has valid whereabouts locally maintained. WDRs are designed for maintaining whereabouts information independent of any location technology applied. Over time, a MS may encounter a plurality of location technologies used to locate it. WDRs maintained to a first MS queue **22** have the following purpose:

1) Maintain timely DLM whereabouts information of the first MS independent of any location technology applied;
2) Maintain whereabouts information of nearby MSs independent of any location technology applied;
3) Provide DLM whereabouts information to nearby MSs for determining their own locations (e.g. provide whereabouts information to at least a second MS for determining its own location);
4) Maintain timely ILM whereabouts information of the first MS independent of any location technology applied;.and
5) Provide ILM whereabouts information to nearby MSs so they can determine their own locations (e.g. first MS providing whereabouts information to at least a second MS for the second MS determining its own whereabouts).

A MS may go in and out of DLM or ILM roles as it is mobile. Direct location methods are not always available to the MS as it roams, therefore the MS preferably does all of 1 through 5 above. When the WDR **1100** contains a MS ID field **1100***a* matching the MS which owns queue **22**, that WDR contains the location (location field **1100***c*) with a specified confidence (field **1100***d*) at a particular time (date/time stamp field **1100***b*) for that MS. Preferably the MS ID field **1100***a*, date/time stamp field **1100***b* and confidence field **1100***d* is all that is required for searching from the queue **22** the best possible, and most timely, MS whereabouts at the time of searching queue **22**. Other embodiments may consult any other fields to facilitate the best possible MS location at the time of searching and/or processing queue **22**. The WDR queue **22** also maintains affirmifier WDRs, and acceptable confidence pacifier WDRs (block **276**), which are used to

calculate a WDR having matching MS field **1100***a* so the MS knows its whereabouts via indirect location methods. Affirmifier and pacifier WDRs have MS ID field **1100***a* values which do not match the MS owning queue **22**. This distinguishes WDRs of queue **22** for A) accessing the current MS location; from B) the WDRs from other MSs. All WDR fields of affirmifier and pacifier originated WDRs are of importance for determining a best location of the MS which owns queue **22**, and in providing LBX functionality.

MS ID field **1100***a* is a unique handle to an MS as previously described. Depending on the installation, MS ID field **1100***a* may be a phone #, physical or logical address, name, machine identifier, serial number, encrypted identifier, concealable derivative of a MS identifier, correlation, pseudo MS ID, or some other unique handle to the MS. An MS must be able to distinguish its own unique handle from other MS handles in field **1100***a*. For indirect location functionality disclosed herein, affirmifier and pacifier WDRs do not need to have a correct originating MS ID field **1100***a*. The MS ID may be null, or anything to distinguish WDRs for MS locations. However, to accomplish other LBX features and functionality, MS Identifiers (MS IDs) of nearby MSs (or unique correlations thereof maintained in queue **22** are to be known for processing by an MS. MS ID field **1100***a* may contain a group identifier of MSs in some embodiments for distinguishing between types of MSs (e.g. to be treated the same, or targeted with communications, as a group), as long as the MS containing queue **22** can distinguish its own originated WDRs **1100**. A defaulted value may also be set for a "do not care" setting (e.g. null).

Date/Time stamp field **1100***b* contains a date/time stamp of when the WDR record **1100** was completed by an MS for its own whereabouts prior to WDR queue insertion. It is in terms of the date/time scale of the MS inserting the local WDR (NTP derived or not). Date/Time stamp field **1100***b* may also contain a date/time stamp of when the WDR record **1100** was determined for the whereabouts of an affirmifier or pacifier originating record **1100** to help an MS determine its own whereabouts, but it should still be in terms of the date/time scale of the MS inserting the local WDR (NTP derived or not) to prevent time conversions when needed, and to promote consistent queue **22** searches/sorts/etc. The date/time stamp field **1100***b* should use the best possible granulation of time, and may be in synch with other MSs and data processing systems according to NTP. A time zone, day/light savings time, and NTP indicator is preferably maintained as part of field **1100***b*. The NTP indicator (e.g. bit) is for whether or not the date/time stamp is NTP derived (e.g. the NTP use setting is checked for setting this bit when completing the WDR for queue **22** insertion). In some embodiments, date/time stamp field **1100***b* is measured in the same granulation of time units to an atomic clock available to MSs of an LN-Expanse **1002**. When NTP is used in a LN-Expanse, identical time server sources are not a requirement provided NTP derived date/time stamps have similar accuracy and dependability.

Location field **1100***c* depends on the installation of the present disclosure, but can include a latitude and longitude, cellular network cell identifier, geocentric coordinates, geodetic coordinates, three dimensional space coordinates, area described by GPS coordinates, overlay grid region identifier or coordinates, GPS descriptors, altitude/elevation (e.g. in lieu of using field **1100***j*), MAPSCO reference, physical or logical network address (including a wildcard (e.g. ip addresses 145.32.*.*)), particular address, polar coordinates, or any other two/three dimensional location methods/means used in identifying the MS location. Data of field **1100***c* is preferably a consistent measure (e.g. all latitude and longitude) for all location technologies that populate WDR queue **22**. Some embodiments will permit using different measures to location field **1100***c* (e.g. latitude and longitude for one, address for another; polar coordinates for another, etc) which will be translated to a consistent measure at appropriate processing times.

Confidence field **1100***d* contains a value for the confidence that location field **1100***c* accurately describes the location of the MS when the WDR is originated by the MS for its own whereabouts. Confidence field **1100***d* contains a value for the confidence that location field **1100***c* accurately describes the location of an affirmifier or pacifier that originated the WDR. A confidence value can be set according to known timeliness of processing, communications and known mobile variables (e.g. MS speed, heading, yaw, pitch, roll, etc) at the time of transmission. Confidence values should be standardized for all location technologies used to determine which location information is of a higher/lower confidence when using multiple location technologies (as determined by fields **1100***e* and **1100***f*) for enabling determination of which data is of a higher priority to use in determining whereabouts. Confidence value ranges depend on the implementation. In a preferred embodiment, confidence values range from 1 to 100 (as discussed previously) for denoting a percentage of confidence. 100% confidence indicates the location field **1100***c* is guaranteed to describe the MS location. 0% confidence indicates the location field **1100***c* is guaranteed to not describe the MS location. Therefore, the lowest conceivable value of a queue **22** for field **100***d* should be 1. Preferably, there is a lowest acceptable confidence floor value configured (by system, administrator, or user) as used at points of queue entry insertion—see block **276** to prevent frivolous data to queue **22**. In most cases, WDRs **1100** contain a confidence field **1100***d* up to 100. In confidence value preferred embodiments, pacifiers know their location with a confidence of less than 75, and affirmifiers know their location with a confidence value 75 or greater. The confidence field is skewed to lower values as the LN-expanse **1002** is expanded further from region **1022**. Confidence values are typically lower when ILMs are used to locate a first set of ILMs (i.e. first tier), and are then lower when the first set of ILMs are used to locate a second set of ILMs (second tier), and then lower again when the second set of ILMs are used to locate a third set of ILMs (third tier), and so on. Often, examination of a confidence value in a WDR **1100** can indicate whether the MS is a DLM, or an ILM far away from DLMs, or an MS which has been located using accurate (high confidence) or inaccurate (low confidence) locating techniques.

Location Technology field **1100***e* contains the location technology used to determine the location of location field **1100***c*. An MS can be located by many technologies. Location Technology field **1100***e* can contain a value from a row of FIG. **9**A or any other location technology used to locate a MS. WDRs inserted to queue **22** for MS whereabouts set field **1100***e* to the technology used to locate the MS. WDRs inserted to queue **22** for facilitating a MS in determining whereabouts set field **1100***e* to the technology used to locate the affirmifier or pacifier. Field **1100***e* also contains an originator indicator (e.g. bit) for whether the originator of the WDR **1100** was a DLM or ILM. When received from a service that has not provided confidence, this field may be used by a DLM to determine confidence field **1100***d*.

Location Reference Info field **1100***f* preferably contains one or more fields useful to locate a MS in processing subsequent of having been inserted to queue **22**. In other embodiments, it contains data that contributed to confidence determination. Location Reference Info field **1100***f* may contain

information (TDOA measurement and/or AOA measurement—see inserted field **1100***f* for FIGS. **2**D, **2**E and **3**C) useful to locate a MS in the future when the WDR originated from the MS for its own whereabouts. Field **1100***f* will contain selected triangulation measurements, wave spectrum used and/or particular communications interfaces **70**, signal strength(s), TDOA information, AOA information, or any other data useful for location determination. Field **1100***f* can also contain reference whereabouts information (FIG. **3**C) to use relative a TDOA or AOA (otherwise WDR location field assumed as reference). In one embodiment, field **1100***f* contains the number of DLMs and ILMs which contributed to calculating the MS location to break a tie between using WDRs with the same confidence values. In another embodiment, a tier of ILMs used to locate the MS is maintained so there is an accounting for the number of ILMs in the LN-expanse between the currently located MS and a DLM. In other embodiments, MS heading, yaw, pitch and roll, or accelerometer values are maintained therein, for example for antenna AOA positioning. When wave spectrum frequencies or other wave characteristics have changed in a transmission used for calculating a TDOA measurement, appropriate information may be carried along, for example to properly convert a time into a distance. Field **1100***f* should be used to facilitate correct measurements and uses, if needed conversions have not already taken place.

Communications reference information field **1100***g* is a multipart record describing the communications session, channel, and bind criteria between the MS and MSs, or service(s), that helped determine its location. In some embodiments, field **1100***g* contains unique MS identifiers, protocol used, logon/access parameters, and useful statistics of the MSs which contributed to data of the location field **1100***c*. An MS may use field **1100***g* for WDRs originated from affirmifiers and pacifiers for subsequent LBX processing.

Speed field **1100***h* contains a value for the MS speed when the WDR is originated by the MS for its own whereabouts. Speed field **1100***d* may contain a value for speed of an affirmifier or pacifier when the WDR was originated elsewhere. Speed is maintained in any suitable units.

Heading field **1100***i* contains a value for the MS heading when the WDR is originated by the MS for its own whereabouts. Heading field **1100***i* may contain a value for heading of an affirmifier or pacifier when the WDR was originated elsewhere. Heading values are preferably maintained in degrees up to 360 from due North, but is maintained in any suitable directional form.

Elevation field **1100***j* contains a value for the MS elevation (or altitude) when the WDR is originated by the MS for its own whereabouts. Elevation field **1100***j* may contain a value for elevation (altitude) of an affirmifier or pacifier when the WDR was originated elsewhere. Elevation (or altitude) is maintained in any suitable units.

Application fields **1100***k* contains one or more fields for describing application(s) at the time of completing, or originating, the WDR **1100**. Application fields **1100***k* may include field(s) for:

a) MS Application(s) in use at time;
b) MS Application(s) context(s) in use at time;
c) MS Application(s) data for state information of MS Application(s) in use at time;
d) MS Application which caused WDR **1100**;
e) MS Application context which caused WDR **1100**;
f) MS Application data for state information of MS Application which caused WDR **1100**;
g) Application(s) in use at time of remote MS(s) involved with WDR;
h) Application(s) context(s) in use at time of remote MS(s) involved with WDR;
i) MS Application(s) data for state information of remote MS(s) involved with WDR;
j) Remote MS(s) criteria which caused WDR **1100**;
k) Remote MS(s) context criteria which caused WDR **1100**;
l) Remote MS(s) data criteria which caused WDR **1100**;
m) Application(s) in use at time of service(s) involved with WDR;
n) Application(s) context(s) in use at time of service(s) involved with WDR;
o) MS Application(s) data for state information of service(s) involved with WDR;
p) Service(s) criteria which caused WDR **1100**;
q) Service(s) context criteria which caused WDR **1100**;
r) Service(s) data criteria which caused WDR **1100**;
s) MS navigation APIs in use;
t) Web site identifying information;
u) Physical or logical address identifying information;
v) Situational location information as described in U.S. Pat. Nos. 6,456,234; 6,731,238; 7,187,997 (Johnson);
w) Transactions completed at a MS;
x) User configurations made at a MS;
y) Environmental conditions of a MS;
z) Application(s) conditions of a MS;
aa) Service(s) conditions of a MS;
bb) Date/time stamps (like field **1100***b*) with, or for, any item of a) through aa); and/or
cc) Any combinations of a) through bb).

Correlation field **1100***m* is optionally present in a. WDR when the WDR is in a transmission between systems (e.g. wireless communications) such as in data **1302** or **1312**. Field **1100***m* provides means for correlating a response to an earlier request, or to correlate a response to an earlier broadcast. Correlation field **1100***m* contains a unique handle. In a LN-expanse which globally uses NTP, there is no need for correlation in data **1302** or **1312**. Correlation field **1100***m* may be present in WDRs of queues **24** or **26**. Alternatively, a MS ID is used for correlation.

Sent date/time stamp field **1100***n* is optionally present in a WDR When the WDR is in transmission between systems (e.g. wireless communications) such as in data **1302** or **1312**. Field **1100***n* contains when the WDR was transmitted. A time zone, day/light savings time, and NTP indicator is preferably maintained as part of field **1100***n*. Field **1100***n* is preferably not present in WDRs of queue **22** (but can be if TDOA measurement calculation is delayed to a later time). In some embodiments, there is no need for field **1100***n*. Whereabouts determined for MSs of an LN-Expanse may be reasonably timely, facilitating simplicity of setting outbound field **1100***b* to the transmission date/time stamp at the sending data processing system, rather than when the WDR was originally completed for whereabouts (e.g. when substantially the same time anyway). Sent date/time field **1100***n* may be present in WDRs of queues **24** or **26**.

Received date/time stamp field **1100***p* is preferably present in a WDR when inserted to queue **26** by receiving thread(s) upon received data **1302** or **1312**. Field **1100***p* contains when the WDR was received by the MS. A time zone, day/light savings time, and NTP indicator is preferably maintained as part of field **1100***p*. Field **1100***p* is preferably not present in WDRs of queue **22** (but can be if TDOA measurement calculation is delayed to a later time). In some embodiments, there is no need for field **1100***p*. For example, thread(s) **1912** may be listening directly on applicable channel(s) and can determine when the data is received. In another embodiment,

thread(s) **1912** process fast enough to determine the date/time stamp of when data **1302** or **1312** is received since minimal time has elapsed between receiving the signal and determining when received. In fact, known processing duration between when received and when determined to be received can be used to correctly alter a received date/time stamp. Received date/time stamp field **1100***p* is preferably added to records placed to queue **26** by receiving thread(s) feeding queue **26**.

Any fields of WDR **1100** which contain an unpredictable number of subordinate fields of data preferably use a tagged data scheme, for example an X.409 encoding for a Token, Length, and Value (called a TLV encoding). Therefore, a WDR **1100**, or field therein, can be a variable sized record. For example, Location Reference info field **1100***f* may contain TTA, 8, 0.1456 where the Token="TTA" for Time Till Arrival (TDOA measurement between when sent and when received), Length=8 for 8 bytes to follow, and Value=0.1456 in time units contained within the 8 bytes; also SS, 4, 50 where Token="Signal Strength", 4=4 for 4 bytes to follow, and Value=50 dBu for the signal strength measurement. This allows on-the-fly parsing of unpredictable, but interpretable, multipart fields. The TLV encoding also enables-on-the-fly configuration for parsing new subordinate fields to any WDR **1100** field in a generic implementation, for example in providing parse rules to a Lex and Yacc implementation, or providing parse rules to a generic top down recursive TLV encoding parser and processor.

Any field of WDR **1100** may be converted: a) prior to insertion to queue **22**; or b) after access to queue **22**; or c) by queue **22** interface processing; for standardized processing. Any field of WDR **1100** may be converted when sending/receiving/broadcasting, or related processing, to ensure a standard format. Other embodiments will store and access values of WDR **1100** field(s) which are already in a standardized format. WDR **1100** fields can be in any order, and a different order when comparing what is in data transmitted versus data maintained to queue **22**.

An alternate embodiment to WDRs maintained to queue **22** preserves transport fields **1100***m*, **1100***n* and/or **1100***p*, for example for use on queue **22**. This would enable **1952** thread(s) to perform TDOA measurements that are otherwise calculated in advance and kept in field **1100***f*. However, queue **22** size should be minimized and the preferred embodiment uses transport fields when appropriate to avoid carrying them along to other processing.

FIGS. **11**B, **11**C and **11**D depict an illustration for describing various embodiments for determining the whereabouts of an MS, for example an ILM **1000***e*. With reference now to FIG. **11**B, a MS **1000***e* location is located by using locations of three (3) other MSs: MS_4, MS_5, and MS_6 (referred to generally as MS_j). MS_j are preferably located with a reasonably high level of confidence. In some embodiments, MS_j are all DLMs. In some embodiments, MS_j are all ILMs. In some embodiments, MS_j are mixed DLMs and ILMs. Any of the MSs may be mobile during locating of MS **1000***e*. Wave spectrums in use, rates of data communications and MS processing speed, along with timeliness of processing described below, provide timely calculations for providing whereabouts of ILM **1000***e* with a high level of confidence. The most confident MSs (MS_j) were used to determine the MS **1000***e* whereabouts. For example, MS_j were all located using a form of GPS, which in turn was used to triangulate the whereabouts of MS **1000***e*. In another example, MS_4 was located by a form of triangulation technology, MS_5 was located by a form of "coming into range" technology, and MS_6 was located by either of the previous two, or some other location technology. It is not important how an MS is located. It is important that each MS know its own whereabouts and maintain a reasonable confidence to it, so that other MSs seeking to be located can be located relative highest confidence locations available. The WDR queue **22** should always contain at least one entry indicating the location of the MS **2** which owns WDR queue **22**. If there are no entries contained on WDR queue **22**, the MS **2** does not know its own location.

With reference now to FIG. **11**C, a triangulation of MS **1000***e* at location **1102** is explained using location (whereabouts) **1106** of MS_4, location (whereabouts) **1110** of MS_5, and location (whereabouts) **1114** of MS_6. Signal transmission distance from MS_j locations are represented by the radiuses, with r_1 the TDOA measurement (time difference between when sent and when received) between MS_4 and MS **1000***e*, with r_2 the TDOA measurement (time difference between when sent and when received) between MS_5 and MS **1000***e*, with r_3 the TDOA measurement (time difference between when sent and when received) between MS_6 and MS **1000***e*. In this example, the known locations of MS_j which are used to determine the location of MS **1000***e* allow triangulating the MS **1000***e* whereabouts using the TDOA measurements. In fact, less triangular data in the illustration can be necessary for determining a highly confident whereabouts of MS **1000***e*.

With reference now to FIG. **11**D, a triangulation of MS **1000***e* at location **1102** is explained using location (whereabouts) **1106** of MS_4, location (whereabouts) **1110** of MS_5, and location (whereabouts) **1114** of MS_6. In some embodiments, AOA measurements taken at a positioned antenna of MS **1000***e* at location **1102** are used relative the whereabouts **1106**, whereabouts **1110**, whereabouts **1114** (AOA **1140**, AOA **1144** and AOA **1142**), wherein AOA measurements are detected for incoming signals during known values for MS heading **1138** with MS yaw, pitch, and roll (or accelerometer readings). AOA triangulation is well known in the art. Line segment **1132** represents the direction of signal arrival to the antenna at whereabouts **1102** from MS_4 at whereabouts **1106**. Line segment **1134** represents the direction of signal arrival to the antenna at whereabouts **1102** from MS_5 at whereabouts **1110**. Line segment **1136** represents the direction of signal arrival to the antenna at whereabouts **1102** from MS_6 at whereabouts **1114**. In this example, the known locations of MS_j which are used to determine the location of MS **1000***e* allow triangulating the MS **1000***e* whereabouts using the AOA measurements. In fact, less triangular data in the illustration can be necessary for determining a highly confident whereabouts of MS **1000***e*. Alternative embodiments will use AOA measurements of outbound signals from the MS at whereabouts **1102** detected at antennas of whereabouts **1106** and/or **1110** and/or **1114**.

Missing Part Triangulation (MPT)

FIGS. **11**C and **11**D illustrations can be used in a complementary manner when only one or two TDOA measurements are available and/or not all stationary locations, or MS reference locations, are known at the time of calculation. Another example is when only one or two AOA angles is available and/or not all stationary locations, or MS reference locations, are known at the time of calculation. However, using what is available from each technology in conjunction with each other allows solving the MS whereabouts (e.g. blocks **952**/**954** processing above). MPT is one example of solving for missing parts using more than one location technology. Condition of data known for locating a MS (e.g. whereabouts **1106**, **1110** and **1114**) may be the following:

1) AAS=two angles and a side;
2) ASA=two angles and a common side;
3) SAS=two sides and the included angle; or
4) SSA=two sides and a non-included angle.

TDOA measurements are distances (e.g. time difference between when sent and when received), and AOA measurements are angles. Each of the four conditions are recognized (e.g. block **952** above), and data is passed for each of the four conditions for processing (e.g. block **954** above). For AAS (#**1**) and ASA (#**2**), processing (e.g. block **954**) finds the third angle by subtracting the sum of the two known angles from 180 degrees (i.e. using mathematical law that triangles' interior angles add up to 180 degrees), and uses the mathematical law of Sines (i.e. a/sin A=b/sin B=c/sin C) twice to find the second and third sides after plugging in the knowns and solving for the unknowns. For SAS (#**3**), processing (e.g. block **954**) uses the mathematical law of Cosines (i.e. $a^2=b^2+c^2-2bc\cos A$) to find the third side, and uses the mathematical law of Sines (sin A/a=sin B/b=sin C/c (derived from law of Sines above)) to find the second angle. For SSA (#**4**), processing (e.g. block **954**) uses the mathematical law of Sines (i.e. (sin A/a=sin B/b=sin C/c) twice to get the second angle, and mathematical law of Sines (a/sin A=b/sin B=c/sin C) to get the third side. Those skilled in the art recognize other useful trigonometric functions and formulas, and similar uses of the same trigonometric functions, for MPT depending on what data is known. The data discovered and processed depends on an embodiment, what reference locations are available, and which parts are missing for MPT. MPT uses different distances (time used to determine length in TDOA) and/or angles (from AOA or TDOA technologies) for deducing a MS location confidently (e.g. MPT). Those skilled in the art recognize that having known reference locations facilitates requiring less triangular information for deducing a MS location confidently. MPT embodiments may exist for any aforementioned wave spectrums.

FIG. **11**E depicts an illustration for describing various embodiments for automatically determining the location of an MS. An MS can be located relative other MSs which were located using any of a variety of location technologies, for example any of those of FIG. **9**A. An MS is heterogeneously located when one of the following conditions are met:

More than one location technology is used during travel of the MS;
More than one location technology is used to determine a single whereabouts of the MS;
MPT is used to locate the MS; and/or
ADLT is used to locate the MS.

The WDR queue **22** and interactions between MSs as described below cause the MS to be heterogeneously located without special consideration to any particular location technology. While WDR **1100** contains field **1100***e*, field **1100***d* provides a standard and generic measurement for evaluating WDRs from different location technologies, without concern for the location technology used. The highest confidence entries to a WDR queue **22** are used regardless of which location technology contributed to the WDR queue **22**.

LBX Configuration

FIG. **12** depicts a flowchart for describing an embodiment of MS initialization processing. Depending on the MS, there are many embodiments of processing when the MS is powered on, started, restarted, rebooted, activated, enabled, or the like. FIG. **12** describes the blocks of processing relevant to the present disclosure as part of that initialization processing. It is recommended to first understand discussions of FIG. **19** for knowing threads involved, and variables thereof. Initialization processing starts at block **1202** and continues to block **1204** where the MS Basic Input Output System (BIOS) is initialized appropriately, then to block **1206** where other character **32** processing is initialized, and then to block **1208** to see if NTP is enabled for this MS. Block **1206** may start the preferred number of listen/receive threads for feeding queue **26** and the preferred number of send threads for sending data inserted to queue **24**, in particular when transmitting CK **1304** embedded in usual data **1302** and receiving CK **1304** or **1314** embedded in usual data **1302** or **1312**, respectively. The number of threads started should be optimal for parallel processing across applicable channel(s). In this case, other character **32** threads are appropriately altered for embedded CK processing (sending at first opportune outbound transmission; receiving in usual inbound transmission).

If block **1208** determines NTP is enabled (as defaulted or last set by a user (i.e. persistent variable)), then block **1210** initializes NTP appropriately and processing continues to block **1212**. If block **1208** determines NTP was not enabled, then processing continues to block **1212**. Block **1210** embodiments are well known in the art of NTP implementations (also see block **1626**). Block **1210** may cause the starting of thread(s) associated with NTP. In some embodiments, NTP use is assumed in the MS. In other embodiments, appropriate NTP use is not available to the MS. Depending on the NTP embodiment, thread(s) may pull time synchronization information, or may listen for and receive pushed time information. Resources **38** (or other MS local resource) provides interface to an MS clock for referencing, maintaining, and generating date/time stamps at the MS. After block **1210** processing, the MS clock is synchronized to NTP. Because of initialization of the MS in FIG. **12**, block **1210** may rely on a connected service to initially get the startup synchronized NTP date/time. MS NTP processing will ensure the NTP enabled/disabled variable is dynamically set as is appropriate (using semaphore access) because an MS may not have continuous clock source access during travel when needed for resynchronization. If the MS does not have access to a clock source when needed, the NTP use variable is disabled. When the MS has (or again gets) access to a needed clock source, then the NTP use variable is enabled.

Thereafter, block **1212** creates shared memory to maintain data shared between processes/threads, block **1214** initializes persistent data to shared memory, block **1216** initializes any non-persistent data to shared memory (e.g. some statistics **14**), block **1218** creates system queues, and block **1220** creates semaphore(s) used to ensure synchronous access by concurrent threads to data in shared memory, before continuing to block **1222**. Shared memory data accesses appropriately utilize semaphore lock windows (semaphore(s) created at block **1220**) for proper access. In one embodiment, block **1220** creates a single semaphore for all shared memory accesses, but this can deteriorate performance of threads accessing unrelated data. In the preferred embodiment, there is a semaphore for each reasonable set of data of shared memory so all threads are fully executing whenever possible. Persistent data is that data which maintains values during no power, for example as stored to persistent storage **60**. This may include data **8** (including permissions **10**, charters **12**, statistics **14**, service directory **16**), data **20**, LBX history **30**, data **36**, resources **38**, and/or other data. Persistent data preferably includes at least the DLMV (see DLM role(s) list Variable below), ILMV (see ILM role(s) list Variable below), process variables **19***xx*-Max values (**19***xx*=**1902**, **1912**, **1922**, **1932**, **1942** and **1952** (see FIG. **19** discussions below)) for the last configured maximum number of threads to run in the

respective process, process variables **19***xx*-PID values (**19***xx*=**1902**, **1912**, **1922**, **1932**, **1942** and **1952** (see FIG. **19** discussions below)) for multi-purpose of: a) holding an Operating System Process Identifier (i.e. O/S PID) for a process started; and b) whether or not the respective process was last enabled (i.e. PID>0) or disabled (i.e. PID<=0), the confidence floor value (see FIG. **14**A), the WTV (see Whereabouts Timeliness Variable (see FIG. **14**A)), the NTP use variable (see FIG. **14**A) for whether or not NTP was last set to disabled or enabled (used at block **1208**), and the Source Periodicity Time Period (SPTP) value (see FIG. **14**B). There are reasonable defaults for each of the persistent data prior to the first use of MS **2** (e.g. NTP use is disabled, and only becomes enabled upon a successful enabling of NTP at least one time). Non-persistent data may include data involved in some regard to data **8** (and subsets of permissions **10**, charters **12**, statistics **14**, service directory **16**), data **20**, LBX history **30**, data **36**, resources **38**, queues, semaphores, etc. Block **1218** creates queues **22**, **24**, and **26**. Queues **1980** and **1990** are also created there if required. Queues **1980** and **1990** are not required when NTP is in use globally by participating data processing systems. Alternate embodiments may use less queues by threads sharing a queue and having a queue entry type field for directing the queue entry to the correct thread. Alternate embodiments may have additional queues for segregating entries of a queue disclosed for best possible performance. Other embodiments incorporate queues figuratively to facilitate explanation of interfaces between processing.

All queues disclosed herein are understood to have their own internally maintained semaphore for queue accesses so that queue insertion, peeking, accessing, etc uses the internally maintained semaphore to ensure two or more concurrently executing threads do not corrupt or misuse data to any queue. This is consistent with most operating system queue interfaces wherein a thread stays blocked (preempted) after requesting a queue entry until a queue entry appears in the queue. Also, no threads will collide with another thread when inserting, peeking, or otherwise accessing the same queue. Therefore, queues are implicitly semaphore protected. Other embodiments may use an explicit semaphore protected window around queue data accessing, in which case those semaphore(s) are created at block **1220**.

Thereafter, block **1222** checks for any ILM roles currently enabled for the MS (for example as determined from persistent storage of an ILM role(s) list Variable (ILMV) preferably preconfigured for the MS at first use, or configured as last configured by a user of the MS). ILM roles are maintained to the ILM role(s) list Variable (ILMV). The ILMV contains one or more entries for an ILM capability (role), each entry with a flag indicating whether it is enabled or disabled (marked=enabled, unmarked=disabled). If block **1222** determines there is at least one ILM role enabled (i.e. as marked by associated flag), then block **1224** artificially sets the corresponding **19***xx*-PID variables to a value greater than 0 for indicating the process(es) are enabled, and are to be started by subsequent FIG. **12** initialization processing. The **19***xx*-PID will be replaced with the correct Process Identifier (PID) upon exit from block **1232** after the process is started. Preferably, every MS can have ILM capability. However, a user may want to (configure) ensure a, DLM has no ILM capability enabled (e.g. or having no list present). In some embodiments, by default, every MS has an unmarked list of ILM capability maintained to the ILMV for 1) USE DLM REFERENCES and 2), USE ILM REFERENCES. USE DLM REFERENCES, when enabled (marked) in the ILMV, indicates to allow the MS of FIG. **12** processing to determine its whereabouts relative remote DLMs. USE ILM REFERENCES, when enabled (marked) in the ILMV, indicates to allow the MS of FIG. **12** processing to determine its whereabouts relative remote ILMs. Having both list items marked indicates to allow determining, MS whereabouts relative mixed DLMs and ILMs. An alternative embodiment may include a USE MIXED REFERENCES option for controlling the MS of FIG. **12** processing to determine its whereabouts relative mixed DLMs and/or ILMs. Alternative embodiments will enforce any subset of these options without exposing user configurations, for example on a MS without any means for being directly located.

For any of the ILMV roles of USE DLM REFERENCES, USE ILM REFERENCES, or both, all processes **1902**, **1912**, **1922**, **1932**, **1942** and **1952** are preferably started (i.e. **1902**-PID, **1912**-PID, **1922**-PID, **1932**-PID, **1942**-PID and **1952**-PID are artificially set at block **1224** to cause subsequent process startup at block **1232**). Characteristics of an anticipated LN-expanse (e.g. anticipated location technologies of participating MSs, MS capabilities, etc) will start a reasonable subset of those processes with at least process **1912** started. Block **1224** continues to block **1226**. If block **1222** determines there are no ILMV role(s) enabled, then block processing continues to block **1226**.

Block **1226** initializes an enumerated process name array for convenient processing reference of associated process specific variables described in FIG. **19**, and continues to block **1228** where the first member of the set is accessed for subsequent processing. The enumerated set of process names has a prescribed start order for MS architecture **1900**. Thereafter, if block **1230** determines the process identifier (i.e. **19***xx*-PID such that **19***xx* is **1902**, **1912**, **1922**, **1932**, **1942**, **1952** in a loop iteration of blocks **1228** through **1234**) is greater than 0 (e.g. this first iteration of **1952**-PID>0 implies it is to be started here; also implies process **1952** is enabled as used in FIGS. **14**A, **28**, **29**A and **29**B), then block **1232** spawns (starts) the process (e.g. **1952**) of FIG. **29**A to start execution of subordinate worker thread(s) (e.g. process **1952** thread(s)) and saves the real PID (Process Identifier) to the PID variable (e.g. **1952**-PID) returned by the operating system process spawn interface. Block **1232** passes as a parameter to the process of FIG. **29**A which process name to start (e.g. **1952**), and continues to block **1234**. If block **1230** determines the current process PID variable (e.g. **1952**-PID) is not greater than 0 (i.e. not to be started; also implies is disabled as used in FIGS. **14**A, **28**, **29**A and **29**B), then processing continues to block **1234**. Block **1234** checks to see if all process names of the enumerated set (pattern of **19***xx*) have been processed (iterated) by blocks **1228** through **1234**. If block **1234** determines that not all process names in the set have been processed (iterated), then processing continues back to block **1228** for handling the next process name in the set. If block **1234** determines that all process names of the enumerated set were processed, then block **1236** checks the DLMV (DLM role(s) list Variable). Blocks **1228** through **1234** iterate every process name of FIG. **19** to make sure that each is started in accordance with non-zero **19***xx*-PID variable values at FIG. **12** initialization.

Block **1236** checks for any DLM roles currently enabled for the MS (for example as determined from persistent storage of a DLM role(s) list Variable (DLMV) preferably preconfigured for the MS at first use if the MS contains DLM capability). DLM capability (roles), whether on-board at the MS, or determined during MS travels (see block **288**), is maintained to the DLM role(s) list Variable (DLMV). The DLMV contains one or more entries for a DLM capability (role), each (role) entry with a flag indicating whether it is enabled or disabled (marked =enabled, unmarked =disabled).

If block **1236** determines there is at least one DLM role enabled (i.e. as marked by associated flag), then block **1238** initializes enabled role(s) appropriately and processing continues to block **1240**. Block **1238** may cause the starting of thread(s) associated with enabled DLM role(s), for DLM processing above (e.g. FIGS. **2**A through **9**B). Block **1238** may invoke API(s), enable flag(s), or initialize as is appropriate for DLM processing described above. Such initializations are well known in the art of prior art DLM capabilities described above. If block **1236** determines there are no DLM roles to initialize at the MS, then processing continues to block **1240**. Any of the FIG. **9**A technologies are eligible in the DLMV as determined to be present at the MS and/or as determined by historical contents of the WDR queue **22** (e.g. location technology field **1100**e with MS ID field **1100***a* for this MS) and/or determined by LBX history **30**. Application Programming Interfaces (APIs) may also be used to determine MS DLM capability (role(s)) for entry(s) to the DLMV.

Block **1240** completes LBX character initialization, and FIG. **12** initialization processing terminates thereafter at block **1242**. Depending on what threads were started as part of block **1206**, Block **1240** may startup the preferred number of listen/receive threads for feeding queue **26** and the preferred number of send threads for sending data inserted to queue **24**, in particular when transmitting new data **1302** and receiving new data **1302** or **1312**. The number of threads started should be optimal for parallel processing across applicable channel(s). Upon encounter of block **1242**, the MS is appropriately operational, and a user at the MS of FIG. **12** processing will have the ability to use the MS and applicable-user interfaces thereof.

With reference now to FIG. **29**A, depicted is a flowchart for describing a preferred embodiment of a process for starting a specified number of threads in a specified thread pool. F*ig*. **29**A is in itself an O/S process, has a process identifier (PID) after being started, will contain at least two threads of processing after being started, and is generic in being able to take on the identity of any process name passed to it (e.g. **19***xx*) with a parameter (e.g. from block **1232**). FIG. **29**A represents the parent thread of a **19***xx* process. The FIG. **29**A process is generic for executing any of processes **19***xx* (i.e. **1902**, **1912**, **1922**, **1932**, **1942** and **1952**) with the prescribed number of worker threads using the **19***xx*-Max configuration (i.e. **1902**-Max, **1912**-Max, **1922**-Max, **1932**-Max, **1942**-Max and **1952**-Max). FIG. **29**A will stay running until it (first all of its worker thread(s)) is terminated. FIG. **29**A consists of an O/S Process **19***xx* with at least a parent thread (main thread) and one worker thread (or number of worker threads for FIG. **19** processing as determined by **19***xx*-Max). The parent thread has purpose to stay running while all worker threads are running, and to own intelligence for starting worker threads and terminating the process when all worker threads are terminated. The worker threads are started subordinate to the FIG. **29**A process at block **2912** using an O/S start thread interface.

A **19***xx* (i.e. **1902**, **1912**, **1922**, **1932**, **1942** and **1952**) process starts at block **2902** and continues to block **2904** where the parameter passed for which process name to start (i.e. take on identity on is determined (e.g. **1952**). Thereafter, block **2906** creates a RAM semaphore (i.e. operating system term for a well performing Random Access Memory (RAM) semaphore with scope only within the process (i.e. to all threads of the process)). The local semaphore name preferably uses the process name prefix (e.g. **1952**-Sem), and is used to synchronize threads within the process. RAM semaphores perform significantly better than global system semaphores. Alternate embodiments will have process semaphore(s) created at block **1220** in advance. Thereafter, block **2908** initializes a thread counter (e.g. **1952**-Ct) to 0 for counting the number of worker threads actually started within the 19xx process (e.g. **1952**), block **2910** initializes a loop variable J to 0, and block **2912** starts a worker thread (the first one upon first encounter of block **2912** for a process) in this process (e.g. process **1902** starts worker thread FIG. **20**, . . . , process **1952** starts worker thread FIG. **26**A—see architecture **1900** description below).

Thereafter, block **2914** increments the loop variable by 1 and block **2916** checks if all prescribed worker threads have been started. Block **2916** accesses the **19***xx*-Max (e.g. **1952**-Max) variable from shared memory using a semaphore for determining the maximum number of threads to start in the process worker thread pool. If block **2916** determines all worker threads have been started, then processing continues to block **2918**. If block **2916** determines that not all worker threads have been started for the process of FIG. **29**A, then processing continues back to block **2912** for starting the next worker thread. Blocks **2912** through **2916** ensure the **19***xx*-Max,(e.g. **1952**-Max) number of worker threads are started within the process of FIG. **29**A.

Block **2918** waits until all worker threads of blocks **2912** through **2916** have been started, as indicated by the worker threads themselves. Block **2918** waits until the process **19***xx*-Ct variable has been updated to the prescribed **19***xx*-Max value by the started worker threads, thereby indicating they are all up and running. When all worker threads are started (e.g. **1952**-Ct=**1952**-Max), thereafter block **2920** waits (perhaps a very long time) until the worker thread count (e.g. **1952**-Ct) has been reduced back down to 0 for indicating that all worker threads have been terminated, for example when the user gracefully powers off the MS. Block **2920** continues to block **2922** when all worker threads have been terminated. Block **2922** sets the shared memory variable for the **19***xx* process (e.g. **1952**-PID) to 0 using a semaphore for indicating that the **19***xx* (e.g. **1952**) process is disabled and no longer running. Thereafter, the **19***xx* process terminates at block **2924**. Waiting at blocks **2918** and **2920** are accomplished in a variety of well known methods:

- Detect signal sent to process by last started (or terminated) worker thread that thread count is now MAX (or 0); or
- Loop on checking the thread count with sleep time between checks, wherein within the loop there is a check of the current count (use RAM semaphore to access), and processing exits the loop (and block) when the count has reached the sought value; or
- Use of a semaphore for a count variable which causes the parent thread of FIG. **29**A to stay blocked prior to the count reaching its value, and causes the parent thread to become cleared (will leave wait block) when the count reaches its sought value.

Starting threads of processing in FIG. **29**A has been presented from a software perspective, but there are hardware/firmware thread embodiments which may be started appropriately to accomplish the same functionality. If the MS operating system does not have an interface for returning the PID at block **1232**, then FIG. **29**A can have a block (e.g. **2905**) used to determine its own PID for setting the **19***xx*-PID variable.

FIGS. **13**A through **13**C depict an illustration of data processing system wireless data transmissions over some wave spectrum. Embodiments may exist for any of the aforementioned wave spectrums, and data carried thereon may or may not be encrypted (e.g. encrypted WDR information). With reference now to FIG. **13**A, a MS, for example a DLM **200***a*, sends/broadcasts data such as a data **1302** in a manner well known to those skilled in the art, for example other character

32 processing data. When a Communications Key (CK) 1304 is embedded within data 1302, data 1302 is considered usual communications data (e.g. protocol, voice, or any other data over conventional forward channel, reverse channel, voice data channel, data transmission channel, or any other prior art use channel) which has been altered to contain CK 1304. Data 1302 contains a CK 1304 which can be detected, parsed, and processed when received by another MS or other data processing system in the vicinity of the MS (e.g. DLM 200*a*) as determined by the maximum range of transmission 1306. CK 1304 permits "piggy-backing" on current transmissions to accomplish new functionality as disclosed herein. Transmission from the MS radiate out from it in all directions in a manner consistent with the wave spectrum used. The radius 1308 represents a first range of signal reception from the MS 200*a*, perhaps by another MS (not shown). The radius 1310 represents a second range of signal reception from the MS 200*a*, perhaps by another MS (not shown). The radius 1311 represents a third range of signal reception from the MS 200*a*, perhaps by another MS (not shown). The radius 1306 represents a last and maximum range of signal reception from the MS 200*a*, perhaps by another MS (not shown). MS design for maximum radius 1306 may take into account the desired maximum range versus acceptable wave spectrum exposure health risks for the user of the MS. The time of transmission from MS 200*a* to radius 1308 is less than times of transmission from MS 200*a* to radiuses 1310, 1311, or 1306. The time of transmission from MS 200*a* to radius 1310 is less than times of transmission from MS 200*a* to radiuses 1311 or 1306. The time of transmission from MS 200*a* to radius 1311 is less than time of transmission from MS 200*a* to radius 1306.

In another embodiment, data 1302 contains a Communications Key (CK) 1304 because data 1302 is new transmitted data in accordance with the present disclosure. Data 1302 purpose is for carrying CK 1304 information for being detected, parsed, and processed when received by another MS or other data processing system in the vicinity of the MS (e.g. DLM 200*a*) as determined by the maximum range of transmission 1306.

With reference now to FIG. 13B, a MS, for example an ILM 1000*k*, sends/broadcasts data such as a data 1302 in a manner well known to those skilled in the art. Data 1302 and CK 1304 are as described above for FIG. 13A. Data 1302 or CK 1304 can be detected, parsed, and processed when received by another MS or other data processing system in the vicinity of the MS (e.g. ILM 1000*k*) as determined by the maximum range of transmission 1306. Transmission from the MS radiate out from it in all directions in a manner consistent with the wave spectrum used, and as described above for FIG. 13A.

With reference now to FIG. 13C, a service or set of services sends/broadcasts data such as a data packet 1312 in a manner well known to those skilled in the art, for example to service other character 32 processing. When a Communications Key (CK) 1314 is embedded within data 1312, data 1312 is considered usual communications data (e.g. protocol, voice, or any other data over conventional forward channel, reverse channel, voice data channel, data transmission channel, or any other prior art use channel) which has been altered to contain CK 1314. Data 1312 contains a CK 1314 which can be detected, parsed, and processed when received by an MS or other data processing system in the vicinity of the service(s) as determined by the maximum range of transmission 1316. CK 1314 permits "piggy-backing" on current transmissions to accomplish new functionality as disclosed herein. Transmissions radiate out in all directions in a manner consistent with the wave spectrum used, and data carried thereon may or may not be encrypted (e.g. encrypted WDR information). The radius 1318 represents a first range of signal reception from the service (e.g. antenna thereof, perhaps by a MS (not shown). The radius 1320 represents a second range of signal reception from the service (e.g. antenna thereof), perhaps by a MS (not shown). The radius 1322 represents a third range of signal reception from the service (e.g. antenna thereof, perhaps by a MS (not shown). The radius 1316 represents a last and maximum range of signal reception from the service (e.g. antenna thereof, perhaps by a MS (not shown). The time of transmission from service to radius 1318 is less than times of transmission from service to radiuses 1320, 1322, or 1316. The time of transmission from service to radius 1320 is less than times of transmission from service to radiuses 1322 or 1316. The time of transmission from service to radius 1322 is less than time of transmission from service to radius 1316. In another embodiment, data 1312 contains a Communications Key (CK) 1314 because data 1312 is new transmitted data in accordance with the present disclosure. Data 1312 purpose is for carrying CK 1314 information for being detected, parsed, and processed when received by another MS or data processing system in the vicinity of the service(s) as determined by the maximum range of transmission.

In some embodiments, data 1302 and 1312 are prior art wireless data transmission packets with the exception of embedding a detectable CK 1304 and/or CK 1314, respectively. Usual data communications of MSs are altered to additionally contain the CK so data processing systems in the vicinity can detect, parse, and process the CK. Appropriate send and/or broadcast channel processing is used. In other embodiments, data 1302 and 1312 are new broadcast wireless data transmission packets for containing CK 1304 and CK 1314, respectively. A MS may use send queue 24 for sending/broadcasting packets to data processing systems in the vicinity, and may use the receive queue 26 for receiving packets from other data processing systems in the vicinity. Contents of CKs (Communications Keys) depend on which LBX features are in use and the functionality intended.

In the case of "piggybacking" on usual communications, receive queue 26 insertion processing simply listens for the usual data and when detecting CK presence, inserts CK information appropriately to queue 26 for subsequent processing. Also in the case of "piggybacking" on usual communications, send queue 24 retrieval processing simply retrieves CK information from the queue and embeds it in an outgoing data 1302 at first opportunity. In the case of new data communications, receive queue 26 insertion processing simply listens for the new data containing CK information, and inserts CK information appropriately to queue 26 for subsequent processing. Also in the case of new data communications, send queue 24 retrieval processing simply retrieves CK information from the queue and transmits CK information as new data.

LBX: LN-EXPANSE Configuration

FIG. 14A depicts a flowchart for describing a preferred embodiment of MS LBX configuration processing. FIG. 14 is of Self Management Processing code 18. MS LBX configuration begins at block 1402 upon user action to start the user interface and continues to block 1404 where user interface objects are initialized for configurations described below with current settings that are reasonable for display to available user interface real estate. Thereafter, applicable settings are presented to the user at block 1406 with options. Block 1406 preferably presents to the user at least whether or not

DLM capability is enabled (i.e. MS to behave as a DLM=at least one role of DLMV enabled), whether or not ILM capability is enabled (i.e. MS to behave as an ILM at least one role of ILMV enabled), and/or whether or not this MS should participate in the LN-expanse as a source location for other MSs (e.g. process **1902** and/or **1942** enabled). Alternative embodiments will further present more or less information for each of the settings, or present information associated with other FIG. **14** blocks of processing. Other embodiments will not configure DLM settings for an MS lacking DLM capability (or when all DLMV roles disabled). Other embodiments will not configure ILM settings when DLM capability is present. Block **1406** continues to block **1408** where processing waits for user action in response to options. Block **1408** continues to block **1410** when a user action is detected. If block **1410** determines the user selected to configure DLM capability (i.e. DLMV role(s)), then the user configures DLM role(s) at block **1412** and processing continues back to block **1406**. Block **1412** processing is described by FIG. **15**A. If block **1410** determines the user did not select to configure DLM capability (i.e. DLMV role(s)), then processing continues to block **1414**. If block **1414** determines the user selected to configure ILM capability (i.e. ILMV role(s)), then the user configures ILM role(s) at block **1416** and processing continues back to block **1406**. Block **1416** processing is described by FIG. **15**B. If block **1414** determines the user did not select to configure ILM capability (i.e. ILMV role(s)), then processing continues to block **1418**. If block **1418** determines the user selected to configure NTP use, then the user-configures NTP use at block **1420** and processing continues back to block **1406**. Block **1420** processing is described by FIG. **16**. If block **1418** determines the user did not select to configure NTP use, then processing continues to block **1422**.

If block **1422** determines the user selected to maintain the WDR queue, then the user maintains WDRs at block **1424** and processing continues back to block **1406**. Block **1424** processing is described by FIG. **17**. Blocks **1412**, **1416**, **1420** and **1424** are understood to be delimited by appropriate semaphore control to avoid multi-threaded access problems. If block **1422** determines the user did not select to maintain the WDR queue, then processing continues to block **1426**. If block **1426** determines the user selected to configure the confidence floor value, then block **1428** prepares parameters for invoking a Configure Value procedure (parameters for reference (address) of value to configure; and validity criteria of value to configure), and the Configure Value procedure of FIG. **18** is invoked at block **1430** with the two (2) parameters. Thereafter, processing continues back to block **1406**. Blocks **1428** and **1430** are understood to be delimited by appropriate semaphore control when modifying the confidence floor value since other threads can access the floor value.

The confidence floor value is the minimum acceptable confidence value of any field **1100***d* (for example as checked by block **276**). No WDR with a field **1100***d* less than the confidence floor value should be used to describe MS whereabouts. In an alternative embodiment, the confidence floor value is enforced as the same value across an LN-expanse with no user control to modify it. One embodiment of FIG. **14** does not permit user control over a minimum acceptable confidence floor value. Various embodiments will default the floor value. Block **1812** enforces an appropriate value in accordance with the confidence value range implemented (e.g. value from 1 to 100). Since the confidence of whereabouts is likely dependent on applications in use at the MS, the preferred embodiment is to permit user configuration of the acceptable whereabouts confidence for the MS. A new confidence floor value can be put to use at next thread(s) startup, or can be used instantly with the modification made, depending on the embodiment. The confidence floor value can be used to filter out WDRs prior to inserting to queue **22**, filter out WDRs when retrieving from queue **22**, filter out WDR information when listening on channel(s) prior to inserting to queue **26**, and/or used in accessing queue **22** for any reason (depending on embodiments). While confidence is validated on both inserts and queries (retrievals/peeks), one or the other validation is fine (preferably on inserts). It is preferred that executable code incorporate checks where applicable since the confidence floor value can be changed after queue **22** is in use. Also, various present disclosure embodiments may maintain all confidences to queue **22**, or a particular set of acceptable confidences.

If block **1426** determines the user did not select to configure the confidence floor value, then processing continues to block **1432**. If block **1432** determines the user selected to configure the Whereabouts Timeliness Variable (WTV), then block **1434** prepares parameters for invoking the Configure Value procedure (parameters for reference (address) of value to configure; and validity criteria of value to configure), and the Configure Value procedure of FIG. **18** is invoked at block **1430** with the two (2) parameters. Thereafter, processing continues back to block **1406**. Blocks **1434** and **1430** are understood to be delimited by appropriate semaphore control when modifying the WTV since other threads can access the WTV.

A critical configuration for MS whereabouts processing is whereabouts timeliness. Whereabouts timeliness is how often (how timely) an MS should have accurate whereabouts. Whereabouts timeliness is dependent on how often the MS is updated with whereabouts information, what technologies are available or are in the vicinity, how capable the MS is of maintaining whereabouts, processing speed(s), transmission speed(s), known MS or LN-expanse design constraints, and perhaps other factors. In some embodiments, whereabouts timeliness is as soon as possible. That is, MS whereabouts is updated whenever possible as often as possible. In fact, the present disclosure provides an excellent system and methodology to accomplish that by leveraging location technologies whenever and wherever possible. However, there should be balance when considering less capable processing of a MS to prevent hogging CPU cycles from other applications at the MS. In other embodiments, a hard-coded or preconfigured time interval is used for keeping an MS informed of its whereabouts in a timely manner. For example, the MS should know its own whereabouts at least every second, or at least every 5 seconds, or at least every minute, etc. Whereabouts timeliness is critical depending on the applications in use at the MS. For example, if MS whereabouts is updated once at the MS every 5 minutes during high speeds of travel when using navigation, the user has a high risk of missing a turn during travel in downtown cities where timely decisions for turns are required. On the other hand, if MS whereabouts is updated every 5 seconds, and an application only requires an update accuracy to once per minute, then the MS may be excessively processing.

In some embodiments, there is a Whereabouts Timeliness Variable (WTV) configured at the MS (blocks **1432**, **1434**, **1430**). Whether it is user configured, system configured, or preset in a system, the WTV is used to:

- Define the maximum period of time for MS whereabouts to become stale at any particular time;
- Cause the MS to seek its whereabouts if whereabouts information is not up to date in accordance with the WTV; and
- Prevent keeping the MS too busy with keeping abreast of its own whereabouts.

In another embodiment, the WTV is automatically adjusted based on successes or failures of automatically locating the MS. As the MS successfully maintains timely whereabouts, the WTV is maintained consistent with the user configured, system configured, or preset value, or in accordance with active applications in use at the time. However, as the MS fails in maintaining timely whereabouts, the WTV is automatically adjusted (e.g. to longer periods of time to prevent unnecessary wasting of power and/or CPU resources). Later, as whereabouts become readily available, the WTV can be automatically adjusted back to the optimal value. In an emergency situation, the user always has the ability to force the MS to determine its own whereabouts anyway. (Blocks **856** and **862** through **878**, in light of a WDR request and WDR response described for architecture **1900**). In embodiments where the WTV is adjusted in accordance with applications in use at the time, the most demanding requirement of any application started is maintained to the WTV. Preferably, each application of the MS initializes to an API of the MS with a parameter of its WTV requirements. If the requirement is more timely than the current value, then the more timely value is used. The WTV can be put to use at next thread(s) startup, or can be used instantly with the modification made, depending on the embodiment.

If block **1432** determines the user did not select to configure the WTV, then processing continues to block **1436**. If block **1436** determines the user selected to configure the maximum number of threads in a **19***xx* process (see **19***xx*-Max variable in FIG. **19** discussions), then block **1438** interfaces with the user until a valid **19***xx*-max variable is selected, and processing continues to block **1440**. If block **1440** determines the **19***xx* process is already running (i.e. **19***xx*-PID>0 implies it is enabled), then an error is provided to the user at block **1442**, and processing continues back to block **1406**. Preferably, block **1442** does not continue back to block **1406** until the user acknowledges the error (e.g. with a user action). If block **1440** determines the user selected **19***xx* process (process **1902**, process **1912**, process **1922**, process **1932**, process **1942**, or process **1952**) is not already running (i.e. **19***xx*-PID=0 implies it is disabled), then block **1444** prepares parameters for invoking the Configure Value procedure (parameters for reference (address) of **19***xx*-Max value to configure; and validity criteria of value to configure), and the Configure Value procedure of FIG. **18** is invoked at block **1430** with the two (2) parameters. Thereafter, processing continues back to block **1406**. Blocks **1438**, **1440**, **1444** and **1430** are understood to be delimited by appropriate semaphore control when modifying the **19***xx*-Max value since other threads can access it. The **19***xx*-Max value should not be modified while the 19xx process is running because the number of threads to terminate may be changed prior to terminating. An alternate embodiment of modifying a process number of threads will dynamically modify the number of threads in anticipation of required processing.

If block **1436** determines the user did not select to configure a process thread maximum (**19***xx*-Max), then block **1446** checks to see if the user selected to (toggle) disable or enable a particular process (i.e. a **19***xx* process of FIG. **19**). If block **1446** determines the user did select to toggle enabling/disabling a particular FIG. **19** process, then block **1448** interfaces with the user until a valid **19***xx* process name is selected, and processing continues to block **1450**. If block **1450** determines the **19***xx* process is already running (i.e. **19***xx*-PID>0 implies it is enabled), then block **1454** prepares parameters (just as does block **2812**). Thereafter, block **1456** invokes FIG. **29**B processing Oust as does block **2814**). Processing then continues back to block **1406**. If block **1450** determines the **19***xx* process is not running (i.e. **19***xx*-PID=0 implies it is disabled), then block **1452** invokes FIG. **29**A processing (just as does block **1232**). Processing then continues back to block **1406**. Block **1456** does not continue back to block **1406** until the process is completely terminated. Blocks **1448**, **1450**, **1452**, **1454** and **1456** are understood to be delimited by appropriate semaphore control.

Preferred embodiments of blocks **1446** and **1448** use convenient names of processes being started or terminated, rather than convenient brief process names such as **1902**, **1912**, **1922**, **1932**, **1942**, or **1952** used in flowcharts. In some embodiments, the long readable name is used, such as whereabouts broadcast process (**1902**), whereabouts collection process (**1912**), whereabouts supervisor process (**1922**), timing determination process (**1932**), WDR request process (**1942**), and whereabouts determination process (**1952**). For example, the user may know that the whereabouts supervisor process enabled/disabled indicates whether or not to have whereabouts timeliness monitored in real time. Enabling the whereabouts supervisor process enables monitoring for the WTV in real time, and disabling the whereabouts supervisor process disables monitoring the WTV in real time.

In another embodiment of blocks **1446** and **1448**, a completely new name or description may be provided to any of the processes to facilitate user interface usability. For example, a new name Peer Location Source Variable (PLSV) can be associated to the whereabouts broadcast process **1902** and/or **1942**. PLSV may be easier to remember. If the PLSV was toggled to disabled, the whereabouts broadcast process **1902** and/or **1942** terminates. If the PLSV was toggled to enabled, the whereabouts broadcast process **1902** and/or **1942** is started. It may be easier to remember that the PLSV enables/disables whether or not to allow this MS to be a location source for other MSs in an LN-expanse.

In other embodiments, a useful name (e.g. PLSV) represents starting and terminating any subset of **19***xx* processes (a plurality (e.g. **1902** and **1942**)) for simplicity. In yet other embodiments, FIG. **14**A/**14**B can be used to start or terminate worker thread(s) in any process, for example to throttle up more worker threads in a process, or to throttle down for less worker threads in a process, perhaps modifying thread instances to accommodate the number of channels for communications, or for the desired performance. There are many embodiments for fine tuning the architecture **1900** for optimal peer to peer interaction. In yet other embodiments, toggling may not be used. There may be individual options available at block **1408** for setting any data of this disclosure. Similarly, the **19***xx*-Max variables may be modified via individual user friendly names and/or as a group of **19***xx*-Max variables.

Referring back to block **1446**, if it is determined the user did not select to toggle for enabling/disabling process(es), then processing continues to block **1458**. If block **1458** determines the user selected to exit FIG. **14**A/**14**B configuration processing, then block **1460** terminates the user interface appropriately and processing terminates at block **1462**. If block **1458** determines the user did not select to exit the user interface, then processing continues to block **1466** of FIG. **14**B by way of off page connector **1464**.

With reference now to FIG. **14**B, depicted is a continued portion flowchart of FIG. **14**A for describing a preferred embodiment of MS LBX configuration processing. If block **1466** determines the user selected to configure the Source Periodicity Time Period (SPTP) value, then block **1468** prepares parameters for invoking the Configure Value procedure (parameters for reference (address) of value to configure; and validity criteria of value to configure), and the Configure Value procedure of FIG. **18** is invoked at block **1470** with the

two (2) parameters. Thereafter, processing continues back to block **1406** by way of off page connector **1498**. Blocks **1468** and **1470** are understood to be delimited by appropriate semaphore control when modifying the SPTP value since other threads can access it. The SPTP configures the time period between broadcasts by thread(s) **1902**, for example 5 seconds. Some embodiments do not permit configuration of the SPTP.

If block **1466** determines the user did not select to configure the SPTP value, then processing continues to block **1472**. If block **1472** determines the user selected to configure service propagation, then the user configures service propagation at block **1474** and processing continues back to block: **1406** by way of off page connector **1498**. If block **1472** determines the user did not select to configure service propagation, then processing continues to block **1476**.

If block **1476** determines the user selected to configure permissions **10**, then the user configures permissions at block **1478** and processing continues back to block **1406** by way of off page connector **1498**. If block **1476** determines the user did not select to configure permissions **10**, then processing continues to block **1480**. If block **1480** determines the user selected to configure charters **12**, then the user configures charters **12** at block **1482** and processing continues back to block **1406** by way of off page connector **1498**. If block. **1480** determines the user did not select to configure charters **12**, then processing continues to block **1484**. If block **1484** determines the user selected to configure statistics **14**, then the user configures statistics **14** at block **1486** and processing continues back to block **1406** by way of off page connector **1498**. If block **1484** determines the user did not select to configure statistics **14**, then processing continues to block **1488**. If block **1488** determines the user selected to configure service informant code **28**, then the user configures code **28** at block **1490** and processing continues back to block **1406** by way of off page connector **1498**. If block **1488** determines the user did not select to configure code **28**, then processing continues to block **1492**. If block **1492** determines the user selected to maintain LBX history **30**, then the user maintains LBX history at block **1494** and processing continues back to block **1406** by way of off page connector **1498**. If block **1492** determines the user did not select to maintain LBX history **30**, then processing continues to block **1496**.

Block **1496** handles other user interface actions leaving block **1408**, and processing continues back to block **1406** by way of off page connector **1498**.

Details of blocks **1474**, **1478**, **1482**, **1486**, **1490**, **1494**, and perhaps more detail to block **1496**, are described with other flowcharts. Appropriate semaphores are requested at the beginning of block processing, and released at the end of block processing, for thread safe access to applicable data at risk of being accessed by another thread of processing at the same time of configuration. In some embodiments, a user/administrator with secure privileges to the MS has ability to perform any subset of configurations of FIGS. **14**A and **14**B processing, while a general user may not. Any subset of FIG. **14** configuration may appear in alternative embodiments, with or without authenticated administrator access to perform configuration.

FIG. **15**A depicts a flowchart for describing a preferred embodiment of DLM role configuration processing of block **1412**. Processing begins at block **1502** and continues to block **1504** which accesses current DLMV settings before continuing to block **1506**. If there were no DLMV entries (list empty) as determined by block **1506**, then block **1508** provides an error to the user and processing terminates at block **1518**. The DLMV may be empty when the MS has no local DLM capability and there hasn't yet been any detected DLM capability, for example as evidenced by WDRs inserted to queue **22**. Preferably, the error presented at block **1508** requires the user to acknowledge the error (e.g. with a user action) before block **1508** continues to block **1518**. If block **1506** determines at least one entry (role) is present in the DLMV, then the current DLMV setting(s) are saved at block **1510**, the manage list processing procedure of FIG. **15**C is invoked at block **1512** with the DLMV as a reference (address) parameter, and processing continues to block **1514**.

Block **1514** determines if there were any changes to the DLMV from FIG. **15**C processing by comparing the DLMV after block **1512** with the DLMV saved at block **1510**. If there were changes via FIG. **15**C processing, such as a role which was enabled prior to block **1512** which is now disabled, or such as a role which was disabled prior to block **1512** which is now enabled, then block **1514** continues to block **1516** which handles the DLMV changes appropriately. Block **1516** continues to block **1518** which terminates FIG. **15**A processing. If block **1514** determines there were no changes via block **1512**, then processing terminates at block **1518**.

Block **1516** enables newly enabled role(s) as does block **1238** described for FIG. **12**. Block **1516** disables newly disabled role(s) as does block **2804** described for FIG. **28**.

FIG. **15**B depicts a flowchart for describing a preferred embodiment of ILM role configuration processing of block **1416**. Processing begins at block **1522** and continues to block **1524** which accesses current ILMV settings before continuing to block **1526**. If there were no ILMV entries (list empty) as determined by block **1526**, then block **1528** provides an error to the user and processing terminates at block **1538**. The ILMV may be empty when the MS is not meant to have ILM capability. Preferably, the error presented at block **1528** requires the user to acknowledge the error before block **1528** continues to block **1538**. If block **1526** determines at least one entry (role) is present in the ILMV, then the current ILMV setting(s) are saved at block **1530**, the manage list processing procedure of FIG. **15**C is invoked with a reference (address) parameter of the ILMV at block **1532**, and processing continues to block **1534**.

Block **1534** determines if there were any changes to the ILMV from FIG. **15**C processing by comparing the ILMV after block **1532** with the ILMV saved at block **1530**. If there were changes via FIG. **15**C processing, such as a role which was enabled prior to block **1532** which is now disabled, or such as a role which was-disabled prior to block **1532** which is now enabled, then block **1534** continues to block **1536** which handles the ILMV changes appropriately. Block **1536** continues to block **1538** which terminates FIG. **15**B processing. If block **1534** determines there were no changes via block **1532**, then processing terminates at block **1538**.

Block **1536** enables newly enabled role(s) as does blocks **1224** through **1234** described for FIG. **12**. Block **1536** disables newly disabled role(s) as does blocks **2806** through **2816** described for FIG. **28**.

FIG. **15**C depicts a flowchart for describing a preferred embodiment of a procedure for Manage List processing. Processing starts at block **1552** and continues to block **1554**. Block **1554** presents the list (DLM capability if arrived to by way of FIG. **15**A; ILM capability if arrived to by way of FIG. **15**B) to the user, as passed to FIG. **15**C processing with the reference parameter by the invoker, with which list items are marked (enabled) and which are unmarked (disabled) along with options, before continuing to block **1556** for awaiting user action. Block **1554** highlights currently enabled roles, and ensures disabled roles are not highlighted in the presented list. When a user action is detected at block **1556**, thereafter,

block **1558** checks if a list entry was enabled (marked) by the user, in which case block **1560** marks the list item as enabled, saves it to the list (e.g. DLMV or ILMV), and processing continues back to block **1554** to refresh the list interface. If block **1558** determines the user did not respond with an enable action, then block **1562** checks for a disable action. If block **1562** determines the user wanted to disable a list entry, then block **1564** marks (actually unmarks it) the list item as disabled, saves it to the list (e.g. DLMV or ILMV), and processing continues back to block **1554**. If block **1562** determines the user did not want to disable a list item, then block **1566** checks if the user wanted to exit FIG. **15**C processing. If block **1566** determines the user did not select to exit list processing, then processing continues to block **1568** where other user interface actions are appropriately handled and then processing continues back to block **1554**. If block **1566** determines the user did select to exit manage list processing, then FIG. **15**C processing appropriately returns to the caller at block **1570**.

FIG. **15**C interfaces with the user for desired DLMV (via FIG. **15**A) or ILMV (via FIG. **15**B) configurations. In some embodiments, it makes sense to have user control over enabling or disabling DLM and/or ILM capability (roles) to the MS, for example for software or hardware testing.

FIG. **16** depicts a flowchart for describing a preferred embodiment of NTP use configuration processing of block **1420**. Processing starts at block **1602** and continues to block **1604** where the current NTP use setting is accessed. Thereafter, block **1606** presents the current NTP use setting to its value of enabled or disabled along with options, before continuing to block **1608** for awaiting user action. When a user action is detected at block **1608**, block **1610** checks if the NTP use setting was disabled at block **1608**, in which case block **1612** terminates NTP use appropriately, block **1614** sets (and saves) the NTP use setting to disabled, and processing continues back to block **1606** to refresh the interface. Block **1612** disables NTP as does block **2828**.

If block **1610** determines the user did not respond for disabling NTP, then block **1616** checks for a toggle to being enabled. If block **1616** determines the user wanted to enable NTP use, then block **1618** accesses known NTP server address(es) (e.g. ip addresses preconfigured to the MS, or set with another user interface at the MS), and pings each one, if necessary, at block **1620** with a timeout. As soon as one NTP server is determined to be reachable, block **1620** continues to block **1622**. If no NTP server was reachable, then the timeout will have expired for each one tried at block **1620** for continuing to block **1622**. Block **1622** determines if at least one NTP server was reachable at block **1620**. If block **1622** determines no NTP server was reachable, then an error is presented to the user at block **1624** and processing continues back to block **1606**. Preferably, the error presented at block **1624** requires the user to acknowledge the error before block **1624** continues to block **1606**. If block **1622** determines that at least one NTP server was reachable, then block **1626** initializes NTP use appropriately, block **1628** sets the NTP use setting to enabled (and saves), and processing continues back to block **1606**. Block **1626** enables NTP as does block **1210**.

Referring back to block **1616**, if it is determined the user did not want to enable NTP use, then processing continues to block **1630** where it is checked if the user wanted to exit FIG. **16** processing. If block **1630** determines the user did not select to exit FIG. **16** processing, then processing continues to block **1632** where other user interface actions leaving block **1608** are appropriately handled, and then processing continues back to block **1606**. If block **1630** determines the user did select to exit processing, then FIG. **16** processing terminates at block **1634**.

FIG. **17** depicts a flowchart for describing a preferred embodiment of WDR maintenance processing of block **1424**. Processing starts at block **1702** and continues to block **1704** where it is determined if there are any WDRs of queue **22**. If block **1704** determines there are no WDRs for processing, then block **1706** presents an error to the user and processing continues to block **1732** where FIG. **17** processing terminates. Preferably, the error presented at block **1706** requires the user to acknowledge the error before block **1706** continues-to block **1732**. If block **1704** determines there is at least one WDR, then processing continues to block **1708** where the current contents of WDR queue **22** is appropriately presented to the user (in a scrollable list if necessary). Thereafter, block **1710** awaits user action. When a user action is detected at block **1710**, block **1712** checks if the user selected to delete a WDR from queue **22**, in which case block **1714** discards the selected WDR, and processing continues back to block **1708** for a refreshed presentation of queue **22**. If block **1712** determines the user did not select to delete a WDR, then block **1716** checks if the user selected to modify a WDR. If block **1716** determines the user wanted to modify a WDR of queue **22**, then block **1718** interfaces with the user for validated WDR changes before continuing back to block **1708**. If block **1716** determines the user did not select to modify a WDR, then block **1720** checks if the user selected to add a WDR to queue **22**. If block **1720** determines the user selected to add a WDR (for example, to manually configure MS whereabouts), then block **1722** interfaces with the user for a validated WDR to add to queue **22** before continuing back to block **1708**. If block **1720** determines the user did not select to add a WDR, then block **1724** checks if the user selected to view detailed contents of a WDR, perhaps because WDRs are presented in an abbreviated form at block **1708**. If it is determined at block **1724** the user did select to view details of a WDR, then block **1726** formats the WDR in detail form, presents it to the user, and waits for the user to exit the view of the WDR before continuing back to block **1708**. If block **1724** determines the user did not select to view a WDR in detail, then block **1728** checks if the user wanted to exit FIG. **17** processing. If block **1728** determines the user did not select to exit FIG. **17** processing, then processing continues to block **1730** where other user interface actions leaving block **1710** are appropriately handled, and then processing continues back to block **1708**. If block **1728** determines the user did select to exit processing, then FIG. **17** processing terminates at block **1732**.

There are many embodiments for maintaining WDRs of queue **22**. In some embodiments, FIG. **17** (i.e. block **1424**) processing is only provided for debug of an MS. In a single instance WDR embodiment, block **1708** presents the one and only WDR which is used to keep current MS whereabouts whenever possible. Other embodiments incorporate any subset of FIG. **17** processing.

FIG. **18** depicts a flowchart for describing a preferred embodiment of a procedure for variable configuration processing, namely the Configure Value procedure, for example for processing of block **1430**. Processing starts at block **1802** and continues to block **1804** where parameters passed by the invoker of FIG. **18** are determined, namely the reference (address) of the value for configuration to be modified, and the validity criteria for what makes the value valid. Passing the value by reference simply means that FIG. **18** has the ability to directly change the value, regardless of where it is located. In some embodiments, the parameter is an address to a memory location for the value. In another embodiment, the

value is maintained in a database or some persistent storage, and FIG. **18** is passed enough information to know how to permanently affect/change the value.

Block **1804** continues to block **1806** where the current value passed is presented to the user (e.g. confidence floor value), and then to block **1808** for awaiting user action. When a user action is detected at block **1808**, block **1810** checks if the user selected to modify the value, in which case block **1812** interfaces with the user for a validated value using the validity criteria parameter before continuing back to block **1806**. Validity criteria may take the form of a value range, value type, set of allowable values, or any other criteria for what makes the value a valid one.

If block **1810** determines the user did not select to modify the value, then block **1814** checks if the user wanted to exit FIG. **18** processing. If block **1814** determines the user did not select to exit FIG. **18** processing, then processing continues to block **1816** where other user interface actions leaving block **1808** are appropriately handled, and then processing continues back to block **1806**. If block **1814** determines the user did select to exit processing, then FIG. **18** processing appropriately returns to the caller at block **1818**.

LBX: LN-EXPANSE Interoperability

FIG. **19** depicts an illustration for describing a preferred embodiment multithreaded architecture of peer interaction processing of a MS in accordance with the present disclosure. MS architecture **1900** preferably includes a set of Operating System (O/S) processes (i.e. O/S terminology "process" with O/S terminology "thread" or "threads (i.e. thread(s))), including a whereabouts broadcast process **1902**, a whereabouts collection process **1912**, a whereabouts supervisor process **1922**, a timing determination process **1932**, a WDR request process **1942**, and a whereabouts determination process **1952**. Further included are queues for interaction of processing, and process associated variables to facilitate processing. All of the FIG. **19** processes are of PIP code **6**. There is preferably a plurality (pool) of worker threads within each of said **19***xx* processes (i.e. **1902**, **1912**, **1922**, **1932**, **1942** and **1952**) for high performance asynchronous processing. Each **19***xx* process (i.e. **1902**, **1912**, **1922**, **1932**, **1942** and **1952**) preferably has at least two (2) threads:

1) "parent thread"; and
2) "worker thread".

A parent thread (FIG. **29**A) is the main process thread for:

starting the particular process;
starting the correct number of worker thread(s) of that particular process;
staying alive while all worker threads are busy processing; and
properly terminating the process when worker threads are terminated.

The parent thread is indeed the parent for governing behavior of threads at the process whole level. Every process has a name for convenient reference, such as the names **1902**, **1912**, **1922**, **1932**, **1942** and **1952**. Of course, these names may take on the associated human readable forms of whereabouts broadcast process, whereabouts collection process, whereabouts supervisor process, timing determination process, WDR request process, and whereabouts determination process, respectively. For brevity, the names used herein are by the process label of FIG. **19** in a form **19***xx*. There must be at least one worker thread in a process. Worker thread(s) are described with a flowchart as follows:

1902—FIG. **20**;
1912—FIG. **21**;
1922—FIG. **22**;
1932—FIG. **23**;
1942—FIG. **25**; and
1952—FIG. **26**A.

Threads of architecture MS are presented from a software perspective, but there are applicable hardware/firmware process thread embodiments accomplished for the same functionality. In fact, hardware/firmware embodiments are preferred when it is known that processing is mature (i.e. stable) to provide the fastest possible performance. Architecture **1900** processing is best achieved at the highest possible performance speeds for optimal wireless communications processing. There are two (2) types of processes for describing the types of worker threads:

1) "Slave to Queue"; and
2) "Slave to Timer".

A **19***xx* process is a slave to queue process when its worker thread(s) are driven by feeding from a queue of architecture **1900**. A slave to queue process stays "blocked" (O/S terminology "blocked"=preempted) on a queue entry retrieval interface until the sought queue item is inserted to the queue. The queue entry retrieval interface becomes "cleared" (O/S terminology "cleared"=clear to run) when the sought queue entry is retrieved from the queue by a thread. These terms (blocked and cleared) are analogous to a semaphore causing a thread to be blocked, and a thread to be cleared, as is well known in the art. Queues have semaphore control to ensure no more than one thread becomes clear at a time for a single queue entry retrieved (as done in an O/S). One thread sees a particular queue entry, but many threads can feed off the same queue to do the same work concurrently. Slave to queue type of processes are **1912**, **1932**, **1942** and **1952**. A slave to queue process is properly terminated by inserting a special termination queue entry for each worker thread to terminate itself after queue entry retrieval.

A **19***xx* process is a slave to timer process when its worker thread(s) are driven by a timer for peeking a queue of architecture **1900**. A timer provides the period of time for a worker thread to sleep during a looped iteration of checking a queue for a sought entry (without removing the entry from the queue). Slave to timer threads periodically peek a queue, and based on what is found, will process appropriately. A queue peek does not alter the peeked queue. The queue peek interface is semaphore protected for preventing peeking at an un-opportune time (e.g. while thread inserting or retrieving from queue). Queue interfaces ensure one thread is acting on a queue with a queue interface at any particular time. Slave to timer type of processes are **1902** and **1922**. A slave to timer process is properly terminated by inserting a special termination queue entry for each worker thread to terminate itself by queue entry peek.

Block **2812** knows the type of **19***xx* process for preparing the process type parameter for invocation of FIG. **29**B at block **2814**. The type of process has slightly different termination requirements because of the worker thread(s) processing type. Alternate embodiments of slave to timer processes will make them slave to queue processes by simply feeding off Thread Request (TR) queue **1980** for driving a worker thread when to execute (and when to terminate). New timer(s) would insert timely queue entries to queue **1980**, and processes **1902** and **1922** would retrieve from the queue (FIG. **24**A record **2400**). The queue entries would become available to queue **1980** when it is time for a particular worker thread to execute. Worker threads of processes **1902** and **1922** could retrieve, and stay blocked on, queue **1980** until an entry was inserted by a timer for enabling a worker thread (field **2400***a* set to **1902** or **1912**). TR queue **1980** is useful for starting any

threads of architecture **1900** in a slave to queue manner. This may be a cleaner architecture for all thread pools to operate the same way (slave to queue). Nevertheless, the two thread pool methods are implemented.

Each **19***xx* process has at least four (4) variables for describing present disclosure processing:

- **19***xx*-PID=The O/S terminology "Process Identifier (PID)" for the O/S PID of the **19***xx* process. This variable is also used to determine if the process is enabled (PID>0), or is disabled (PID=0 (i.e. <=0));
- **19***xx*-Max=The configured number of worker thread(s) for the **19***xx* process;
- **19***xx*-Sem=A process local semaphore for synchronizing **19***xx* worker threads, for example in properly starting up worker threads in process **19***xx*, and for properly terminating worker threads in process **19***xx*; and
- **19***xx*-Ct=A process local count of the number of worker thread(s) currently running in the **19***xx* process.

19*xx*-PID and **19***xx*-Max are variables of PIP data **8**. **19***xx*-Sem and **19***xx*-Ct are preferably process **19***xx* stack variables within the context of PIP code **6**. **19***xx*-PID is a semaphore protected global variable in architecture **1900** so that it can be used to determine whether or not a particular **19***xx* process is enabled (i.e. running) or disabled (not running). **19***xx*-Max is a semaphore protected global variable in architecture **1900** so that user configuration processing outside of architecture **1900** can be used to administrate a desired number of worker threads for a **19***xx* process. Alternate embodiments will not provide user configuration of **19***xx*-Max variables (e.g. hard coded maximum number of threads), in which case no **19***xx*-Max global variable is necessary. "Thread(s) **19***xx*" is a brief form of stating "worker-thread(s) of the **19***xx* process".

Receive (Rx) queue **26** is for receiving CK **1304** or CK **1314** data (e.g. WDR or WDR requests), for example from wireless transmissions. Queue **26** will receive at least WDR information (destined for threads **1912**) and WDR requests (FIG. **24**C records **2490** destined for threads **1942**). At least one thread (not shown) is responsible for listening on appropriate channel(s) and immediately depositing appropriate records to queue **26** so that they can be processed by architecture **1900**. Preferably, there is a plurality (pool) of threads for feeding queue **26** based on channel(s).being listened on, and data **1302** or **1312** anticipated for being received. Alternative embodiments of thread(s) **1912** may themselves directly be listening, on appropriate channels and immediately processing packets identified, in lieu of a queue **26**. Alternative embodiments of thread(s) **1942** may themselves directly be listening on appropriate channels and immediately processing packets identified, in lieu of a queue **26**. Queue **26** is preferred to isolate channel(s) (e.g. frequency(s)) and transmission reception processing in well known modular (e.g. Radio Frequency (RF)) componentry, while providing a high performance queue interface to other asynchronous threads of architecture **1900** (e.g. thread(s) of process **1912**). Wave spectrums (via particular communications interface **70**) are appropriately processed for feeding queue **26**. As soon as a record is received by an MS, it is assumed ready for processing at queue **26**. All queue **26** accesses are assumed to have appropriate semaphore control to ensure synchronous access by any thread at any particular time to prevent data corruption and misuse. Queue entries inserted to queue **26** may have arrived on different channel(s), and in such embodiments a channel qualifier may further direct queue entries from queue **26** to a particular thread **1912** or **1942** (e.g. thread(s) dedicated to channel(s)). In other embodiments, receive processing feeds queue **26** independent of any particular channel(s) monitored, or received on (the preferred embodiment described). Regardless of how data is received and then immediately placed on queue **26**, a received date/time stamp (e.g. fields **1100***p* or **2490***c*) is added to the applicable record for communicating the received date/time stamp to a thread (e.g. thread(s) **1912** or **1942**) of when the data was received. Therefore, the queue **26** insert interface tells the waiting thread(s) when the data was actually received. This ensures a most accurate received date/time stamp as close to receive processing as possible (e.g. enabling most accurate TDOA measurements). An alternate embodiment could determine applicable received date/time stamps in thread(s) **1912** or thread(s) **1942**. Other data placed into received WDRs are: wave spectrum and/or particular communications interface **70** of the channel received on, and heading/yaw/pitch/roll (or accelerometer readings) with AOA measurements, signal strength, and other field **1100***f* eligible data of the receiving MS. Depending on alternative embodiments, queue **26** may be viewed metaphorically for providing convenient grounds of explanation.

Send (Tx) queue **24** is for sending/communicating CK **1304** data, for example for wireless transmissions. At least one thread (not shown) is responsible for immediately transmitting (e.g. wirelessly) anything deposited to queue **24**. Preferably, there is a plurality (pool) of threads for feeding off of queue **24** based on channel(s) being transmitted on, and data **1302** anticipated for being sent. Alternative embodiments of thread(s) of processes **1902**, **1922**, **1932** and **1942** may themselves directly transmit (send/broadcast) on appropriate channels anything deposited to queue **24**, in lieu of a queue **24**. Queue **24** is preferred to isolate channel(s) (e.g. frequency(s)) and transmission processing in well known modular (e.g. RF) componentry, while providing a high performance queue interface to other asynchronous threads of architecture **1900** (e.g. thread(s) **1942**). Wave spectrums and/or particular communications interface **70** are appropriately processed for sending from queue **24**. All queue **24** accesses are assumed to have appropriate semaphore control to ensure synchronous access by any thread at any particular time to prevent data corruption and misuse. As soon as a record is inserted to queue **24**, it is assumed sent immediately. Preferably, fields sent depend on fields set. Queue entries inserted to queue **24** may contain specification for which channel(s) to send on in some embodiments. In other embodiments, send processing feeding from queue **24** has intelligence for which channel(s) to send on (the preferred embodiment described). Depending on alternative embodiments, queue **24** may be viewed metaphorically for providing convenient grounds of explanation.

When interfacing to queue **24**, the term "broadcast" refers to sending outgoing data in a manner for reaching as many MSs as possible (e.g. use all participating communications interfaces **70**), whereas the term "send" refers to targeting a particular MS or group of MSs.

WDR queue **22** preferably contains at least one WDR **1100** at any point in time, for at least describing whereabouts of the MS of architecture **1900**. Queue **22** accesses are assumed to have appropriate semaphore control to ensure synchronous access by any thread at any particular time to prevent data corruption and misuse. A single instance of data embodiment of queue **22** may require an explicit semaphore control for access. In a WDR plurality maintained to queue **22**, appropriate queue interfaces are again provided to ensure synchronous thread access (e.g. implicit semaphore control). Regardless, there is still a need for a queue **22** to maintain a plurality of WDRs from remote MSs. The preferred embodiment of all queue interfaces uses queue interface maintained semaphore(s) invisible to code making use of queue (e.g.

API) interfaces. Depending on alternative embodiments, queue **22** may be viewed metaphorically for providing convenient grounds of explanation.

Thread Request (TR) queue **1980** is for requesting processing by either a timing determination (worker) thread of process **1932** (i.e. thread **1932**) or whereabouts determination (worker) thread of process **1952** (i.e. thread **1952**). When requesting processing by a thread **1932**, TR queue **1980** has requests (retrieved via processing **1934** after insertion processing **1918**) from a thread **1912** to initiate TDOA measurement. When requesting processing by a thread **1952**, TR queue **1980** has requests (retrieved via processing **1958** after insertion processing **1918** or **1930**) from a thread **1912** or **1922** so that thread **1952** performs whereabouts determination of the MS of architecture **1900**. Requests of queue **1980** comprise records **2400**. Preferably, there is a plurality (pool) of threads **1912** for feeding queue **1980** (i.e. feeding from queue **26**), and for feeding a plurality each of threads **1932** and **1952** from queue **1980**. All queue **1980** accesses are assumed to have appropriate semaphore control to ensure synchronous access by any thread at any particular time to prevent data corruption and misuse. Depending on alternative embodiments, queue **1980** may be viewed metaphorically for providing convenient grounds of explanation.

With reference now to FIG. **24**A, depicted is an illustration for describing a preferred embodiment of a thread request queue record, as maintained to Thread Request (TR) queue **1980**. TR queue **1980** is not required when a LN-expanse globally uses NTP, as found in thread **19***xx* processing described for architecture **1900**, however it may be required at a MS which does not have NTP, or a MS which interacts with another data processing system (e.g. MS) that does not have NTP. Therefore, TR queue record **2400** (i.e. queue entry **2400**) may, or may not, be required. This is the reason FIG. **1**A does not depict queue **1980**. When NTP is in use globally (in LN-expanse), TDOA measurements can be made using a single unidirectional data (**1302** or **1312**) packet containing a sent date/time stamp (of when the data was sent). Upon receipt, that sent date/time stamp received is compared with the date/time of receipt to determine the difference. The difference is a TDOA measurement. Knowing transmission speeds with a TDOA measurement allows calculating a distance. In this NTP scenario, no thread(s) **1932** are required.

Threads **1912** and/or DLM processing may always insert the MS whereabouts without requirement for thread(s) **1952** by incorporating thread **1952** logic into thread **1912**, or by directly starting (without queue **1980**) a thread **1952** from a thread **1912**. Therefore, threads **1952** may not be required. If threads **1952** are not required, queue **1980** may not be required by incorporating thread **1932** logic into thread **1912**, or by directly starting (without queue **1980**) a thread **1932** from a thread **1912**. Therefore, queue **1980** may not be required, and threads **1932** may not be required.

Records **2400** (i.e. queue entries **2400**) contain a request type field **2400***a* and data field **2400***b*. Request type field **2400***a* simply routes the queue entry to destined thread(s) (e.g. thread(s) **1932** or thread(s) **1952**). A thread **1932** remains blocked on queue **1980** until a record **2400** is inserted which has a field **2400***a* containing the value **1932**. A thread **1952** remains blocked on queue **1980** until a record **2400** is inserted which has a field **2400***a* containing the value **1952**. Data field **2400***b* is set to zero (0) when type field **2400***a* contains **1952** (i.e. not relevant). Data field **2400***b* contains an MS ID (field **1100***a*) value, and possibly a targeted communications interface **70** (or wave spectrum if one to one), when type field contains **1932**. Field **2400***b* will contain information for appropriately targeting the MS ID with data (e.g. communications interface to use if MS has multiple of them). An MS with only one communications interface can store only a MS ID in field **2400***b*.

Records **2400** are used to cause appropriate processing by **19***xx* threads (e.g. **1932** or **1952**) as invoked when needed (e.g. by thread(s) **1912**). Process **1932** is a slave to queue type of process, and there are no queue **1980** entries **2400** which will not get timely processed by a thread **1932**. No interim pruning is necessary to queue **1980**.

With reference now back to FIG. **19**, Correlation Response (CR) queue **1990** is for receiving correlation data for correlating requests transmitted in data **1302** with responses received in data **1302** or **1312**. Records **2450** are inserted to queue **1990** (via processing **1928**) from thread(s) **1922** so that thread(s) **1912** (after processing **1920**) correlate data **1302** or **1312** with requests sent by thread(s) **1922** (e.g. over interface **1926**), for the purpose of calculating a TDOA measurement. Additionally, records **2450** are inserted to queue **1990** (via processing **1936**) from thread(s) **1932** so that thread(s) **1912** (after processing **1920**) correlate data **1302** or **1312** with requests sent by thread(s) **1932** (e.g. over interface **1938**), for the purpose of calculating a TDOA measurement. Preferably, there is a plurality (pool) of threads for feeding queue **1990** and for feeding from queue **1990** (feeding from queue **1990** with thread(s) **1912**). All queue **1990** accesses are assumed to have appropriate semaphore control to ensure synchronous access by any thread at any particular time to prevent data corruption and misuse. Depending on alternative embodiments, queue **1990** may be viewed metaphorically for providing convenient grounds of explanation.

With reference now to FIG. **24**B, depicted is an illustration for describing a preferred embodiment of a correlation response queue record, as maintained to Correlation Response (CR) queue **1990**. CR queue **1990** is not required when a LN-expanse globally uses NTP, as found in thread **19***xx* processing described for architecture **1900**, however it may be required at a MS which does not have NTP, or a MS which interacts with another data processing system (e.g. MS) that does not have NTP. Therefore, CR record **2450** (i.e. queue entry **2450**) may, or may not, be required. This is the reason FIG. **1**A does not depict queue **1990**. The purpose of CR queue **1990** is to enable calculation of TDOA measurements using correlation data to match a request with a response. When NTP is used globally in the LN-expanse, no such correlations between a request and response is required, as described above. In the NTP scenario, thread(s) **1912** can deduce TDOA measurements directly from responses (see FIG. **21**), and there is no requirement for threads **1932**.

TDOA measurements are best taken using date/time stamps as close to the processing points of sending and receiving as possible, otherwise critical regions of code may be required for enabling process time adjustments to the measurements when processing is "further out" from said points. This is the reason MS receive processing provides received date/time stamps with data inserted to queue **26** (field **1100***p* or **2490***c*). In a preferred embodiment, send queue **24** processing inserts to queue **1990** so the date/time stamp field **2450***a* for when sent is as close to just prior to having been sent as possible. However, there is still the requirement for processing time spent inserting to queue **1990** prior to sending anyway. Anticipated processing speeds of architecture **1900** allow reasonably moving sent date/time stamp setting just a little "further out" from actually sending to keep modular send processing isolated. A preferred embodiment (as presented) assumes the send queue **24** interface minimizes processing instructions from when data is placed onto queue **24** and when it is actually sent, so that the

sending thread(s) **19***xx* (**1902**, **1922**, **1932** and **1942**) insert to queue **1990** with a reasonably accurate sent/date stamp field **2450***a*. This ensures a most accurate sent date/time stamp (e.g. enabling most accurate TDOA measurements). An alternate embodiment makes appropriate adjustments for more accurate time to consider processing instructions up to the point of sending after queue **1990** insertion.

Records **2450** (i.e. queue entries **2450**) contain a date/time stamp field **2450***a* and a correlation data field **2450***b*. Date/time stamp field **2450***a* contains a date/time stamp of when a request (data **1302**) was sent as set by the thread inserting the queue entry **2450**. Correlation data field **2450***b* contains unique correlation data (e.g. MS id with suffix of unique number) used to provide correlation for matching sent requests (data **1302**) with received responses (data **1302** or **1312**), regardless of the particular communications interface(s) used (e.g. different wave spectrums supported by MS). Upon a correlation match, a TDOA measurement is calculated using the time difference between field **2450***a* and a date/time stamp of when the response was received (e.g. field **1100***p*). A thread **1912** accesses queue **1990** for a record **2450** using correlation field **2450***b* to match, when data **1302** or **1312** contains correlation data for matching. A thread **1912** then uses the field **2450***a* to calculate a TDOA measurement. Process **1912** is not a slave to queue **1990** (but is to queue **26**). A thread **1912** peeks queue **1990** for a matching entry when appropriate. Queue **1990** may contain obsolete queue entries **2450** until pruning is performed. Some WDR requests may be broadcasts, therefore records **2450** may be used for correlating a plurality of responses. In another record **2450** embodiment, an additional field **2450***c* is provided for specification of which communication interface(s) and/or channel(s) to listen on for a response.

With reference now back to FIG. **19**, any reasonable subset of architecture **1900** processing may be incorporated in a MS. For example in one minimal subset embodiment, a DLM which has excellent direct locating means only needs a single instance WDR (queue **22**) and a single thread **1902** for broadcasting whereabouts data to facilitate whereabouts determination by other MSs. In a near superset embodiment, process **1942** processing may be incorporated completely into process **1912**, thereby eliminating processing **1942** by having threads **1912** feed from queue **26** for WDR requests as well as WDR information. In another subset embodiment, process **1922** may only send requests to queue **24** for responses, or may only start a thread **1952** for determining whereabouts of the MS. There are many viable subset embodiments depending on the MS being a DLM or ILM, capabilities of the MS, LN-expanse deployment design choices, etc. A reference to FIG. **19** accompanies thread **19***xx*flowcharts (FIGS. **20**, **21**, **22**, **23**, **25** and **26**A). The user, preferably an administrator type (e.g. for lbxPhone™ debug) selectively configures whether or not to start or terminate a process (thread pool), and perhaps the number of threads to start in the pool (see FIG. **14**A). Starting a process (and threads) and terminating: processes (and threads) is shown in flowcharts **29**A and **29**B. There are other embodiments for properly starting and terminating threads without departing from the spirit and scope of this disclosure.

FIG. **20** depicts a flowchart for describing a preferred embodiment of MS whereabouts broadcast processing, for example to facilitate other MSs in locating themselves in an LN-expanse. FIG. **20** processing describes a process **1902** worker thread, and is of PIP code **6**. Thread(s) **1902** purpose is for the MS of FIG. **20** processing (e.g. a first, or sending, MS) to periodically transmit whereabouts information to other MSs (e.g. at least a second, or receiving, MS) to use in locating themselves. It is recommended that validity criteria set at block **1444** for **1902**-Max be fixed at one (1) in the preferred embodiment. Multiple channels for broadcast at block **2016** should be isolated to modular send processing (feeding from a queue **24**).

In an alternative embodiment having multiple transmission channels visible to process **1902**, there can be a worker thread **1902** per channel to handle broadcasting on multiple channels. If thread(s) **1902** (block **2016**) do not transmit directly over the channel themselves, this embodiment would provide means for communicating the channel for broadcast to send processing when interfacing to queue **24** (e.g. incorporate a channel qualifier field with WDR inserted to queue **24**). This embodiment could allow specification of at least one (1) worker thread per channel, however multiple worker threads configurable for-process **1902** as appropriated for the number of channels configurable for broadcast.

Processing begins at block **2002**, continues to block **2004** where the process worker thread count **1902**-Ct is accessed and incremented by 1 (using appropriate semaphore access (e.g. **1902**-Sem)), and continues to block **2006** for peeking WDR queue **22** for a special termination request entry. Block **2004** may also check the **1902**-Ct value, and signal the process **1902** parent thread that all worker threads are running when **1902**-Ct reaches **1902**-Max. Thereafter, if block **2008** determines that a worker thread termination request was not found in queue **22**, processing continues to block **2010**. Block **2010** peeks the WDR queue **22** (using interface **1904**) for the most recent highest confidence entry for this MS whereabouts by searching queue **22** for: the MS ID field **1100***a* matching the MS ID of FIG. **20** processing, and a confidence field **1100***d* greater than or equal to the confidence floor value, and a most recent NTP enabled date/time stamp field **1100***b* within a prescribed trailing period of time (e.g. preferably less than or equal to 2 seconds). For example, block **2010** peeks the queue (i.e. makes a copy for use if an entry found for subsequent processing, but does not remove the entry from queue) for a WDR of this MS (i.e. MS of FIG. **20** processing) which has the greatest confidence over 75 and has been most recently inserted to queue **22** with an NTP date/time stamp in the last 2 seconds. Date/time stamps for MS whereabouts which are not NTP derived have little use in the overall palette of process **19***xx* choices of architecture **1900** because receiving data processing systems (e.g. MSs) will have no means of determining an accurate TDOA measurement in the unidirectional transmission from an NTP disabled MS. A receiving data processing system will still require a bidirectional correlated exchange with the MS of FIG. **20** processing to determine an accurate TDOA measurement in its own time scale (which is accomplished with thread(s) **1922** pulling WDR information anyway). An alternate embodiment to block **2010** will not use the NTP indicator as a search criteria so that receiving data processing systems can receive to a thread **1912**, and then continue for appropriate correlation processing, or can at least maintain whereabouts to queue **22** to know who is nearby.

Thread **1902** is of less value to the LN-expanse when it broadcasts outdated/invalid whereabouts of the MS to facilitate locating other MSs. In an alternate embodiment, a movement tolerance (e.g. user configured or system set (e.g. 3 meters)) is incorporated at the MS, or at service(s) used to locate the MS, for knowing when the MS has significantly moved (e.g. more than 3 meters) and how long it has been (e.g. 45 seconds) since last significantly moving. In this embodiment, the MS is aware of-the period of time since last significantly moving and the search time criteria is set using the amount of time since the MS significantly moved (which-

ever is greater). This way a large number of (perhaps more confident candidates) WDRs are searched in the time period when the MS has not significantly moved. Optional blocks **278** through **284** may have been incorporated to FIG. **2**F for movement tolerance processing just described, in which case the LWT is compared to the current date/time of block **2010** processing to adjust block **2010** search time criteria for the correct trailing period. In any case, a WDR is sought at block **2010** which will help other MSs in the LN-expanse locate themselves, and to let other MSs know who is nearby.

Thereafter, if block **2012** determines a useful WDR was found, then block **2014** prepares the WDR for send processing, block **2016** broadcasts the WDR information (using send interface **1906**) by inserting to queue **24** so that send processing broadcasts data **1302** (e.g. on all available communications interface(s) **70**), for example as far as radius **1306**, and processing continues to block **2018**. The broadcast is for reception by data processing systems (e.g. MSs) in the vicinity. At least fields **1100***b*, **1100***c*, **1100***d*, and **1100***n* are broadcast. See FIG. **11**A descriptions. Fields are set to the following upon exit from block **2014**:

MS ID field **1100***a* is preferably set with: Field **1100***a* from queue **22**, or transformed (if not already) into a pseudo MS ID (possibly for future correlation) if desired. This field may also be set to null (not set) because it is not required when the NTP indicator of field **1100***b* is enabled and the broadcast is sent with an NTP enabled field **1100***n*.

DATE/TIME STAMP field **1100***b* is preferably set with: Field **1100***b* from queue **22**.

LOCATION field **1100***c* is preferably set with: Field **1100***c* from queue **22**.

CONFIDENCE field **1100***d* is preferably set with: Field **1100***d* from queue **22**.

LOCATION TECHNOLOGY field **1100***e* is preferably set with: Field **1100***e* from queue **22**.

LOCATION REFERENCE INFO field **1100***f* is preferably set with: null (not set). Null indicates to send processing feeding from queue **24** to use all available comm. interfaces **70** (i.e. Broadcast). Specifying a comm. interface targets the specified interface (i.e. send).

COMMUNICATIONS REFERENCE INFO field **1100***g* is preferably set with: null (not set). If MS ID (or pseudo MS ID) is sent, this is all that is required to target this MS.

SPEED field **1100***h* is preferably set with: Field **1100***h* from queue **22**.

HEADING field **1100***i* is preferably set with: Field **1100***i* from queue **22**.

ELEVATION field **1100***j* is preferably set with: Field **1100***j* from queue **22**.

APPLICATION FIELDS field **1100***k* is preferably set with: Field **1100***k* from queue **22**. An alternate embodiment will add, alter, or discard data (with or without date/time stamps) here at the time of block **2014** processing.

CORRELATION FIELD **1100***m* is preferably set with: null (not set).

SENT DATE/TIME STAMP field **1100***n* is preferably set with: Sent date/time stamp as close in processing the broadcast of block **2016** as possible.

RECEIVED DATE/TIME STAMP field **1100***p* is preferably set with: Not Applicable (i.e. N/A for sending).

Block **2018** causes thread **1902** to sleep according to the SPTP setting (e.g. a few seconds). When the sleep time has elapsed, processing continues back to block **2006** for another loop iteration of blocks **2006** through **2016**. Referring back to block **2012**, if a useful WDR was not found (e.g. candidates too old), then processing continues to block **2018**. Referring back to block **2008**, if a worker thread termination request entry was found at queue **22**, then block **2020** decrements the worker thread count by 1 (using appropriate semaphore access (e.g. **1902**-Sem)), and thread **1902** processing terminates at block **2022**. Block **2020** may also check the **1902**-Ct value, and signal the process **1902** parent thread that all worker threads are terminated when **1902**-Ct equals zero (0).

Block **2016** causes broadcasting data **1302** containing CK **1304** wherein CK **1304** contains WDR information prepared as described above for block **2014**. Alternative embodiments of block **2010** may not search a specified confidence value, and broadcast the best entry available anyway so that listeners in the vicinity will decide what to do with it. A semaphore protected data access (instead of a queue peek) may be used in embodiments where there is always one WDR current entry maintained for the MS.

In the embodiment wherein usual MS communications data **1302** of the MS is altered to contain CK **1304** for listening MSs in the vicinity, send processing feeding from queue **24**, caused by block **2016** processing, will place WDR information as CK **1304** embedded in usual data **1302** at the next opportune time of sending usual data **1302**. If an opportune time is not timely, send processing should discard the send request of block **2016** to avoid broadcasting outdated whereabouts information (unless using a movement tolerance and time since last significant movement). As the MS conducts its normal communications, transmitted data **1302** contains new data CK **1304** to be ignored by receiving MS other character **32** processing, but to be found by listening MSs within the vicinity which anticipate presence of CK **1304**. Otherwise, when LN-Expanse deployments have not introduced CK **1304** to usual data **1302** communicated on a receivable signal by MSs in the vicinity, FIG. **20** sends repeated timely pulsed broadcasts of new data **1302** (per SPTP) for MSs in the vicinity of the first MS to receive. In any case, appropriate implementation should ensure field **1100***n* is as accurate as possible for when data **1302** is actually sent.

An alternate embodiment to architecture **1900** for elimination of process **1902** incorporates a trigger implementation for broadcasting MS whereabouts at the best possible time—i.e. when the MS whereabouts is inserted to queue **22**. As soon as a new (preferably NTP enabled) WDR candidate becomes available, it can be broadcast at a new block **279** of FIG. **2**F. (e.g. new block **279** continued to from block **278** and then continuing to block **280**). Fields are set as described above for FIG. **20**. Preferably, the new block **279** starts an asynchronous thread consisting of blocks **2014** and **2016** so that FIG. **2**F processing performance is not impacted. In a further embodiment, block **279** can be further enhanced using the SPTP value to make sure that too many broadcasts are not made. The SPTP (Source Periodicity Time Period) could be observed for getting as close as possible to broadcasting whereabouts in accordance with SPTP (e.g. worst case there are not enough broadcasts).

FIG. **21** depicts a flowchart for describing a preferred embodiment of MS whereabouts collection processing. FIG. **21** processing describes a process **1912** worker thread, and is of PIP code **6**. Thread(s) **1912** purpose is for the MS of FIG. **21** processing (e.g. a second, or receiving, MS) to collect potentially useful WDR information from other MSs (e.g. at least a first, or sending, MS) in the vicinity for determining whereabouts of the receiving (second) MS. It is recommended that validity criteria set at block **1444** for **1912**-Max be set as high as possible (e.g. 10) relative performance considerations of architecture **1900**, with at least one thread per channel that WDR information may be received on by the

receiving MS. Multiple channels for receiving data fed to queue **26** should be isolated to modular receive processing (feeding a queue **26**).

In an alternative embodiment having multiple receiving transmission channels visible to process **1912** (e.g. thread(s) **1912** receiving directly), there can be a worker thread **1912** per channel to handle receiving on multiple channels simultaneously. If thread(s) **1912** do not receive directly from the channel, the preferred embodiment of FIG. **21** would not need to convey channel information to thread(s) **1912** waiting on queue **26** anyway. Embodiments could allow specification/configuration of many thread(s) **1912** per channel.

Processing begins at block **2102**, continues to block **2104** where the process worker thread count **1912**-Ct is accessed and incremented by 1 (using appropriate semaphore access (e.g. **1912**-Sem)), and continues to block **2106** for interim housekeeping of pruning the WDR queue by invoking a Prune Queues procedure of FIG. **27**. Block **2104** may also check the **1912**-Ct value, and signal the process **1912** parent thread that all worker threads are running when **1912**-Ct reaches **1912**-Max. Block **2106** may not be required since block **2130** can cause queue **22** pruning (block **292**).

Thereafter, block **2108** retrieves from queue **26** a WDR (using interface **1914**), perhaps a special termination request entry, or a WDR received in data **1302** (CK **1304**) or data **1312** (CK **1314**), and only continues to block **2110** when a WDR has been retrieved. Block **2108** stays blocked on retrieving from queue **26** until any WDR is retrieved. If block **2110** determines that a special WDR indicating to terminate was not found in queue **26**, processing continues to block **2112**. Block **2112** adjusts date/time stamp field **1100***b* if necessary depending on NTP use in the LN-expanse and adjusts the confidence field **1100***d* accordingly. In a preferred embodiment, fields **1100***b* and **1100***d* for the WDR in process is set as follows for certain conditions:

- Fields **1100***b*, **1100***n* and **1100***p* all NTP indicated: keep fields **1100***b* and **1100***d* as is; or
- Fields **1100***b* and **1100***n* are NTP indicated, **1100***p* is not: Is correlation (field **1100***m*) present?: No, then set confidence (field **1100***d*) to 0 (for filtering out at block **2114**)/Yes, then set field **1100***b* to **1100***p* (in time terms of this MS) and adjust confidence lower based on differences between fields **1100***b*, **1100***n* and **1100***p*; or
- Fields **1100***b* and **1100***p* are NTP indicated, **1100***n* is not: Is correlation present?: No, then set confidence to 0 (for filtering out at block **2114**)/Yes, then set field **1100***b* to **1100***p* (in time terms of this MS) and adjust confidence lower based on differences between fields **1100***b*, **1100***n* and **1100***p*; or
- Fields **1100***b* NTP indicated, **1100***n* and **1100***p* not: Is correlation present?: No, then set confidence to 0 (for filtering out at block **2114**)/Yes, then set field **1100***b* to **1100***p* (in time terms of this MS) and adjust confidence lower based on differences between fields **1100***b*, **1100***n* and **1100***p*; or
- Field **1100***b* not NTP indicated, **1100***n* and **1100***p* are: Is correlation present?: No, then set confidence to 0 (for filtering out at block **2114**)/Yes, then set field **1100***b* to **1100***p* (in time terms of this MS) and adjust confidence lower based on differences between fields **1100***b*, **1100***n* and **1100***p*; or
- Fields **1100***b* and **1100***p* are not NTP indicated, **1100***n* is: Is correlation present?: No, then set confidence to 0 (for filtering out at block **21-14**)/Yes, then set field **1100***b* to **1100***p* (in time terms of this MS) and adjust confidence lower based on differences between fields **1100***b*, **1100***n* and **1100***p*; or
- Fields **1100***b* and **1100***n* are not NTP indicated, **1100***p* is: Is correlation present?: No, then set confidence to 0 (for filtering out at block **2114**)/Yes, then set field **1100***b* to **1100***p* (in time terms of this MS) and adjust confidence lower based on differences between fields **1100***b*, **1100***n* and **1100***p*; or
- Fields **1100***b*, **1100***n* and **1100***p* not NTP indicated: Is correlation-present?: No, then set confidence to 0 (for filtering out at block **2114**)/Yes, then set field **1100***b* to **1100***p* (in time terms of this MS) and adjust confidence lower based on differences between fields **1100***b*, **1100***n* and **1100***p*.

NTP ensures maintaining a high confidence in the LN-expanse, but absence of NTP is still useful. Confidence values should be adjusted with the knowledge of the trailing time periods used for searches when sharing whereabouts (e.g. thread(s) **1942** searches). Block **2112** continues to block **2114**.

If at block **2114**, the WDR confidence field **1100***d* is not greater than the confidence floor value, then processing continues back to block **2106**. If block **2114** determines that the WDR field **1100***d* is satisfactory, then block **2116** initializes a TDOA_FINAL variable to False, and block **2118** checks, if the WDR from block **2108** contains correlation (field **1100***m*).

If block **2118** determines the WDR does not contain correlation, then block **2120** accesses the ILMV, block **2122** determines the source (ILM or DLM) of the WDR using the originator indicator of field **1100***e*, and block **2124** checks suitability for collection of the WDR. While processes **19***xx* running are generally reflective of the ILMV roles configured, it is possible that the more descriptive nature of ILMV role(s) not be one to one in relationship to **19***xx* processes, in particular depending on the subset of architecture **1900** in use. Block **2124** is redundant anyway because of block **274**. If block **2124** determines the ILMV role is disabled for collecting this WDR, then processing continues back to block **2106**. If block **2124** determines the ILMV role is enabled for collecting this WDR, then processing continues to block **2126**.

If block **2126** determines both the first (sending) and second (receiving) MS are NTP enabled (i.e. Fields **1100***b*, **1100***n* and **1100***p* are NTP indicated) OR if TDOA_FINAL is set to True (as arrived to via block **2150**), then block **2128** completes the WDR for queue **22** insertion, block **2130** prepares parameters for FIG. **2**F processing and block **2132** invokes FIG. **2**F processing (interface **1916**). Parameters set at block **2130** are: WDRREF=a reference or pointer to the WDR completed at block **2128**; DELETEQ=FIG. **21** location queue discard processing; and SUPER=FIG. **21** supervisory notification processing. Block **2128** calculates a TDOA measurement whenever possible and inserts to field **1100***f*. See FIG. **11**A descriptions. Fields are set to the following upon exit from block **2128**:

- MS ID field **1100***a* is preferably set with: Field **1100***a* from queue **26**.
- DATE/TIME STAMP field **1100***b* is preferably set with: Preferred embodiment discussed for block **2112**.
- LOCATION field **1100***c* is preferably set with: Field **1100***c* from queue **26**.
- CONFIDENCE field **1100***d* is preferably set with: Confidence at equal to or less than field **1100***d* received from queue **26** (see preferred embodiment for block **2112**).
- LOCATION TECHNOLOGY field **1100***e* is preferably set with: Field **1100***e* from queue **26**.
- LOCATION REFERENCE INFO field **1100***f* is preferably set with: All available measurements from receive processing (e.g. AOA, heading, yaw, pitch, roll, signal strength,

wave spectrum, particular communications interface **70**, etc), and TDOA measurement(s) as determined in FIG. **21** (blocks **2128** and **2148**).

COMMUNICATIONS REFERENCE INFO field **1100***g* is preferably set with: Field **1100***g* from queue **26**.

SPEED field **1100***h* is preferably set with: Field **1100***h* from queue **26**.

HEADING field **1100***i* is preferably set with: Field **1100***i* from queue **26**.

ELEVATION field **1100***j* is preferably set with: Field **1100***j* from queue **26**.

APPLICATION FIELDS field **1100***k* is preferably set with: Field **1100***k* from queue **26**. An alternate embodiment will add, alter, or discard data (with or without date/time stamps) here at the time of block **2128** processing.

CORRELATION FIELD **1100***m* is preferably set with: Not Applicable (i.e. not maintained to queue **22**). Was used by FIG. **21** processing.

SENT DATE/TIME STAMP field **1100***n* is preferably set with: Not Applicable (i.e. not maintained to queue **22**). Was used by FIG. **21** processing.

RECEIVED DATE/TIME STAMP field **1100***p* is preferably set with: Not Applicable (i.e. not maintained to queue **22**). Was used by FIG. **21** processing.

Block **2132** continues to block **2134** where a record **2400** is built (i.e. field **2400***a*=**1952** and field **2400***b* is set to null (e.g. −1)) and then block **2136** inserts the record **2400** to TR queue **1980** (using interface **1918**) so that a thread **1952** will perform processing. Blocks **2134** and **2136** may be replaced with an alternative embodiment for starting a thread **1952**. Block **2136** continues back to block **2106**.

Referring now back to block **2126**, if it is determined that a TDOA measurement cannot be made (i.e. (field **1100***n* or **1100***p* not NTP indicated) OR if TDOA_FINAL is set to False), then block **2138** checks if the WDR contains a MS ID (or pseudo MS ID). If block **2138** determines there is none, then processing continues back to block **2106** because there is no way to distinguish one MS from another with respect to the WDR retrieved at block **2108** for directing bidirectional correlation. An alternate embodiment will use a provided correlation field **1100***m* received at block **2108**, instead of a field **1100***a*, for knowing how to target the originating MS for TDOA measurement processing initiated by a thread **1932**. If block **2138** determines there is a usable MS ID (or correlation field), then block **2140** builds a record **2400** (field **2400***a*=**1932**, field **2400***b*=the MS ID (or pseudo MS ID, or correlation) and particular communications interface from field **1100***f* (if available) of the WDR of block **2108**, and block **2142** inserts the record **2400** to queue **1980** (interface **1918**) for starting a thread **1932**. Block **2142** continues back to block **2106**. An alternate embodiment causes block **2126** to continue directly to block **2140** (no block **2138**) for a No condition from block **2126**. Regardless of whether the originating MS ID can be targeted, a correlation (in lieu of an MS ID) may be used when the MS responds with a broadcast. The WDR request made by thread **1932** can be a broadcast rather than a targeted request. Thread(s) **1932** can handle sending targeted WDR requests (to a known MS ID) and broadcast WDR requests.

Referring back to block **2118**, if it is determined the WDR does contain correlation (field **1100***m*), block **2144** peeks the CR queue **1990** (using interface **1920**) for a record **2450** containing a match (i.e. field **1100***m* matched to field **2450***b*). Thereafter, if block **2146** determines no correlation was found on queue **1990** (e.g. response took too long and entry was pruned), then processing continues to block **2120** already described. If block **2146** determines the correlation entry was found (i.e. thread **1912** received a response from an earlier request (e.g. from a thread **1922** or **1932**) then block **2148** uses date/time stamp field **2450***a* (from block **2144**) with field **1100***p* (e.g. from block **2108**) to calculate a TDOA measurement in time scale of the MS of FIG. **21** processing, and sets field **1100***f* appropriately in the WDR. Note that correlation field **2450***b* is valid across all available MS communications interfaces (e.g. all supported active wave spectrums). The TDOA measurement considers duration of time between the earlier sent date/time of record **2450** and the later time of received date/time field **1100***p*. The TDOA measurement may further be altered at block **2148** processing time to a distance knowing the velocity of the wave spectrum used as received to queue **26**. Block **2148** continues to block **2150** where the TDOA_FINAL variable is set to True, then to block **2120** for processing already described.

Referring back to block **2110**, if a WDR for a worker thread termination request was found at queue **26**, then block **2152** decrements the worker thread count by 1 (using appropriate semaphore access (e.g. **1912**-Sem)), and thread **1912** processing terminates at block **2154**. Block **2152** may also check the **1912**-Ct value, and signal the process **1912** parent thread that all worker threads are terminated when **1912**-Ct equals zero (0).

In the embodiment wherein usual MS communications data **1302** of the MS is altered to contain CK **1304** or **1314** for listening MSs in the vicinity, receive processing feeding queue **26** will place WDR information to queue **26** as CK **1304** or **1314** is detected for being present in usual communication data **1302** or **1304**. As normal communications are conducted, transmitted data **1302** or **1312** contains new data CK **1304** or **1314** to be ignored by receiving MS other character **32** processing, but to be found by listening MSs within the vicinity which anticipate presence, of CK **1304** or **1314**. Otherwise, when LN-Expanse deployments have not introduced CK **1304** (or **1314**) to usual data **1302** (or **1312**) communicated on a receivable signal by MSs in the vicinity, FIG. **21** receives new data **1302** (or **1312**) sent. In any case, field **1100***p* should be as accurate as possible for when data **1302** (or **1312**) was actually received. Critical regions of code and/or anticipated execution timing may be used to affect a best setting of field **1100***p*.

So, FIG. **21** is responsible for maintaining whereabouts of others to queue **22** with data useful for triangulating itself.

FIG. **22** depicts a flowchart for describing a preferred embodiment of MS whereabouts supervisor processing, for example to ensure the MS of FIG. **22** processing (e.g. first MS) is maintaining timely whereabouts information for itself. FIG. **22** processing describes a process **1922** worker thread, and is of PIP code **6**. Thread(s) **1922** purpose is for the MS of FIG. **22** processing (e.g. a first, or sending, MS), after determining its whereabouts are stale, to periodically transmit requests for whereabouts information from MSs in the vicinity (e.g. from at least a second, or receiving, MS), and/or to start a thread **1952** for immediately determining whereabouts. Alternative embodiments to FIG. **22** will implement processing of blocks **2218** through **2224**, or processing of blocks **2226** through **2228**, or both as depicted in FIG. **22**. It is recommended that validity criteria set at block **1444** for **1922**-Max be fixed at one (1) in the preferred embodiment. Multiple channels for broadcast at block **2224** should be isolated to modular send processing feeding from a queue **24**.

In an alternative embodiment having multiple transmission channels visible to process **1922**, there can be a worker thread **1922** per channel to handle broadcasting on multiple channels. If thread(s) **1922** (block **2224**) do not transmit directly over the channel, this embodiment would provide means for

communicating the channel for broadcast to send processing when interfacing to queue **24** (e.g. incorporate a channel qualifier field with WDR request inserted to queue **24**). This embodiment could allow specification of one (1) thread per channel, however multiple worker threads configurable for process **1922** as determined by the number of channels configurable for broadcast.

Processing begins at block **2202**, continues to block **2204** where the process worker thread count **1922**-Ct is accessed and incremented by 1 (using appropriate semaphore access (e.g. **1922**-Sem)), and continues to block **2206** for interim housekeeping of pruning the CR queue by invoking a Prune Queues procedure of FIG. **27**. Block **2204** may also check the **1922**-Ct value, and signal the process **1922** parent thread that all worker threads are running when **1922**-Ct reaches **1922**-Max. Block **2206** continues to block **2208** for peeking WDR queue **22** (using interface **1924**) for a special termination request entry. Thereafter, if block **2210** determines that a worker thread termination request was not found in queue **22**, processing continues to block **2212**. Block **2212** peeks the WDR queue **22** (using interface **1924**) for the most recent highest confidence entry for this MS whereabouts by searching queue **22** for: the MS ID field **1100***a* matching the MS ID of FIG. **22** processing, and a confidence field **1100***d* greater than or equal to the confidence floor value, and a most recent date/time stamp field **1100***b* within a prescribed trailing period of time of block **2212** search processing using a function of the WTV (i.e. f(WTV)=short-hand for "function of WTV") for the period. For example, block **2212** peeks the queue (i.e. makes a copy for use if an entry found for subsequent processing, but does not remove the entry from queue) for a WDR of the first MS which has the greatest confidence over 75 and has been most recently inserted to queue **22** in the last 3 seconds. Since the MS whereabouts accuracy may be dependent on timeliness of the WTV, it is recommended that the f(WTV) be some value less than or equal to WTV, but preferably not greater than the WTV. Thread **1922** is of less value to the MS when not making sure in a timely manner the MS is maintaining timely whereabouts for itself. In an alternate embodiment, a movement tolerance (e.g. user configured or system set (e.g. 3 meters)) is incorporated at the MS, or at service(s) used to locate the MS, for knowing when the MS has significantly moved (e.g. more than 3 meters) and how long it has been (e.g. 45 seconds) since last significantly moving. In this embodiment, the MS is aware of the period of time since last significantly moving and the f(WTV) is set using the amount of time since the MS significantly moved (i.e. f(WTV)=as described above, or the amount of time since significantly moving, whichever is greater). This way a large number of (perhaps more confident candidates) WDRs are searched in the time period when the MS has not significantly moved. Optional blocks **278** through **284** may have been incorporated to FIG. **2**F for movement tolerance processing just described, in which case the LWT is compared to the current date/time to adjust the WTV for the correct trailing period. In any case, a WDR is sought at block **2212** which will verify whether or not MS whereabouts are current.

Thereafter, if block **2214** determines a satisfactory WDR was found, then processing continues to block **2216**. Block **2216** causes thread **1922** to sleep according to a f(WTV) (preferably a value less than or equal to the WTV (e.g. 95% of WTV)). When the sleep time has elapsed, processing continues back to block **2206** for another loop iteration of blocks **2206** through **2214**.

If block **2214** determines a current WDR was not found, then block **2218** builds a WDR request (e.g. containing record **2490** with field **2490***a* for the MS of FIG. **22** processing (MS ID or pseudo MS ID) so receiving MSs in the LN-expanse know who to respond to, and field **2490***b* with appropriate correlation for response), block **2220** builds a record **2450** (using correlation generated for the request at block **2218**), block **2222** inserts the record **2450** to queue **1990** (using interface **1928**), and block **2224** broadcasts the WDR request (record **2490**) for responses. Absence of field **2490***d* indicates to send processing feeding from queue **24** to broadcast on all available comm. interfaces **70**.

With reference now to FIG. **24**C, depicted is an illustration for describing a preferred embodiment of a WDR request record, as communicated to queue **24** or **26**. When a LN-expanse globally uses NTP, as found in thread **19***xx* processing described for architecture **1900**, a WDR request record **2490** may, or may not, be required. TDOA calculations can be made using a single unidirectional data (**1302** or **1312**) packet containing a sent date/time stamp (of when the data was sent) as described above.

Records **2490** contain a MS ID field **2490***a* and correlation field **2490***b*. MS ID field **2490***a* contains an MS ID (e.g. a value of field **1100***a*). An alternate embodiment will contain a pseudo MS ID (for correlation), perhaps made by a derivative of the MS ID with a unique (suffix) portion, so that receiving MSs can directly address the MS sending the request without actually knowing the MS ID (i.e. they know the pseudo MS ID which enables the MS to recognize originated transmissions). Correlation data field **2490***b* contains unique correlation data (e.g. MS id with suffix of unique number) used to provide correlation for matching sent requests (data **1302**) with received WDR responses (data **1302** or **1312**). Upon a correlation match, a TBOA measurement is calculated using the time difference between field **2450***a* and a date/time stamp of when the response was received (e.g. field **1100***p*). Received date/time stamp field **2490***c* is added by receive processing feeding queue **26** when an MS received the request from another MS. Comm interface field **2490***d* is added by receive processing inserting to queue **26** for how to respond and target the originator. Many MSs do not have choices of communications interfaces, so field **2490***d* may not be required. If available it is used, otherwise a response can be a broadcast. Field **2490***d* may contain a wave spectrum identifier for uniquely identifying how to respond (e.g. one to one with communications interface), or any other value for indicating how to send given how the request was received.

With reference back to FIG. **22**, block **2218** builds a request that receiving MSs will know is for soliciting a response with WDR information. Block **2218** generates correlation for field **2450***b* to be returned in responses to the WDR request broadcast at block **2224**. Block **2220** also sets field **2450***a* to when the request was sent. Preferably, field **2450***a* is set as close to the broadcast as possible. In an alternative embodiment, broadcast processing feeding from queue **24** makes the record **2450** and inserts it to queue **1990** with a most accurate time of when the request was actually sent. Fields **2450***a* are to be as accurate as possible. Block **2224** broadcasts the WDR request data **1302** (using send interface **1926**) by inserting to queue **24** so that send processing broadcasts data **1302**, for example as far as radius **1306**. Broadcasting preferably uses all available communications interface(s) **70** (e.g. all available wave spectrums). Therefore, the comm interface field **2490***d* is not set (which implies to send processing to do a broadcast).

Block **2224** continues to block **2226** where a record **2400** is built (i.e. field **2400***a*=**1952** and field **2400***b* is set to null (e.g. −1)) and then block **2228** inserts the record **2400** to TR queue **1980** (using interface **1930**) so that a thread **1952** will perform processing. Blocks **2226** and **2228** may be replaced with an

alternative embodiment for starting a thread **1952**. Block **2228** continues back to block **2216**.

Referring back to block **2210**, if a worker thread termination request entry was found at queue **22**, then block **2230** decrements the worker thread count by 1 (using appropriate semaphore access (e.g. **1922**-Sem)), and thread **1922** processing terminates at block **2232**. Block **2230** may also check the **1922**-Ct value, and signal the process **1922** parent thread that all worker threads are terminated when **1922**-Ct equals zero (0).

In the embodiment wherein usual MS communications data **1302** of the MS is altered to contain CK **1304** for listening MSs in the vicinity, send processing feeding from queue **24**, caused by block **2224** processing, will place the request as CK **1304** embedded in usual data **1302** at the next opportune time of sending usual data **1302**. This may require the alternative embodiment of adding the entry to queue **1990** being part of send processing. As the MS conducts its normal communications, transmitted data **1302** contains new data CK **1304** to be ignored by receiving MS other character **32** processing, but to be found by listening MSs within the vicinity which anticipate presence of CK **1304**. Otherwise, when LN-Expanse deployments have not introduced CK **1304** to usual data **1302** communicated on a receivable signal by MSs in the vicinity, FIG. **22** sends new WDR request data **1302**.

FIG. **23** depicts a flowchart for describing a preferred embodiment of MS timing determination processing. FIG. **23** processing describes a process **1932** worker thread, and is of PIP code **6**. Thread(s) **1932** purpose is for the MS of FIG. **23** processing to determine TDOA measurements when needed for WDR information received. It is recommended that validity criteria set at block **1444** for **1932**-Max be set as high as possible (e.g. 12) relative performance considerations of architecture **1900**, to service multiple threads **1912**. Processing begins at block **2302**, continues to block **2304** where the process worker thread count **1932**-Ct is accessed and incremented by 1 (using appropriate semaphore access (e.g. **1932**-Sem)), and continues to block **2306** for interim housekeeping of pruning the CR queue by invoking a Prune Queues procedure of FIG. **27**. Block **2304** may also-check the **1932**-Ct value, and signal the process **1932** parent thread that all worker threads are running when **1932**-Ct reaches **1932**-Max.

Thereafter, block **2308** retrieves from queue **1980** a record **2400** (using interface **1934**), perhaps a special termination request entry, or a record **2400** received from thread(s) **1912**, and only continues to block **2310** when a record **2400** containing field **2400***a* set to **1932** has been retrieved. Block **2308** stays blocked on retrieving from queue **1980** until a record **2400** with field **2400***a*=**1932** is retrieved. If block **2310** determines a special entry indicating to terminate was not found in queue **1980**, processing continues to block **2312**.

If at block **2312**, the record **2400** does not contain a MS ID (or pseudo MS ID) in field **2400***b*, processing continues to block **2314** for building a WDR request (record **2490**) to be broadcast, and then to block **2318**. Broadcasting preferably uses all available communications interface(s) **70** (e.g. all available wave spectrums). If block **2312** determines the field **2400***b* is a valid MS ID (not null), block **2316** builds a WDR request targeted for the MS ID, and processing continues to block **2318**. A targeted request is built for targeting the MS ID (and communications interface, if available) from field **2400***b*. Send processing is told which communications interface to use, if available (e.g. MS has multiple), otherwise send processing will target each available interface. In the unlikely case a MS ID is present in field **2400***b* without the communications interface applicable, then all communications interfaces **70** are used with the targeted MS ID. In MS embodiments with multiple communications interfaces **70**, then **2400***b* is to contain the applicable communication interface for sending. Block **2318** generates appropriate correlation for a field **2450***b* (e.g. to be compared with a response WDR at block **2144**), block **2320** sets field **2450***a* to the current MS date/time stamp, block **2322** inserts the record **2450** to queue **1990** (using interface **1936**), and block **2324** sends/broadcasts (using interface **1938**) a WDR request (record **2490**). Thereafter, processing continues back to block **2306** for another loop iteration. An alternative embodiment will only target a WDR request to a known MS ID. For example, block **2312** would continue back to block **2306** if no MS ID is found (=null), otherwise it will continue to block **2316** (i.e. no use for block **2314**).

Block **2318** sets field **2450***b* to correlation to be returned in responses to the WDR request sent/broadcast at block **2324**. Block **2320** sets field **2450***a* to when the request is sent. Preferably, field **2450***a* is set as close as possible to when a send occurred. In an alternative embodiment, send processing feeding from queue **24** makes the record **2450** and inserts it to queue **1990** with a most accurate time of when the request was actually sent. Fields **2450***a* are to be as accurate as possible. Block **2324** sends/broadcasts the WDR request data **1302** (using send interface **1938**) by inserting to queue **24** a record **2490** (**2490***a*=the targeted MS ID (or pseudo MS ID) OR null if arrived to from block **2314**, field **2490***b*=correlation generated at block **2318**) so that send processing sends data **1302**, for example as far as radius **1306**. A null MS ID may be responded to by all MSs in the vicinity. A non-null MS ID is to be responded to by a particular MS. Presence of field **2490***d* indicates to send processing feeding from queue **24** to target the MS ID over the specified comm. interface (e.g. when MS has a plurality of comm. interfaces **70** (e.g. cellular, Wifi, Bluetooth, etc; i.e. MS supports multiple classes of wave spectrum)).

Referring back to block **2310**, if a worker thread termination request was found at queue **1980**, then block **2326** decrements the worker thread count by 1 (using appropriate semaphore access (e.g. **1932**-Sem)), and thread **1932** processing terminates at block **2328**. Block **2326** may also check the **1932**-Ct value, and signal the process **1932** parent thread that all worker threads are terminated when **1932**-Ct equals zero (0).

In the embodiment wherein usual MS communications data **1302** of the MS is altered to contain CK **1304** for listening MSs in the vicinity, send processing feeding from queue **24**, caused by block **2324** processing, will place the WDR request as CK **1304** embedded in usual data **1302** at the next opportune time of sending usual data **1302**. As the MS conducts its normal communications, transmitted data **1302** contains new data CK **1304** to be ignored by receiving MS other character **32** processing, but to be found by listening MSs within the vicinity which anticipate presence of CK **1304**. This may require the alternative embodiment of adding the entry to queue **1990** being part of send processing. Otherwise, when LN-Expanse deployments have not introduced CK **1304** to usual data **1302** communicated on a receivable signal by MSs in the vicinity, FIG. **22** sends/broadcasts new WDR request data **1302**.

An alternate embodiment to block **2324** can wait for a response with a reasonable timeout, thereby eliminating the need for blocks **2318** through **2322** which is used to correlate the subsequent response (to thread **1912**) with the request sent at block **2324**. However, this will cause a potentially unpredictable number of simultaneously executing thread(s) **1932** when many MSs are in the vicinity.

Thread(s) **1932** are useful when one or both parties to WDR transmission (sending and receiving MS) do not have NTP enabled. TDOA measurements are taken to triangulate the MS relative other MSs in real time.

FIG. **25** depicts a flowchart for describing a preferred embodiment of MS WDR request processing, for example when a remote MS requests (e.g. from FIGS. **22** or **23**) a WDR. Receive processing identifies targeted requests destined (e.g. FIG. **23**) for the MS of FIG. **25** processing, and identifies general broadcasts (e.g. FIG. **22**) for processing as well. FIG. **25** processing describes a process **1942** worker thread, and is of PIP code **6**. Thread(s) **1942** purpose is for the MS of FIG. **25** processing to respond to incoming WDR requests. It is recommended that validity criteria set at block **1444** for **1942**-Max be set as high as possible (e.g. 10) relative performance considerations of architecture **1900**, to service multiple WDR requests simultaneously. Multiple channels for receiving data fed to queue **26** should be isolated to modular receive processing.

In an alternative embodiment having multiple receiving transmission channels visible to process **1942**, there can be a worker thread **1942** per channel to handle receiving on multiple channels simultaneously. If thread(s) **1942** do not receive directly from the channel, the preferred embodiment of FIG. **25** would not need to convey channel information to thread(s) **1942** waiting on queue **24** anyway. Embodiments could allow specification/configuration of many thread(s) **1942** per channel.

Processing begins at block **2502**, continues to block **2504** where the process worker thread count **1942**-Ct is accessed and incremented by 1 (using appropriate semaphore access (e.g. **1942**-Sem)), and continues to block **2506** for retrieving from queue **26** a record **2490** (using interface **1948**), perhaps a special termination request entry, and only continues to block **2508** when a record **2490** is retrieved. Block **2506** stays blocked on retrieving from queue **26** until any record **2490** is retrieved. If block **2508** determines a special entry indicating to terminate was not found in queue **26**, processing continues to block **2510**. There are various embodiments for thread(s) **1912** and thread(s) **1942** to feed off a queue **26** for different record types, for example, separate queues **26**A and **26**B, or a thread target field with either record found at queue **26** (e.g. like field **2400***a*). In another embodiment, thread(s) **1912** are modified with logic of thread(s) **1942** to handle all records described for a queue **26**, since thread(s) **1912** are listening for queue **26** data anyway.

Block **2510** peeks the WDR queue **22** (using interface **1944**) for the most recent highest confidence entry for this MS whereabouts by searching queue **22** for: the MS ID field **1100***a* matching the MS ID of FIG. **25** processing, and a confidence field **1100***d* greater than or equal to the confidence floor value, and a most recent date/time stamp field **1100***b* within a prescribed trailing period of time of block **2510** search processing (e.g. 2 seconds). For example, block **2510** peeks the queue (i.e. makes a copy for use if an entry found for subsequent processing, but does not remove the entry from queue) for a WDR of the MS (of FIG. **25** processing) which has the greatest confidence over 75 and has been most recently inserted to queue **22** in the last 2 seconds. It is recommended that the trailing period of time used by block **2510** be never greater than a few seconds. Thread **1942** is of less value to the LN-expanse when it responds with outdated/invalid whereabouts of the MS to facilitate locating other MSs. In an alternate embodiment, a movement tolerance (e.g. user configured or system set (e.g. 3 meters)) is incorporated at the MS, or at service(s) used to locate the MS, for knowing when the MS has significantly moved (e.g. more than 3 meters) and how long it has been (e.g. 45 seconds) since last significantly moving. In this embodiment, the MS is aware of the period of time since last significantly moving and the trailing period of time used by block **2510** is set using the amount of time since the MS significantly moved, or the amount of time since significantly moving, whichever is greater. This way a large number of (perhaps more confident candidate) WDRs are searched in the time period when the MS has not significantly moved. Optional blocks **278** through **284** may have been incorporated to FIG. **2**F for movement tolerance processing just described, in which case the LWT is compared to the current date/time to adjust the trailing period of time used by block **2510** for the correct trailing period. In any case, a WDR is sought at block **2510** to satisfy a request helping another MS in the LN-expanse locate itself.

Thereafter, if block **2512** determines a useful WDR was not found, then processing continues back to block **2506** for another loop iteration of processing an inbound WDR request. If block **2512** determines a useful WDR was found, then block **2514** prepares the WDR for send processing with correlation field **1100***m* set from correlation field **2490***b* retrieved at block **2506**, and block **2516** sends/broadcasts (per field **2490***a*) the WDR information (using send interface **1946**) by inserting to queue **24** so that send processing transmits data **1302**, for example as far as radius **1306**, and processing continues back to block **2506**. At least fields **1100***b*, **1100***c*, **1100***d*, **1100***m* and **1100***n* are sent/broadcast. See FIG. **11**A descriptions. Fields are set to the following upon exit from block **2514**:

MS ID field **1100***a* is preferably set with: Field **2490***a* from queue **26**.

DATE/TIME STAMP field **1100***b* is preferably set with: Field **1100***b* from queue **22**.

LOCATION field **1100***c* is preferably set with: Field **1100***c* from queue **22**.

CONFIDENCE field **1100***d* is preferably set with: Field **1100***d* from queue **22**.

LOCATION TECHNOLOGY field **1100***e* is preferably set with: Field **1100***e* from queue **22**.

LOCATION REFERENCE INFO field **1100***f* is preferably set with: null (not set) for Broadcast by send processing, otherwise set to field **2490***d* for Send by send processing.

COMMUNICATIONS REFERENCE INFO field **1100***g* is preferably set with: null (not set).

SPEED field **1100***h* is preferably set with: Field **1100***h* from queue **22**.

HEADING field **1100***i* is preferably set with: Field **1100***i* from queue **22**.

ELEVATION field **1100***j* is preferably set with: Field **1100***j* from queue **22**.

APPLICATION FIELDS field **1100***k* is preferably set with: Field **1100***k* from queue **22**. An alternate embodiment will add, alter, or discard data (with or without date/time stamps) here at the time of block **2514** processing.

CORRELATION FIELD **1100***m* is preferably set with: Field **2490***b* from queue **26**.

SENT DATE/TIME STAMP field **1100***n* is preferably set with: Sent date/time stamp as close in processing the send/broadcast of block **2516** as possible.

RECEIVED DATE/TIME STAMP field **1100***p* is preferably set with: Not Applicable (i.e. N/A for sending).

Embodiments may rely completely on the correlation field **2490***b* with no need for field **2490***a*. Referring back to block **2508**, if a worker thread termination request was found at queue **26**, then block **2518** decrements the worker thread count by 1 (using appropriate semaphore access (e.g. **1942**-Sem)), and thread **1942** processing terminates at block **2520**.

Block **2518** may also check the **1942**-Ct value, and signal the process **1942** parent thread that all worker threads are terminated when **1942**-Ct equals zero (0).

Block **2516** causes sending/broadcasting data **1302** containing CK **1304**, depending on the type of MS, wherein CK **1304** contains WDR information prepared as described above for block **2514**. Alternative embodiments of block **2510** may not search a specified confidence value, and broadcast the best entry available anyway so that listeners in the vicinity will decide what to do with it. A semaphore protected data access (instead of a queue peek) may be used in embodiments where there is always one WDR current entry maintained for the MS.

In the embodiment wherein usual MS communications data **1302** of the MS is altered to contain CK **1304** for listening MSs in the vicinity, send processing feeding from queue **24**, caused by block **2516** processing, will place WDR information as CK **1304** embedded in usual data **1302** at the next opportune time of sending usual data **1302**. If an opportune time is not timely, send processing should discard the send request of block **2516** to avoid broadcasting outdated whereabouts information (unless using a movement tolerance and time since last significant movement). As the MS conducts its normal communications, transmitted data **1302** contains new data CK **1304** to be ignored by receiving MS other character **32** processing, but to be found by listening MSs within the vicinity which anticipate presence of CK **1304**. Otherwise, when LN-Expanse deployments have not introduced CK **1304** to usual data **1302** communicated on a receivable signal by MSs in the vicinity, (FIG. **25** sends/broadcasts new WDR response data **1302**). In any case, field **1100***n* should be as accurate as possible for when data **1302** is actually sent. Critical regions of code (i.e. prevent thread preemption) and/or anticipated execution timing may be used to affect a best setting of field **1100***n*.

In an alternate embodiment, records **2490** contain a sent date/time stamp field **2490***e* of when the request was sent by a remote MS, and the received date/time stamp field **2490***c* is processed at the MS in FIG. **25** processing. This would enable block **2514** to calculate a TDOA measurement for returning in field **1100***f* of the WDR sent/broadcast at block **2516**.

FIG. **26**A depicts a flowchart for describing a preferred embodiment of MS whereabouts determination processing. FIG. **26**A processing describes a process **1952** worker thread, and is of PIP code **6**. Thread(s) **1952** purpose is for the MS of FIG. **26**A processing to determine its own whereabouts with useful WDRs from other MSs. It is recommended that validity criteria set at block **1444** for **1952**-Max be set as high as possible (e.g. **10**) relative performance considerations of architecture **1900**, to service multiple threads **1912**. **1952**-Max may also be set depending on what DLM capability exists for the MS of FIG. **26**A processing. In an alternate embodiment, thread(s) **19***xx* are automatically throttled up or down (e.g. **1952**-Max) per unique requirements of the MS as it travels.

Processing begins at block **2602**, continues to block **2604** where the process worker thread count **1952**-Ct is accessed and incremented by 1 (using appropriate semaphore access (e.g. **1952**-Sem)), and continues to block **2606** for interim housekeeping of pruning the WDR queue by invoking a Prune Queues procedure of FIG. **27**. Block **2604** may also check the **1952**-Ct value, and signal the process **1952** parent thread that all worker threads are running when **1952**-Ct reaches **1952**-Max. Block **2606** may not be necessary since pruning may be accomplished at block **2620** when invoking FIG. **2**F (block **292**).

Thereafter, block **2608** retrieves from queue **1980** a record **2400** (using interface **1958**), perhaps a special termination request entry, or a record **2400** received from thread(s) **1912**, and only continues to block **2610** when a record **2400** containing field **2400***a* set to **1952** has been retrieved. Block **2608** stays blocked on retrieving from queue **1980** until a record **2400** with field **2400***a* =**1952** is retrieved. If block **2610** determines a special entry indicating to terminate was not found in queue **1980**, processing continues to block **2612**.

Block **2612** peeks the WDR queue **22** (using interface **1954**) for the most recent highest confidence entry for this MS whereabouts by searching queue **22** for: the MS ID field **1100***a* matching the MS ID of FIG. **26**A processing, and a confidence field **1100***d* greater than or equal to the confidence floor value, and a most recent date/time stamp field **1100***b* within a prescribed trailing period of time of block **2612** search processing using a f(WTV) for the period. For example, block **2612** peeks the queue (i.e. makes a copy for use if an entry found for subsequent processing, but does not remove the entry from queue) for a WDR of the MS (of FIG. **26**A processing) which has the greatest confidence over 75 and has been most recently inserted to queue **22** in the last 2 seconds. Since MS whereabouts accuracy may be dependent on timeliness of the WTV, it is recommended that the f(WTV) be some value less than or equal to WTV. In an alternate embodiment, a movement tolerance (e.g. user configured or system set (e.g. 3 meters)) is incorporated at the MS, or at service(s) used to locate the MS, for knowing when the MS has significantly moved (e.g. more than 3 meters) and how long it has been (e.g. 45 seconds) since last significantly moving. In this embodiment, the MS is aware of the period of time since last significantly moving and the f(WTV) is set using the amount of time since the MS significantly moved (i.e. f(WTV) =as described above, or the amount of time since significantly moving, whichever is greater). This way a large number of (perhaps more confident candidate) WDRs are searched in the time period when the MS has not significantly moved. Optional blocks **278** through **284** may have been incorporated to FIG. **2**F for movement tolerance processing just described, in which case the LWT is compared to the current date/time to adjust the WTV for the correct trailing period.

Thereafter, if block **2614** determines a timely whereabouts for this MS already exists to queue **22** (current WDR found), then processing continues back to block **2606** for another loop iteration of processing. If **2614** determines a satisfactory WDR does not already exist in queue **22**, then block **2600** determines a new highest confidence WDR for this MS (FIG. **26**B processing) using queue **22**.

Thereafter, if block **2616** determines a WDR was not created (BESTWDR variable=null) for the MS of FIG. **26**A processing (by block **2600**), then processing continues back to block **2606**. If block **2616** determines a WDR was created (BESTWDR=WDR created by FIG. **26**B) for the MS of FIG. **26**A processing by block **2600**, then processing continues to block **2618** for preparing FIG. **2**F parameters and FIG. **2**F processing is invoked with the new WDR at block **2620** (for interface **1956**) before continuing back to block **2606**. Parameters set at block **2618** are: WDRREF=a reference or pointer to the WDR completed at block **2600**; DELETEQ=FIG. **26**A location queue discard processing; and SUPER=FIG. **26**A supervisory notification processing.

Referring back to block **2610**, if a worker thread termination request was found at queue **1980**, then block **2622** decrements the worker thread count by 1 (using appropriate semaphore access (e.g. **1952**-Sem)), and thread **1952** processing terminates at block **2624**. Block **2622** may also check

the **1952**-Ct value, and signal the process **1952** parent thread that all worker threads are terminated when **1952**-Ct equals zero (0).

Alternate embodiments to FIG. **26**A will have a pool of thread(s) **1952** per location technology (WDR field **1100***e*) for specific WDR field(s) selective processing. FIG. **26**A processing is shown to be generic with handling all WDRs at block **2600**.

FIG. **26**B depicts a flowchart for describing a preferred embodiment of processing for determining a highest possible confidence whereabouts, for example in ILM processing, such as processing of FIG. **26**A block **2600**. Processing starts at block **2630**, and continues to block **2632** where variables are initialized (BESTWDR=null, THIS_MS=null, REMOTE_MS=null). BESTWDR will reference the highest confidence WDR for whereabouts of the MS of FIG. **26**B processing (i.e. this MS) upon return to FIG. **26**A when whereabouts determination is successful, otherwise BESTWDR is set to null (none found). THIS_MS points to an appropriately sorted list of WDRs which were originated by this MS and are DLM originated (i.e. inserted by the DLM of FIG. **26**B processing). REMOTE_MS points to an appropriately sorted list of WDRs which were originated by other MSs (i.e. from DLMs and/or ILMs and collected by the ILM of FIG. **26**B processing).

Thereafter, block **2634** peeks the WDR queue **22** (using interface **1954**) for most recent WDRs by searching queue **22** for: confidence field **1100***d* greater than or equal to the confidence floor value, and a most recent date/time stamp field **1100***b* within a prescribed trailing period of time of block **2634** search processing using a f(WTV) for the period. For example, block **2634** peeks the queue (i.e. makes a copy of all WDRs to a result list for use if any found for subsequent processing, but does not remove the entry(s) from queue) for all WDRs which have confidence over 75 and has been most recently inserted to queue **22** in the last 2 seconds. It is recommended that the f(WTV) used here be some value less than or equal to the WTV (want to be ahead of curve, so may use a percentage (e.g. 90%)), but preferably not greater than a couple/few seconds (depends on MS, MS applications, MS environment, whereabouts determination related variables, etc).

In an alternative embodiment, thread(s) **1952** coordinate with each other to know successes, failures or progress of their sister threads for automatically adjusting the trailing f(WTV) period of time appropriately. See "Alternative IPC Embodiments" below.

Thread **1952** is of less value to the MS when whereabouts are calculated using stale WDRs, or when not enough useful WDRs are considered. In an alternate embodiment, a movement tolerance (e.g. user configured or system set (e.g. 3 meters)) is incorporated at the MS, or at service(s) used to locate the MS, for knowing when the MS has significantly moved (e.g. more than 3 meters) and how long it has been (e.g. 45 seconds) since last significantly moving. In this embodiment, the MS is aware of the period of time since last significantly moving and the f(WTV) is set using the amount of time since the MS significantly moved (i.e. f(WTV)=as described above, or the amount of time since significantly moving, whichever is greater): This way a large number of (perhaps more confident candidates) WDRs are searched in the time period when the MS has not significantly moved. Optional blocks **278** through **284** may have been incorporated to FIG. **2**F for movement tolerance processing just described, in which case the LWT is compared to the current date/time to adjust the WTV for the correct trailing period. In any case, all useful WDRs are sought at block **2634** and placed into a list upon exit from block **2634**.

Thereafter, block **2636** sets THIS_MS list and REMOTE_MS list sort keys to be used at blocks **2644** and **2654**. Blocks **2638** through **2654** will prioritize WDRs found at block **2634** depending on the sort keys made at block **2636**. A number of variables may be used to determine the best sort keys, such as the time period used to peek at block **2634** and/or the number of entries in the WDR list returned by block **2634**, and/or other variables. When the time period of search is small (e.g. less than a couple seconds), lists (THIS_MS and REMOTE_MS) should be prioritized primarily by confidence (fields **1100***d*) since any WDRs are valuable for determining whereabouts. This is the preferred embodiment.

When the time period is great, careful measure must be taken to ensure stale WDRs are not used (e.g. >few seconds, and not considering movement tolerance). Depending on decision embodiments, there will be preferred priority order sort keys created at exit from block **2636**, for example "key**1**/key**2**/key**3**" implies that "key**1**" is a primary key, "key**2**" is a second order key, and "key**3**" is a third order key. A key such as "field-1100b/field-1100d/field-1100f:signal-strength" would sort WDRs first by using date/time stamp fields **1100***b*, then by confidence value fields **1100***d* (sorted within matching date/time stamp WDRs), then by signal-strength field **1100***f* sub-field values (sorted within matching WDR confidences; no signal strength present=lowest priority). Another sort key may be "field-**1100***d*/field-**1100***b*" for sorting WDRs first by using confidence values, then by date/time stamps (sorted within matching WDR confidences). The same or different sort keys can be used for lists THIS_MS and REMOTE_MS. Any WDR data (fields or subfields) can be sorted with a key, and sort keys can be of N order dimension such that "key**1**/key**2**/ . . . /keyN". Whatever sort keys are used, block **2686** will have to consider confidence versus being stale, relative to the WTV. In the preferred embodiment, the REMOTE_MS and THIS_MS lists are set with the same sort keys of "field-**1100***d*/field-**1100***b*" (i.e. peek time period used at block **2634** is less than 2 seconds) so that confidence is primary.

Thereafter, block **2638** gets the first (if any) WDR in the list returned at block **2634** (also processes next WDR in list when encountered again in loop of blocks **2638** through **2654**), and block **2640** checks to see if all WDRs have already been processed. If block **2640** finds that all WDRs have not been processed, then block **2642** checks the WDR origination. If block **2642** determines the WDR is one that originated from a remote MS (i.e. MS ID does not match the MS of FIG. **26**B processing), then block **2644** inserts the WDR into the REMOTE_MS list using the desired sort key (confidence primary, time secondary) from block **2636**, and processing continues to block **2638** for another loop iteration. If block **2642** determines the WDR is one that originated from this MS (MS ID field **1100***a* matches the MS of FIG. **26**B processing (e.g. this MS being a DLM at the time of WDR creation (this MS ID=field **1100***a*) or this MS being an ILM at the time of WDR creation (previous processing of FIG. **26**A)), then processing continues to block **2646** to determine how to process the WDR which was inserted by "this MS" for its own whereabouts.

Block **2646** accesses field **1100***f* for data found there (e.g. FIGS. **2**D and **2**E may have inserted useful TDOA measurements, even though DLM processing occurred; or FIG. **3**C may have inserted useful TDOA and/or AOA measurements with reference station(s) whereabouts; or receive processing

may have inserted AOA and related measurements). Thereafter, if block **2648** determines presence of TDOA and/or AOA data, block **2650** checks if reference whereabouts (e.g. FIG. **3**C selected stationary reference location(s)) is also stored in field **1100***f*. If block **2650** determines whereabouts information is also stored to field **1100***f*, then block **2652** makes new WDR(s) from the whereabouts information containing at least the WDR Core and field **1100***f* containing the AOA and/or TDOA information as though it were from a remote DLM or ILM. Block **2652** also performs the expected result of inserting the WDR of loop processing into the THIS_MS list using the desired sort key from block **2636**. Processing then continues to block **2644** where the newly made WDR(s) is inserted into the REMOTE_MS list using the desired sort key (confidence primary, time secondary) from block **2636**. Block **2644** continues back to block **2638**.

Referring back to block **2650**, if it is determined that whereabouts information was not present with the AOA and/or TDOA information of field **1100***f*, then processing continues to block **2644** for inserting into the REMOTE_MS list (appropriately with sort key from block **2636**) the currently looped WDR from block **2634**. In-range location technology associates the MS with the antenna (or cell tower) location, so that field **1100***c* already contains the antenna (or cell tower) whereabouts, and the TDOA information was stored to determine how close the MS was to the antenna (or cell tower) at the time. The WDR will be more useful in the REMOTE_MS list, then if added to the THIS_MS list (see loop of blocks **2660** through **2680**). Referring back to block **2648**, if it is determined that no AOA and/or TDOA information was in field **1100***f*, then processing continues to block **2654** for inserting the WDR into the THIS_MS list (appropriately with sort key (confidence primary, time secondary) from block **2636**).

Block **2654** handles WDRs that originated from the MS of FIG. **26**B (this MS), such as described in FIGS. **2**A through **9**B, or results from previous FIG. **26**A processing. Block **2644** maintains remote DLMs and/or ILMs (their whereabouts) to the REMOTE_MS list in hope WDRs contain useful field **1100***f* information for determining the whereabouts of the MS of FIG. **26**B processing. Block **2652** handles WDRs that originated from the MS of FIG. **26**B processing (this MS), but also processes fields from stationary references used (e.g. FIG. **3**C) by this MS which can be helpful as though the WDR was originated by a remote ILM or DLM. Thus, block **2652** causes inserting to both lists (THIS_MS and REMOTE_MS) when the WDR contains useful information for both. Blocks **2652**, **2654** and **2644** cause the iterative loop of blocks **2660** through **2680** to perform ADLT using DLMs and/or ILMs. Alternate embodiments of blocks **2638** through **2654** may use peek methodologies to sort from queue **22** for the REMOTE_MS and THIS_MS lists.

Referring back to block **2640**, if it is determined that all WDRs in the list from block **2634** have been processed, then block **2656** initializes a DISTANCE list and ANGLE list each to null, block **2658** sets a loop iteration pointer to the first entry of the prioritized REMOTE_MS list (e.g. first entry higher priority than last entry in accordance with sort key used), and block **2660** starts the loop for working with ordered WDRs of the REMOTE_MS list. Exit from block **2640** to block **2656** occurs when the REMOTE_MS and THIS_MS lists are in the desired priority order for subsequent processing. Block **2660** gets the next (or first) $REMOTE_{13}$ MS list entry for processing before continuing to block **2662**. If block **2662** determines all WDRs have not yet been processed from the REMOTE_MS list, then processing continues to block **2664**.

Blocks **2664** and **2670** direct collection of all useful ILM triangulation measurements for TDOA, AOA, and/or MPT triangulation of this MS relative known whereabouts (e.g. other MSs). It is interesting to note that TDOA and AOA measurements (field **1100***f*) may have been made from different communications interfaces **70** (e.g. different wave spectrums), depending on interfaces the MS has available (i.e. all can participate). For example, a MS with blue-tooth, WiFi and cellular phone connectivity (different class wave spectrums supported) can be triangulated using the best available information (i.e. heterogeneous location technique). Examination of fields **1100***f* in FIG. **17** can show wave spectrums (and/or particular communications interfaces **70**) inserted by receive processing for what the MS supports. If block **2664** determines an AOA measurement is present (field **1100***f* sub-field), then block **2666** appends the WDR to the ANGLE list, and processing continues to block **2668**. If block **2664** determines an AOA measurement is not present, then processing continues to block **2670**. If block **2670** determines a TDOA measurement is present (field **1100***f* sub-field), then block **2672** appends the WDR to the DISTANCE list, and processing continues to block **2674**. Block **2674** uses WDRs for providing at least an in-range whereabouts of this MS by inserting to the THIS_MS list in sorted confidence priority order (e.g. highest confidence first in list, lowest confidence at end of list). Block **2674** continues to block **2668**. Block **2674** may cause duplicate WDR(s) inserted to the THIS_MS list, but this will have no negative effect on selected outcome.

Block **2668** compares the ANGLE and DISTANCE lists constructed thus far from loop processing (blocks **2660** through **2682**) with minimum triangulation requirements (e.g. see "Missing Part Triangulation (MPT)" above). Three (3) sides, three (3) angles and a side, and other known triangular solution guides will also be compared. Thereafter, if block **2676** determines there is still not enough data to triangulate whereabouts of this MS, then processing continues back to block **2660** for the next REMOTE_MS list entry, otherwise block **2678** maximizes diversity of WDRs to use for triangulating. Thereafter, block **2680** uses the diversified DISTANCE and ANGLE lists to perform triangulation of this MS, block **2682** inserts the newly determined WDR into the THIS_MS list in sort key order, and continues back to block **2660**. Block **2680** will use heterogeneous (MPT), TDOA and/or AOA triangulation on ANGLE and DISTANCE lists for determining whereabouts.

Block **2682** preferably keeps track of (or checks THIS_MS for) what it has thus far determined whereabouts for in this FIG. **26**B thread processing to prevent inserting the same WDR to THIS_MS using the same REMOTE_MS data. Repeated iterations of blocks **2676** through **2682** will see the same data from previous iterations and will use the best of breed data in conjunction with each other at each iteration (in current thread context). While inserting duplicates to THIS_MS at block **2682** does not cause failure, it may be avoided for performance reasons. Duplicate insertions are preferably avoided at block **2674** for performance reasons as well, but they are again not harmful. Block **2678** preferably keeps track of previous diversity order in this FIG. **26**B thread processing to promote using new ANGLE and DISTANCE data in whereabouts determination at block **2680** (since each iteration is a superset of a previous iteration (in current thread context). Block **2678** promotes using WDRs from different MSs (different MS IDs), and from MSs located at significantly different whereabouts (e.g. to maximize surroundedness), preferably around the MS of FIG. **26**B processing. Block **2678** preferably uses sorted diversity pointer lists so as to not affect actual ANGLE and DISTANCE list order. The

sorted pointer lists provide pointers to entries in the ANGLE and DISTANCE lists for a unique sorted order governing optimal processing at block **2680** to maximize unique MSs and surrounded-ness, without affecting the lists themselves (like a SQL database index). Different embodiments of blocks **2678** through **2682** should minimize inserting duplicate WDRs (for performance reasons) to THIS_MS which were determined using identical REMOTE_MS list data. Block **2682** causes using ADLT at blocks **2684** through **2688** which uses the best of breed whereabouts, either as originated by this MS maintained in THIS_MS list up to the thread processing point of block **2686**, or as originated by remote MSs (DLMs and/or ILMs) processed by blocks **2656** through the start of block **2684**.

Referring back to block **2662**, if it is determined that all WDRs in the REMOTE_MS list have been processed, then block **2684** sets the BESTWDR reference to the head of THIS_MS (i.e. BESTWDR references first WDR in THIS_MS list which is so far the best candidate WDR (highest confidence) for this MS whereabouts, or null if the list is empty). It is possible that there are other WDRs with matching confidence adjacent to the highest confidence entry in the THIS_MS list. Block **2684** continues to block **2686** for comparing matching confidence WDRs, and if there are matches, then breaking a tie between WDRs with matching confidence by consulting any other WDR field(s) (e.g. field **1100***f* signal strength, or location technology field **1100***e*, etc). If there is still a tie between a plurality of WDRs then block **2686** may average whereabouts to the BESTWDR WDR using the matching WDRs. Thereafter processing continues to block **2688** where the BESTWDR is completed, and processing terminates at block **2690**. Block **2688** also frees resources (if any) allocated by FIG. **26**B processing (e.g. lists). Blocks **2686** through **2688** result in setting BESTWDR to the highest priority WDR (i.e. the best possible whereabouts determined). It is possible that FIG. **26**B processing causes a duplicate WDR inserted to queue **22** (at block **2620**) for this MS whereabouts determination, but that is no issue except for impacting performance to queue **22**. An alternate embodiment to queue **22** may define a unique index for erring out when inserting a duplicate to prevent frivolous duplicate entries, or block **2688** will incorporate processing to eliminate the chance of inserting a WDR of less use than what is already contained at queue **22**. Therefore, block **2688** may include processing for ensuring a duplicate will not be inserted (e.g. null the BESTWDR reference) prior to returning to FIG. **26**A at block **2690**.

Averaging whereabouts at block **2686** occurs only when there are WDRs at the head of the list with a matching highest confidence value and still tie in other WDR fields consulted, yet whereabouts information is different. In this case, all matching highest confidence whereabouts are averaged to the BESTWDR to come up with whereabouts in light of all matching WDRs. Block **2686** performs ADLT when finalizing a single whereabouts (WDR) using any of the whereabouts found in THIS_MS (which may contain at this point DLM whereabouts originated by this MS and/or whereabouts originated by remote DLMs and/or ILMs). Block **2686** must be cognizant of sort keys used at blocks **2652** and **2654** in case confidence is not the primary key (time may be primary).

If no WDRs were found at block **2634**, or no THIS_MS list WDRs were found at blocks **2652** and **2654**, and no REMOTE_MS list entries were found at block **2644**; or no THIS_MS list WDRs were found at blocks **2652** and **2654**, and no REMOTE_MS list entries were found useful at blocks **2664** and/or **2670**; then block **2684** may be setting BESTWDR to a null reference (i.e. none in list) in which case block **2686** does nothing. Hopefully, at least one good WDR is determined for MS whereabouts and a new WDR is inserted for this MS to queue **22**, otherwise a null BESTWDR reference will be returned (checked at block **2616**). See FIG. **11**A descriptions. If BESTWDR is not null, then fields are set to the following upon exit from block **2688**:

MS ID field **1100***a* is preferably set with: MS ID of MS of FIG. **26**B processing.

DATE/TIME STAMP field **1100***b* is preferably set with: Date/time stamp of block **2688** processing.

LOCATION field **1100***c* is preferably set with: Resulting whereabouts after block **2688** completion.

CONFIDENCE field **1100***d* is preferably set with: WDR Confidence at THIS_MS list head.

LOCATION TECHNOLOGY field **1100***e* is preferably set with: "ILM TDOA Triangulation", "ILM AOA Triangulation", "ILM MPT Triangulation" or "ILM in-range", as determined by the WDRs inserted to MS_LIST at blocks **2674** and **2682**. The originator indicator is set to ILM.

LOCATION REFERENCE INFO field **1100***f* is preferably set with: null (not set), but may be set with contributing data for analysis of queue **22** provided it is marked for being overlooked by future processing of blocks **2646** and **2648** (e.g. for debug purpose).

COMMUNICATIONS REFERENCE INFO field **1100***g* is preferably set with: null (not set).

SPEED field **1100***h* is preferably set with: Block **2688** may compare prioritized entries and their order of time (field **1100***b*) in THIS_MS list for properly setting this field, if possible.

HEADING field **1100***i* is preferably set with: null (not set). Block **2688** may compare prioritized entries and their order of time (field **1100***b*) in THIS_MS list for properly setting this field, if possible.

ELEVATION field **1100***j* is preferably set with: Field **1100***j* of BESTWDR (may be averaged if WDR tie(s)), if available.

APPLICATION FIELDS field **1100***k* is preferably set with: Field(s) **1100***k* from BESTWDR or tie(s) thereof from THIS_MS. An alternate embodiment will add, alter, or discard data (with or without date/time stamps) here at the time of block **2688** processing.

CORRELATION FIELD **1100***m* is preferably set with: Not Applicable (i.e. not maintained to queue **22**).

SENT DATE/TIME STAMP field **1100***n* is preferably set with: Not Applicable (i.e. not maintained to queue **22**).

RECEIVED DATE/TIME STAMP field **1100***p* is preferably set with: Not Applicable (i.e. not maintained to queue **22**).

Block **2680** determines whereabouts using preferred guidelines, such as whereabouts determined never results in a confidence value exceeding any confidence value used to determine whereabouts. Some embodiments will use the mean (average) of confidence values used, some will use the highest, and some the lowest of the WDRs used. Preferred embodiments tend to properly skew confidence values to lower values as the LN-Expanse grows away from region **1022**. Blocks **2668** through **2680** may consult any of the WDR fields (e.g. field **1100***f* sub-fields yaw, pitch, roll; speed, heading, etc) to deduce the most useful WDR inputs for determining an optimal WDR for this MS whereabouts.

Alternative IPC Embodiments

Thread(s) **1952** are started for every WDR collected from remote MSs. Therefore, it is possible that identical new WDRs are inserted to queue **22** using the same WDR information at blocks **2634** of simultaneously executing threads **1952**, but this will not cause a problem since at least one will

be found when needed, and duplicates will be pruned together when appropriate. Alternative embodiments provide IPC (Interprocess Communications Processing) coordination between **1952** threads for higher performance processing, for example:

- As mentioned above, thread(s) **1952** can coordinate with each other to know successes, failures or progress of their sister **1952** thread(s) for automatically adjusting the trailing f(WTV) period of time appropriately. The f(WTV) period of time used at block **2634** would be semaphore accessed and modified (e.g. increased) for another **1952** thread when a previous **1952** thread was unsuccessful in determining whereabouts (via semaphore accessed thread outcome indicator). After a successful determination, the f(WTV) period of time could be reset back to the smaller window. One embodiment of increasing may start with 10% of the WTV, then 20% at the next thread, 30% at the next thread, up to 90%, until a successful whereabouts is determined. After successful whereabouts determination, a reset to its original starting value is made.
- A semaphore accessed thread **1952** busy flag is used for indicating a certain thread is busy to prevent another **1952** thread from doing the same or similar work. Furthermore, other semaphore protected data for what work is actually being performed by a thread can be informative to ensure that no thread **1952** starts for doing duplicated effort.
- Useful data of statistics **14** may be appropriately accessed by thread(s) **1952** for dynamically controlling key variables of FIG. **26**B processing, such as the search f(WTV) time period, sort keys used, when to quit loop processing (e.g. on first successful whereabouts determination at block **2680**), surrounded-ness preferences, etc. This can dynamically change the FIG. **26**B logic from one thread to another for desired results.

FIG. **26**B continues processing through every WDR retrieved at block **2634**. An alternative embodiment will terminate processing after finding the first (which is highest priority data supported) successful triangulation at block **2682**.

FIG. **27** depicts a flowchart for describing a preferred embodiment of queue prune processing. Queue pruning is best done on an interim basis by threads which may insert to the queue being pruned. In an alternate embodiment, a background asynchronous thread will invoke FIG. **27** for periodic queue pruning to ensure no queue which can grow becomes too large. The Prune Queues procedure starts at block **2702** and continues to block **2704** where parameters passed by a caller for which queue(s) (WDR and/or CR) to prune are determined. Thereafter, if block **2706** determines that the caller wanted to prune the WDR queue **22**, block **2708** appropriately prunes the queue, for example discarding old entries using field **1100***b*, and processing continues to block **2710**. If block **2706** determines that the caller did not want to prune the WDR queue **22**, then processing continues to block **2710**. If block **2710** determines that the caller wanted to prune the CR queue **1990**, block **2712** appropriately prunes the queue, for example discarding old entries using field **2450***a*, and processing continues to block **2714**. If block **2710** determines that the caller did not want to prune the CR queue **1990**, then processing continues to block **2714**. Block **2714** appropriately returns to the caller.

The current design for queue **1980** does not require FIG. **27** to prune it. Alternative embodiments may add additional queues for similar processing. Alternate embodiments may use FIG. **27** like processing to prune queues **24**, **26**, or any other queue under certain system circumstances. Parameters received at block **2704** may also include how to prune the queue, for example when using different constraints for what indicates entry(s) for discard.

FIG. **28** depicts a flowchart for describing a preferred embodiment of MS termination processing. Depending on the MS, there are many embodiments of processing when the MS is powered off, restarted, rebooted, reactivated, disabled, or the like. FIG. **28** describes the blocks of processing relevant to the present disclosure as part of that termination processing. Termination processing starts at block **2802** and continues to block **2804** for checking any DLM roles enabled and appropriately terminating if any are found (for example as determined from persistent storage variable DLMV). Block **2804** may cause the termination of thread(s) associated with enabled DLM role(s) for DLM processing above (e.g. FIGS. **2**A through **9**B). Block **2804** may invoke API(s), disable flag(s), or terminate as is appropriate for DLM processing described above. Such terminations are well known in the art of prior art DLM capabilities described above. Block **2804** continues to block **2806**.

Blocks **2806** through **2816** handle termination of all processes/threads associated with the ILMV roles so there is no explicit ILMV check required. Block **2806** initializes an enumerated process name array for convenient processing reference of associated process specific variables described in FIG. **19**, and continues to block **2808** where the first member of the set is accessed for subsequent processing. The enumerated set of process names has a prescribed termination order for MS architecture **1900**. Thereafter, if block **2810** determines the process identifier (i.e. **19***xx*-PID such that **19***xx* is **1902**, **1912**, **1922**, **1932**, **1942**, **1952** in a loop iteration of blocks **2808** through **2816**) is greater than 0 (e.g. this first iteration of **1912**-PID >0 implies it is to be terminated here; also implies process **1912** is enabled as used in FIGS. **14**A, **28**, **29**A and **29**B), then block **2812** prepares parameters for FIG. **29**B invocation, and block **2814** invokes (calls) the procedure of FIG. **29**B to terminate the process (of this current loop iteration (**19***xx*)). Block **2812** prepares the second parameter in accordance with the type of **19***xx* process. If the process (**19***xx*) is one that is slave to a queue for dictating its processing (i.e. blocked on queue until queue entry present), then the second parameter (process type) is set to 0 (directing FIG. **29**A processing to insert a special termination queue entry to be seen by worker thread(s) for terminating). If the process (**19***xx*) is one that is slave to a timer for dictating its processing (i.e. sleeps until it is time to process), then the second parameter (process type) is set to the associated **19***xx*-PID value (directing FIG. **29**B to use in killing/terminating the PID in case the worker thread(s) are currently sleeping). Block **2814** passes the process name and process type as parameters to FIG. **29**B processing. Upon return from FIG. **29**B, block **2814** continues to block **2816**. If block **2810** determines that the **19***xx* process is not enabled, then processing continues to block **2816**. Upon return from FIG. **29**B processing, the process is terminated and the associated **19***xx*-PID variable is already set to 0 (see blocks **2966**, **2970**, **2976** and **2922**).

Block **2816** checks to see if all process names of the enumerated set (**19***xx*) have been processed (iterated) by blocks **2808** through **2816**. If block **2816** determines that not all process names in the set have been processed (iterated), then processing continues back to block **2808** for handling the next process name in the set. If block **2816** determines that all process names of the enumerated set were processed, then block **2816** continues to block **2818**.

Block **2818** destroys semaphore(s) created at block **1220**. Thereafter, block **2820** destroys queue(s) created at block **1218** (may have to remove all entries first in some embodiments), block **2822** saves persistent variables to persistent storage (for example to persistent storage **60**), block **2824** destroys shared memory created at block **1212**, and block **2826** checks the NTP use variable (saved prior to destroying shared memory at block **2824**).

If block **2826** determines NTP is enabled, then block **2828** terminates NTP appropriately (also see block **1612**) and processing continues to block **2830**. If block **2826** determines NTP was not enabled, then processing continues to block **2830**. Block **2828** embodiments are well known in the art of NTP implementations. Block **2828** may cause terminating of thread(s) associated with NTP use.

Block **2830** completes LBX character termination, then block **2832** completes other character **32** termination processing, and FIG. **28** processing terminates thereafter at block **2834**. Depending on what threads were started at block **1240**, block **2830** may terminate the listen/receive threads for feeding queue **26** and the send threads for sending data inserted to queue **24**. Depending on what threads were started at block **1206**, block **2832** may terminate the listen/receive threads for feeding queue **26** and the send threads for sending data inserted to queue **24** (i.e. other character **32** threads altered to cause embedded CK processing). Upon encounter of block **2834**, the MS is appropriately terminated for reasons at set forth above for invoking FIG. **28**.

With reference now to FIG. **29**B, depicted is a flowchart for describing a preferred embodiment of a procedure for terminating a process started by FIG. **29**A. When invoked by a caller, the procedure starts at block **2952** and continues to block **2954** where parameters passed are determined. There are two parameters: the process name to terminate, and the type of process to terminate. The type of process is set to 0 for a process which has worker threads which are a slave to a queue. The type of process is set to a valid O/S PID when the process worker threads are slave to a timer.

Thereafter, if block **2956** determines the process type is 0, then block **2958** initializes a loop variable J to 0, and block **2960** inserts a special termination request queue entry to the appropriate queue for the process worker thread to terminate. See FIG. **19** discussions for the queue inserted for which **19***xx* process name.

Thereafter, block **2962** increments the loop variable by 1 and block **2964** checks if all process prescribed worker threads have been terminated. Block **2964** accesses the **19***xx*-Max (e.g. **1952**-Max) variable from shared memory using a semaphore for determining the maximum number of threads to terminate in the process worker thread pool. If block **2964** determines all worker threads have been terminated, processing continues to block **2966** for waiting until the **19***xx*-PID variable is set to disabled (e.g. set to 0 by block **2922**), and then to block **2978** which causes return to the caller. Block **2966** uses a preferred choice of waiting described for blocks **2918** and **2920**. The **19***xx* process (e.g. **1952**) will have its **19***xx*-PID (e.g. **1952**-PID) variable set at 0 (block **2922**) when the process terminates. In some embodiments, the waiting methodology used at block **2966** may use the **19***xx*-PID variable, or may be signaled by the last terminating worker thread, or by block **2922**.

If block **2964** determines that not all worker threads have been terminated yet, then processing continues back to block **2960** to insert another special termination request queue entry to the appropriate queue for the next process worker thread to terminate. Blocks **2960** through **2964** insert the proper number of termination queue entries to the same queue so that all of the 19xx process worker threads terminate.

Referring back to block **2956**, if it is determined the process type is not 0 (i.e. is a valid O/S PID), then block **2968** inserts a special WDR queue **22** entry enabling a queue peek for worker thread termination. The reader will notice that the process termination order of block **2806** ensures processes which were slaves to the WDR queue **22** have already been terminated. This allows processes which are slaves to a timer to see the special termination queue entry inserted at block **2968** since no threads (which are slaves to queue) will remove it from queue **22**. Thereafter, block **2970** waits until the **19***xx* process name (parameter) worker threads have been terminated using a preferred choice of waiting described for blocks **2918** and **2920**. The **19***xx* process (e.g. **1902**) will have its **19***xx*-PID (e.g. **1902**-PID) variable set at 0 (block **2922**) when the process terminates. In some embodiments, the waiting methodology used at block **2970** may use the **19***xx*-PID variable, or may be signaled by the last terminating worker thread, or by block **2922**. Block **2970** also preferably waits for a reasonable timeout period in anticipation of known sleep time of the **19***xx* process being terminated, for cases where anticipated sleep times are excessive and the user should not have to wait for lengthy FIG. **28** termination processing. If the timeout occurs before the process is indicated to be terminated, then block **2970** will continue to block **2972**. Block **2970** also continues to block **2972** when the process has successfully terminated.

If block **2972** determines the **19***xx* process did terminate, the caller is returned to at block **2978** (i.e. **19***xx*-PID already set to disabled (0)). If block **2972** determines the **19***xx*process termination timed out, then block **2974** forces an appropriate O/S kill to the PID thereby forcing process termination, and block **2976** sets the **19***xx*-PID variable for disabled (i.e. process **19***xx* was terminated). Thereafter, block **2978** causes return to the caller.

There are many embodiments for setting certain queue entry field(s) identifying a special queue termination entry inserted at blocks **2960** and **2968**. Some suggestions: In the case of terminating thread(s) **1912**, queue **26** insertion of a WDR preferably sets the MS ID field with a value that will never appear in any other case except a termination request (e.g. −100). In the case of terminating thread(s) **1902**, **1922** and **1952**, queue **22** insertion of a WDR preferably sets the MS ID field with a value that will never appear in any other case except a termination request (e.g. −100). In the case of terminating thread(s) **1942**, queue **26** insertion of a WDR request preferably sets the MS ID field with a value that will never appear in any other case except a termination request (e.g. −100). In the case of terminating thread(s) **1932**, queue **1980** insertion of a thread request queue record **2400** preferably sets field **2400***a* with a value that will never appear in any other case except a termination request (e.g. −100). Of course, any available field(s) can be used to indicate termination to particular thread(s)).

Terminating threads of processing in FIG. **29**B has been presented from a software perspective, but there are hardware/firmware thread embodiments which may be terminated appropriately to accomplish the same functionality. If the MS operating system does not have an interface for killing the PID at block **2974**, then blocks **2972** through **2976** can be eliminated for relying on a FIG. **28** invocation timeout (incorporated for block **2814**) to appropriately rob power from remaining thread(s) of processing.

An ILM has many methods and systems for knowing its own location. LBX depends on MSs maintaining their own

whereabouts. No service is required to maintain the whereabouts of MSs in order to accomplish novel functionality.

Other Embodiments

As mentioned above, architecture **1900** provides a set of processes which can be started or terminated for desired functionality. Thus, architecture **1900** provides a palette from which to choose desired deployment methods for an LN expanse.

In some embodiments, all whereabouts information can be pushed to expand the LN-expanse. In such embodiments, the palette of processes to choose from includes at least process **1902**, process **1912** and process **1952**. Additionally, process **1932** would be required in anticipation of LN-expanse participating data processing systems having NTP disabled or unavailable. Additionally, process **1922** could be used for ensuring whereabouts are timely (e.g. specifically using all blocks except **2218** through **2224**). Depending on DLM capability of MSs in the LN-expanse, a further subset of processes **1902**, **1912**, **1952** and **1932** may apply. Thread(s) **1902** beacon whereabouts information, regardless of the MS being an affirmifier or pacifier.

In some embodiments, all whereabouts information can be pulled to expand the LN-expanse. In such embodiments, the palette of processes to choose from includes at least process **1922** (e.g. specifically using all blocks except **2226** and **2228**), process **1912**, process **1952** and process **1942**. Additionally, process **1932** would be required in anticipation of LN-expanse participating data processing systems having NTP disabled or unavailable. Depending on DLM capability of MSs in the LN-expanse, a further subset of processes **1922**, **1912**, **1952**, **1942** and **1932** may apply.

There are many embodiments derived from architecture **1900**. Essential components are disclosed for deployment varieties. In communications protocols which acknowledge a transmission, processes **1932** may not be required even in absence of NTP use. A sending MS appends a sent date/time stamp (e.g. field **1100***n*) on its time scale to outbound data **1302** and an acknowledging MS (or service) responds with the sent date/time stamp so that when the sending MS receives it (receives data **1302** or **1312**), the sending MS (now a receiving MS) calculates a TDOA measurement by comparing when the acknowledgement was received and when it was originally sent. Appropriate correlation outside of process **1932** deployment enables the sending MS to know which response went with which data **1302** was originally sent. A MS can make use of **19***xx* processes as is appropriate for functionality desired.

In push embodiments disclosed above, useful summary observations are made. Service(s) associated with antennas periodically broadcast (beacon) their reference whereabouts (e.g. WDR information) for being received by MSs in the vicinity. When such services are NTP enabled, the broadcasts include a sent date/time stamp (e.g. field **1100***n*). Upon receipt by a NTP enabled MS in the vicinity, the MS uses the date/time stamp of MS receipt (e.g. **1100***p*) with the date/time stamp of when sent (e.g. field **1100***n*) to calculate a TDOA measurement. Known wave spectrum velocity can translate to a distance. Upon receipt of a plurality of these types of broadcasts from different reference antennas, the MS can triangulate itself for determining its whereabouts relative known whereabouts of the reference antennas. Similarly, reference antennas are replaced by other NTP enabled MSs which similarly broadcast their whereabouts. A MS can be triangulated relative a mixture of reference antennas and other NTP enabled MSs, or all NTP enabled MSs. Stationary antenna triangulation is accomplished the same way as triangulating from other MSs. NTP use allows determining MS whereabouts using triangulation achievable in a single unidirectional broadcast of data (**1302** or **1312**). Furthermore, reference antennas (service(s)) need not communicate new data **1312**, and MSs need not communicate new data **1302**. Usual communications data **1312** are altered with a CK **1314** as described above. Usual communications data **1302** are altered with a CK **1304** as described above. This enables a MS with not only knowing there are nearby hotspots, but also where all parties are located (including the MS). Beaconing hotspots, or other broadcasters, do not need to know who you are (the MS ID), and you do not need to know who they are in order to be located. Various bidirectional correlation embodiments can always be used for TDOA measurements.

In pull embodiments disclosed above, data processing systems wanting to determine their own whereabouts (requestors) broadcast their requests (e.g. record **2490**). Service(s) or MSs (responders) in the vicinity respond. When responders are NTP enabled, the responses include a sent date/time stamp (e.g. field **1100***n*) that by itself can be used to calculate a TDOA measurement if the requestor is NTP enabled. Upon receipt by a requester with no NTP, the requestor uses the date/time stamp of a correlated receipt (e.g. **1100***p*) with the date/time stamp of when sent (e.g. fields **1100***n* or **2450***a*) to calculate a time duration (TDOA) for whereabouts determination, as described above. New data or usual communications data applies as described above.

If NTP is available to a data processing system, it should be used whenever communicating date/time information (e.g. NTP bit of field **1100***b*, **1100***n* or **1100***p*) so that by chance a receiving data processing is also NTP enabled, a TDOA measurement can immediately be taken. In cases, where either the sending (first) data processing system or receiving (second) data processing system is not NTP enabled, then the calculating data processing system wanting a TDOA measurement will need to calculate a sent and received time in consistent time scale terms. This includes a correlated bidirectional communications data flow to properly determine duration in time terms of the calculating data processing system. In a send initiated embodiment, a first (sending) data processing system incorporates a sent date/time stamp (e.g. fields **1100***n* or **2450***a*) and determines when a correlated response is received to calculate the TDOA measurement (both times in terms of the first (sending) data processing system). In another embodiment, a second (receiving) data processing system receives a sent date/time stamp (e.g. field **1100***n*) and then becomes a first (sending) data processing as described in the send initiated embodiment. Whatever embodiment is used, it is beneficial in the LN-expanse to minimize communications traffic.

The NTP bit in date/time stamps enables optimal elegance in the LN-expanse for taking advantage of NTP when available, and using correlated transmissions when it is not. A NTP enabled MS is somewhat of a chameleon in using unidirectional data (**1302** or **1312** received) to determine whereabouts relative NTP enabled MS(s) and/or service(s), and then using bidirectional data (**1302**/**1302** or **1302**/**1312**) relative MS(s) and/or service(s) without NTP. A MS is also a chameleon when considering it may go in and out of a DLM or ILM identity/role, depending on what whereabouts technology is available at the time.

The MS ID (or pseudo MS ID) in transmissions is useful for a receiving data processing system to target a response by addressing the response back to the MS ID. Targeted transmissions target a specific MS ID (or group of MS IDs), while

broadcasting is suited for reaching as many MS IDs as possible. Alternatively, just a correlation is enough to target a data source.

In some embodiments where a MS is located relative another MS, this is applicable to something as simple as locating one data processing system using the location of another data processing system. For example, the whereabouts of a cell phone (first data processing system) is used to locate an in-range automotive installed (second) data processing system for providing new locational applications to the second data processing system (or visa-versa). In fact, the second data processing may be designed for using the nearby first data processing system for determining its whereabouts. Thus, as an MS roams, in the know of its own whereabouts, the MS whereabouts is shared with nearby data processing systems for new functionality made available to those nearby data processing systems when they know their own whereabouts (by associating to the MS whereabouts). Data processing systems incapable of being located are now capable of being located, for example locating a data processing equipped shopping cart with the location of an MS, or plurality of MSs.

Architecture **1900** presents a preferred embodiment for IPC (Interprocess Communications Processing), but there are other embodiments for starting/terminating threads, signaling between processes, semaphore controls, and carrying out present disclosure processing without departing from the spirit and scope of the disclosure. In some embodiments, threads are automatically throttled up or down (e.g. **1952**-Max) per unique requirements of the MS as determined by how often threads loop back to find an entry already waiting in a queue. If thread(s) spend less time blocked on queue, they can be automatically throttled up. If thread(s) spend more time blocked on queue, they can be automatically throttled down. Timers can be associated with queue retrieval to keep track of time a thread is blocked.

LBX history **30** preferably maintains history information of key points in processing where history information may prove useful at a future time. Some of the useful points of interest may include:

- Interim snapshots of permissions **10** (for documenting who had What permissions at what time) at block **1478**;
- Interim snapshots of charters **12** (for documenting charters in effect at what times) at block **1482**;
- Interim snapshots of statistics **14** (for documenting useful statistics worthy of later browse) at block **1486**;
- Interim snapshots of service propagation data of block **1474**;
- Interim snapshots of service informant settings of block **1490**;
- Interim snapshots of LBX history maintenance/configurations of block **1494**;
- Interim snapshots of a subset of WDR queue **22** using a configured search criteria;
- Interim snapshots of a subset of Send queue **24** using a configured search criteria;
- Interim snapshots of a subset of Receive queue **26** using a configured search criteria;
- Interim snapshots of a subset of PIP data **8**;
- Interim snapshots of a subset of data **20**;
- Interim snapshots of a subset of data **36**;
- Interim snapshots of other resources **38**;
- Trace, debug, and/or dump of any execution path subset of processing flowcharts described; and/or
- Copies of data at any block of processing in any flowchart heretofore described.

Entries in LBX history **30** preferably have entry qualifying information including at least a date/time stamp of when added to history, and preferably an O/S PID and O/S TID (Thread Identifier) associated with the logged entry, and perhaps applicable applications involved (e.g. see fields **1100***k*). History **30** may also be captured in such a way there are conditions set up in advance (at block **1494**), and when those conditions are met, applicable data is captured to history **30**. Conditions can include terms that are MS system wide, and when the conditions are met, the data for capture is copied to history. In these cases, history **30** entries preferably include the conditions which were met to copy the entry to history. Depending on what is being kept to history **30**, this can become a large amount of information. Therefore, FIG. **27** can include new blocks for pruning history **30** appropriately. In another embodiment, a separate thread of processing has a sleeper loop which when awake will prune the history **30** appropriately, either in its own processing or by invoking new FIG. **27** blocks for history **30**. A parameter passed to processing by block **2704** may include how to prune the history, including what data to prune, how old of data to prune, and any other criteria appropriate for maintaining history **30**. In fact, any pruning by FIG. **27** may include any reasonable parameters for how to prune particular data of the present disclosure.

Location applications can use the WDR queue for retrieving the most recent highest confidence entry, or can access the single instance WDR maintained (or most recent WDR of block **289** discussed above). Optimally, applications are provided with an API that hides what actually occurs in ongoing product builds, and for ensuring appropriate semaphore access to multi-threaded accessed data.

Correlation processing does not have to cause a WDR returned. There are embodiments for minimal exchanges of correlated sent date/time stamps and/or received date/time stamps so that exchanges are very efficient using small data exchanges. Correlation of this disclosure was provided to show at least one solution, with keeping in mind that there are many embodiments to accomplish relating time scales between data processing systems.

Architecture **1900** provides not only the foundation for keeping an MS abreast of its whereabouts, but also the foundation upon which to build LBX nearby functionality. Whereabouts of MSs in the vicinity are maintained to queue **22**. Permissions **10** and charters **12** can be used for governing which MSs to maintain to queue **22**, how to maintain them, and what processing should be performed. For example, MS user Joe wants to alert MS user Sandy when he is in her vicinity, or user Sandy wants to be alerted when Joe is in her vicinity. Joe configures permissions enabling Sandy to be alerted with him being nearby, or Sandy configured permissions for being alerted. Sandy accepts the configuration Joe made, or Joe accepts the configuration Sandy made. Sandy's queue **22** processing will ensure Joe's WDRs are processed uniquely for desired functionality.

FIG. **8**C was presented in the context of a DLM, however architecture **1900** should be applied for enabling a user to manually request to be located with ILM processing if necessary. Blocks **862** through **870** are easily modified to accomplish a WDR request (like blocks **2218** through **2224**). In keeping with current block descriptions, block **872** would become a new series of blocks for handling the case when DLM functionality was unsuccessful. New block **872**-A would broadcast a WDR request soliciting response (see blocks **2218** through **2224**). Thereafter, a block **872**-B would wait for a brief time, and subsequently a block **872**-C would check to see if whereabouts have been determined (e.g. check

queue **22**). Thereafter, if a block **872**-D determines whereabouts were not determined, an error could be provided to the user, otherwise the MS whereabouts were successfully determined and processing continues to block **874**. Applications that may need whereabouts can now be used. There are certainly emergency situations where a user may need to rely on other MSs in the vicinity for being located.

To maintain modularity in interfaces to queues **24** and **26**, parameters may be passed rather than having the modular send/receive processing access fields of application records. When WDRs are "sent", the WDR will be targeted (e.g. field **1100***a*), perhaps also with field **1100***f* indicating which communications interface to send on (e.g. MS has plurality of comm. interfaces **70**). When WDRs are "broadcast" (e.g. null MS ID), the WDR is preferably outbound on all available comm. interfaces **70**), unless field **1100***f* indicates to target a comm. interface. Analogously, when WDR requests are "sent", the request will be targeted (e.g. field **2490***a*), perhaps also with field **2490***d* indicating which communications interface to send on (e.g. MS has plurality of comm. interfaces **70**). When WDR requests are "broadcast" (e.g. null MS ID), the WDR is preferably outbound on all available comm. interfaces **70**), unless field **1100***f* indicates to target a comm. interface.

Fields **1100***m*, **1100***n*, **1100***p*, **2490***b* and **2490***c* are also of interest to the transport layer. Any subset, or all, of transport related fields may be passed as parameters to send processing, or received as parameters from receiving processing to ensure send and receive processing is adaptable using pluggable transmission/reception technologies.

An alternate embodiment to the BESTWDR WDR returned by FIG. **26**B processing may be set with useful data for reuse toward a future FIG. **26**B processing thread whereabouts determination. Field **1100***f* (see pg. **168**) can be set with useful data for that WDR to be in turn used at a subsequent whereabouts determination of FIG. **26**B. This is referred to as Recursive Whereabouts Determination (RWD) wherein ILMs determine WDRs for their whereabouts and use them again for calculating future whereabouts (by populating useful TDOA, AOA, MPT and/or whereabouts information to field **1100***f*).

An alternate embodiment may store remote MS movement tolerances (if they use one) to WDR field **1100***f* so the receiving MS can determine how stale are other WDRs in queue **22** from the same MS, for example when gathering all useful WDRs to start with in determining whereabouts of FIG. **26**B processing (e.g. block **2634**). Having movement tolerances in effect may prove useful for maximizing useful WDRs used in determining a whereabouts (FIG. **26**B processing).

While various embodiments of the present disclosure have been described above, it should be understood that they have been presented by way of example only, and not limitation. Thus, the breadth and scope of the present disclosure should not be limited by any of the above-described exemplary embodiments, but should be defined only in accordance with the following claims and their equivalents.

What is claimed is:

1. A method by a receiving mobile data processing system, said method comprising:

receiving, by said receiving mobile data processing system, a plurality of whereabouts data records for a plurality of other mobile data processing systems wherein each record of said plurality of whereabouts data records is sent to said receiving mobile data processing system directly from a particular mobile data processing system, said each record containing location information for said particular mobile data processing system, confidence information for distinguishing which of said whereabouts data records is of higher priority, and identity information for identifying a particular user associated with said particular mobile data processing system wherein said identity information is for an alert determined by said receiving mobile data processing system that said particular user is nearby said receiving mobile data processing system; and

determining whereabouts of said receiving mobile data processing system using said whereabouts data records.

2. The method of claim **1** wherein said plurality of other mobile data processing systems includes a directly located mobile data processing system.

3. The method of claim **1** wherein said plurality of other mobile data processing systems includes an indirectly located mobile data processing system.

4. The method of claim **1** further including determining whereabouts of said receiving mobile data processing system by directly locating said receiving mobile data processing system.

5. The method of claim **1** wherein said

each record contains sent time information determined by said particular mobile data processing system at the time of sending said each record using an originating system time reference synchronized to a network time reference, and wherein receipt time information is determined by said receiving mobile data processing system at the time of receiving said each record using a receiving system time reference synchronized to said network time reference; and further including:

determining measurement information wherein said sent time information and said receipt time information are assumed synchronized to said network time reference; and

determining whereabouts of said receiving mobile data processing system using said measurement information.

6. The method of claim **1** wherein said receiving mobile data processing system is enabled with network time protocol using a network time reference and at least one of said plurality of other mobile data processing systems is enabled with network time protocol using said network time reference for measuring by said receiving mobile data processing system a transmission time between a receipt time determined by said receiving mobile data processing system and a sent time determined by said at least one of said plurality of other mobile data processing systems.

7. The method of claim **1** wherein said determining whereabouts of said receiving mobile data processing system includes determining a single location using said plurality of whereabouts data records wherein at least some of said records are originated from different location methods, said different location methods including global positioning, triangulation using angle of arrival information, triangulation using time information, triangulation using a combination of angle of arrival and time information, within-range proximity, graphical locating, physically sensing, transaction sensing, or other method.

8. The method of claim **1** wherein said determining whereabouts of said receiving mobile data processing system includes determining a single location using a plurality of radio communications interfaces of said receiving mobile data processing system for receiving said plurality of whereabouts data records by substantially different communication protocols.

9. The method of claim **1** wherein said each record contains application information for a user's specified data.

10. The method of claim 1 wherein said whereabouts data records are received wirelessly from said other mobile data processing systems to said receiving mobile data processing system through no intervening data processing system.

11. The method of claim 1 wherein said each record contains application information for at least one application in use at said particular mobile data processing system.

12. The method of claim 1 further including:

storing particular information for said each record to a historical collection of record information at said receiving mobile data processing system, wherein said particular information is searchable with a query having a conditional match on at least one data field of said record information;

searching said historical collection of record information upon determining a most recently determined whereabouts of said receiving mobile data processing system is stale; and

determining whereabouts of said receiving mobile data processing system using said record information found upon said searching said historical collection.

13. The method of claim 12 further including searching said historical collection of record information upon determining said receiving mobile data processing system significantly moved since said determining said most recently determined whereabouts of said receiving mobile data processing system.

14. The method of claim 12 wherein data for at least one application in use at said receiving mobile data processing system is used to alter said particular information.

15. The method of claim 1 wherein said receiving, by said receiving mobile data processing system, a plurality of whereabouts data records for a plurality of other mobile data processing systems is performed for a response to a user's request to locate said receiving mobile data processing system.

16. The method of claim 1 wherein said each record of said plurality of whereabouts data records is sent using sound wave information.

17. The method of claim 16 wherein said sound wave information is from a sound wave that repels pests.

18. The method of claim 1 further including maintaining a user configured permission for how to process said whereabouts data records.

19. The method of claim 1 further including maintaining a user configured conditional expression for how to process said whereabouts data records.

20. The method of claim 1 further including informing a remote service with a situational location of said receiving mobile data processing system.

21. The method of claim 1 further including maintaining a service directory including routing entries at said receiving mobile data processing system for how another mobile data processing system can find a service through said receiving mobile data processing system.

22. The method of claim 1 wherein said each record is beaconed by said particular mobile data processing system in accordance with a configuration for periodic beaconing maintained at said particular mobile data processing system.

23. A receiving mobile data processing system, said system comprising:

one or more processors;

memory coupled to said one or more processors and storing instructions, which when executed by said one or more processors, causes said one or more processors to perform operations comprising:

receiving, by said receiving mobile data processing system, a plurality of whereabouts data records for a plurality of other mobile data processing systems wherein each record of said plurality of whereabouts data records is sent to said receiving mobile data processing system directly from a particular mobile data processing system, said each record containing location information for said particular mobile data processing system, confidence information for distinguishing which of said whereabouts data records is of higher priority, and identity information for identifying a particular user associated with said particular mobile data processing system wherein said identity information is for an alert determined by said receiving mobile data processing system that said particular user is nearby said receiving mobile data processing system; and

determining whereabouts of said receiving mobile data processing system using said whereabouts data records.

24. The system of claim 23 wherein said plurality of other mobile data processing systems includes a directly located mobile data processing system.

25. The system of claim 23 wherein said plurality of other mobile data processing systems includes an indirectly located mobile data processing system.

26. The system of claim 23 wherein said operations further includes determining whereabouts of said receiving mobile data processing system by directly locating said receiving mobile data processing system.

27. The system of claim 23 wherein said

each record contains sent time information determined by said particular mobile data processing system at the time of sending said each record using an originating system time reference synchronized to a network time reference, and wherein receipt time information is determined by said receiving mobile data processing system at the time of receiving said each record using a receiving system time reference synchronized to said network time reference; and operations further including:

determining measurement information wherein said sent time information and said receipt time information are assumed synchronized to said network time reference; and

determining whereabouts of said receiving mobile data processing system using said measurement information.

28. The system of claim 23 enabled with network time protocol using a network time reference and at least one of said plurality of other mobile data processing systems is enabled with network time protocol using said network time reference for measuring by said receiving mobile data processing system a transmission time between a receipt time determined by said receiving mobile data processing system and a sent time determined by said at least one of said plurality of other mobile data processing systems.

29. The system of claim 23 wherein said determining whereabouts of said receiving mobile data processing system includes determining a single location using said plurality of whereabouts data records wherein at least some of said records are originated from different location methods, said different location methods including global positioning, triangulation using angle of arrival information, triangulation using time information, triangulation using a combination of angle of arrival and time information, within-range proximity, graphical locating, physically sensing, transaction sensing, or other method.

30. The system of claim 23 wherein said determining whereabouts of said receiving mobile data processing system includes determining a single location using a plurality of radio communications interfaces of said receiving mobile data processing system for receiving said plurality of whereabouts data records by substantially different communication protocols.

31. The system of claim 23 wherein said whereabouts data records are received wirelessly from said other mobile data processing systems to said receiving mobile data processing system through no intervening data processing system.

32. The system of claim 23 wherein said each record contains application information for at least one application in use at said particular mobile data processing system.

33. The system of claim 23 wherein said operations further includes:

storing particular information for said each record to a historical collection of record information at said receiving mobile data processing system, wherein said particular information is searchable with a query having a conditional match on at least one data field of said record information;

searching said historical collection of record information upon determining a most recently determined whereabouts of said receiving mobile data processing system is stale; and

determining whereabouts of said receiving mobile data processing system using said record information found upon said searching said historical collection.

34. The system of claim 33 wherein said operations further includes searching said historical collection of record information upon determining said receiving mobile data processing system significantly moved since said determining said most recently determined whereabouts of said receiving mobile data processing system.

35. The system of claim 33 wherein data for at least one application in use at said receiving mobile data processing system is used to alter said particular information.

36. The system of claim 23 wherein said receiving, at said receiving mobile data processing system, a plurality of whereabouts data records for a plurality of other mobile data processing systems is performed for a response to a user's request to locate said receiving mobile data processing system.

37. The system of claim 23 wherein said each record of said plurality of whereabouts data records is sent using sound wave information.

38. The system of claim 37 wherein said sound wave information is from a sound wave that repels pests.

39. The system of claim 23 wherein said operations further includes maintaining a user configured permission for how to process said whereabouts data records.

40. The system of claim 23 wherein said operations further includes maintaining a user configured conditional expression for how to process said whereabouts data records.

41. The system of claim 23 wherein said operations further includes informing a remote service with a situational location of said receiving mobile data processing system.

42. The system of claim 23 wherein said operations further includes maintaining a service directory including routing entries at said receiving mobile data processing system for how another mobile data processing system can find a service through said receiving mobile data processing system.

43. The system of claim 23 wherein said each record is beaconed by said particular mobile data processing system in accordance with a configuration for periodic beaconing maintained at said particular mobile data processing system.

44. A method by a receiving handheld mobile data processing system, said method comprising:

receiving, by said receiving handheld mobile data processing system, a plurality of whereabouts data records for a plurality of other handheld mobile data processing systems wherein each record of said plurality of whereabouts data records is sent to said receiving handheld mobile data processing system directly from a particular handheld mobile data processing system, said each record containing location information for said particular handheld mobile data processing system, confidence information for distinguishing which of said whereabouts data records is of higher priority, and identity information for identifying a particular user associated with said particular handheld mobile data processing system wherein said identity information is for an alert determined by said receiving handheld mobile data processing system that said particular user is nearby said receiving handheld mobile data processing system; and

determining whereabouts of said receiving handheld mobile data processing system using said whereabouts data records.

45. A method by a receiving mobile data processing system, the method comprising:

receiving a plurality of unidirectional broadcast wireless data records from a plurality of other mobile data processing systems wherein each record of the plurality of unidirectional broadcast wireless data records is beaconed by a particular mobile data processing system in accordance with a configuration for periodic beaconing maintained at the particular mobile data processing system, and contains:

location information for the particular mobile data processing system,

confidence information for distinguishing which of said data records is of higher priority,

identity information for identifying a particular user associated with the particular mobile data processing system wherein the identity information is for an alert determined by the receiving mobile data processing system that the particular user is nearby the receiving mobile data processing system, and

application information for at least one application in use at the particular mobile data processing system;

storing particular information for the each record to a historical collection of record information at the receiving mobile data processing system, wherein the particular information is searchable with a query having a conditional match on at least one data field of the record information;

searching the historical collection of record information upon determining a most recently determined whereabouts of the receiving mobile data processing system is stale; and

determining whereabouts of the receiving mobile data processing system using the record information found upon the searching the historical collection.

46. The method of claim 45 further including searching the historical collection of record information upon determining the receiving mobile data processing system significantly moved since the determining the most recently determined whereabouts of the receiving mobile data processing system.

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