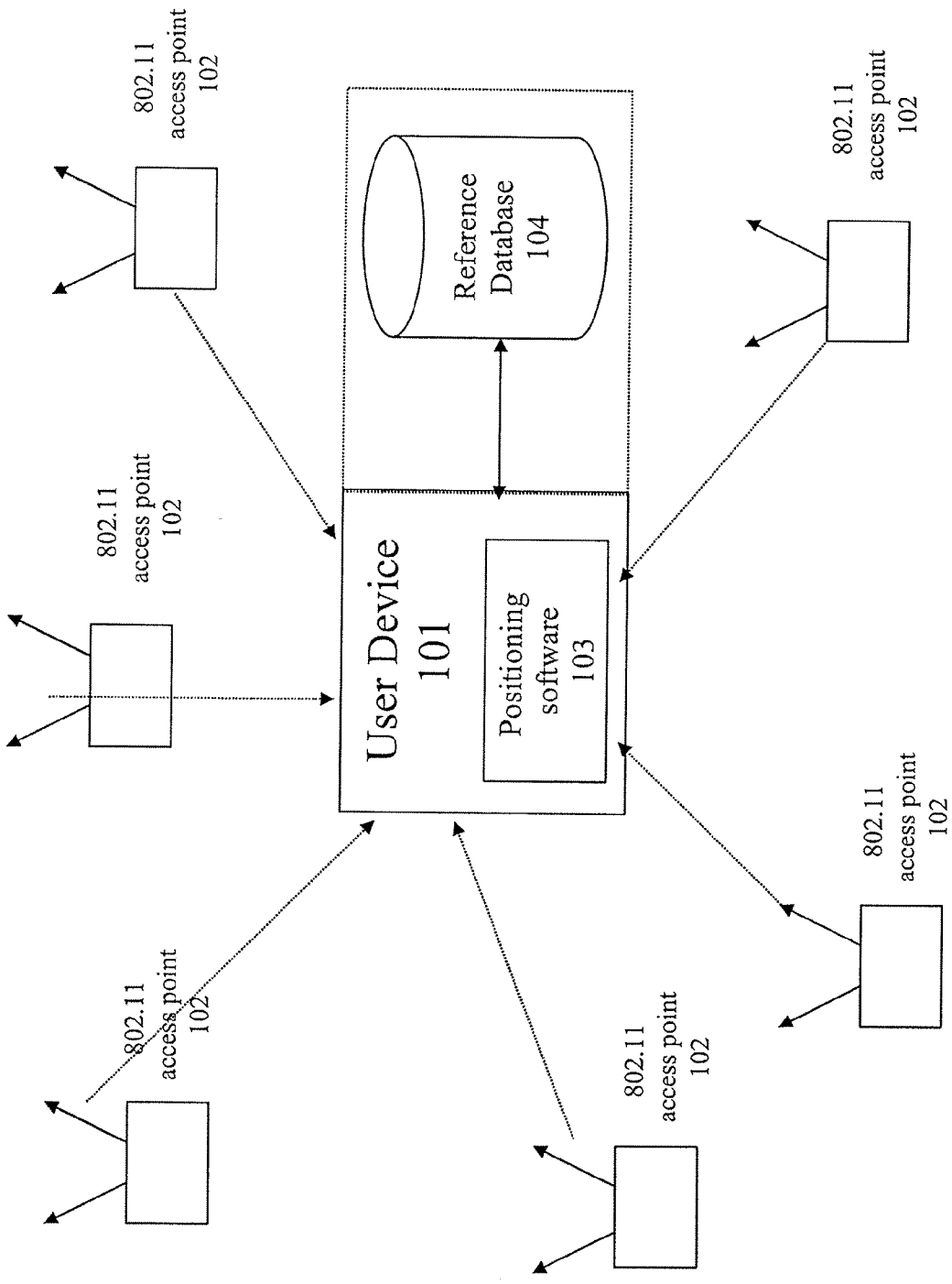

802.11
access point
102
802.11
access point
102
802.11
access point
102
802.11
access point
102
802.11
access point
102
802.11
access point
102
802.11
access point
102
Reference
Database
104
User Device
101
Positioning
software
103

Figure 1

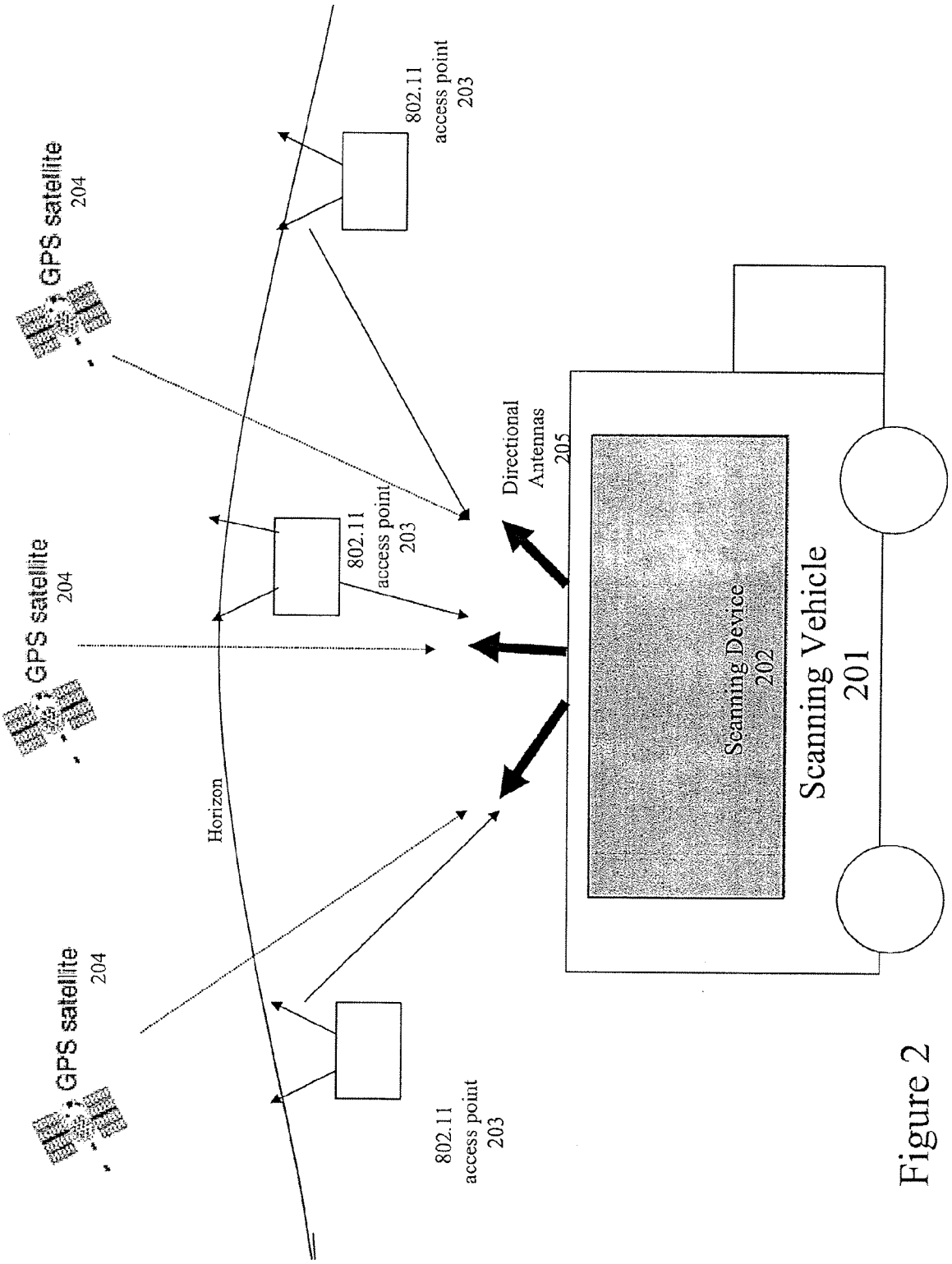

GPS satellite
204
GPS satellite
204
GPS satellite
204
802.11
access point
203
802.11
access point
203
802.11
access point
203
Horizon
Directional
Antennas
205
Scanning Device
202
Scanning Vehicle
201

Figure 2

Figure 3: Example scanning scenario showing arterial bias

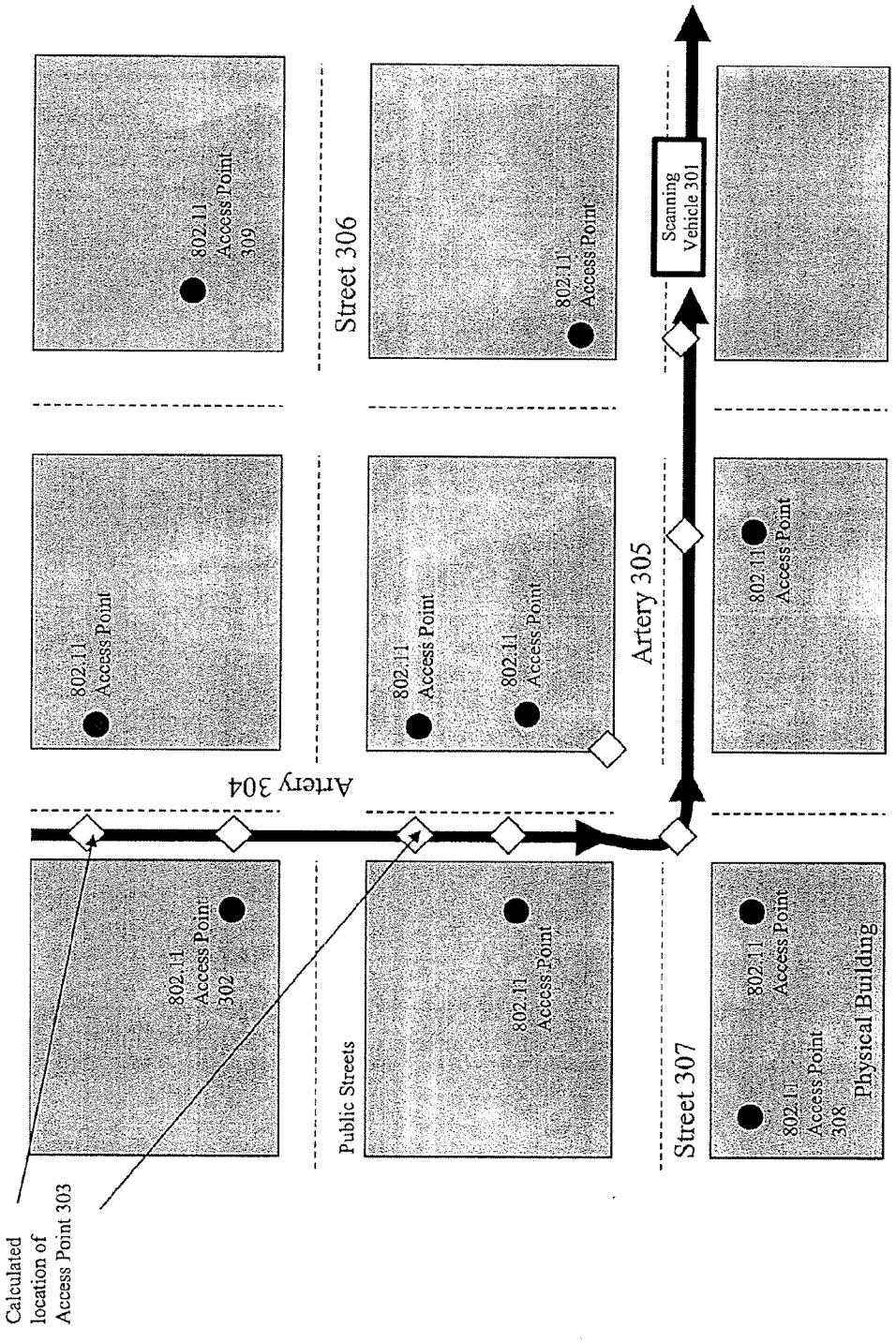
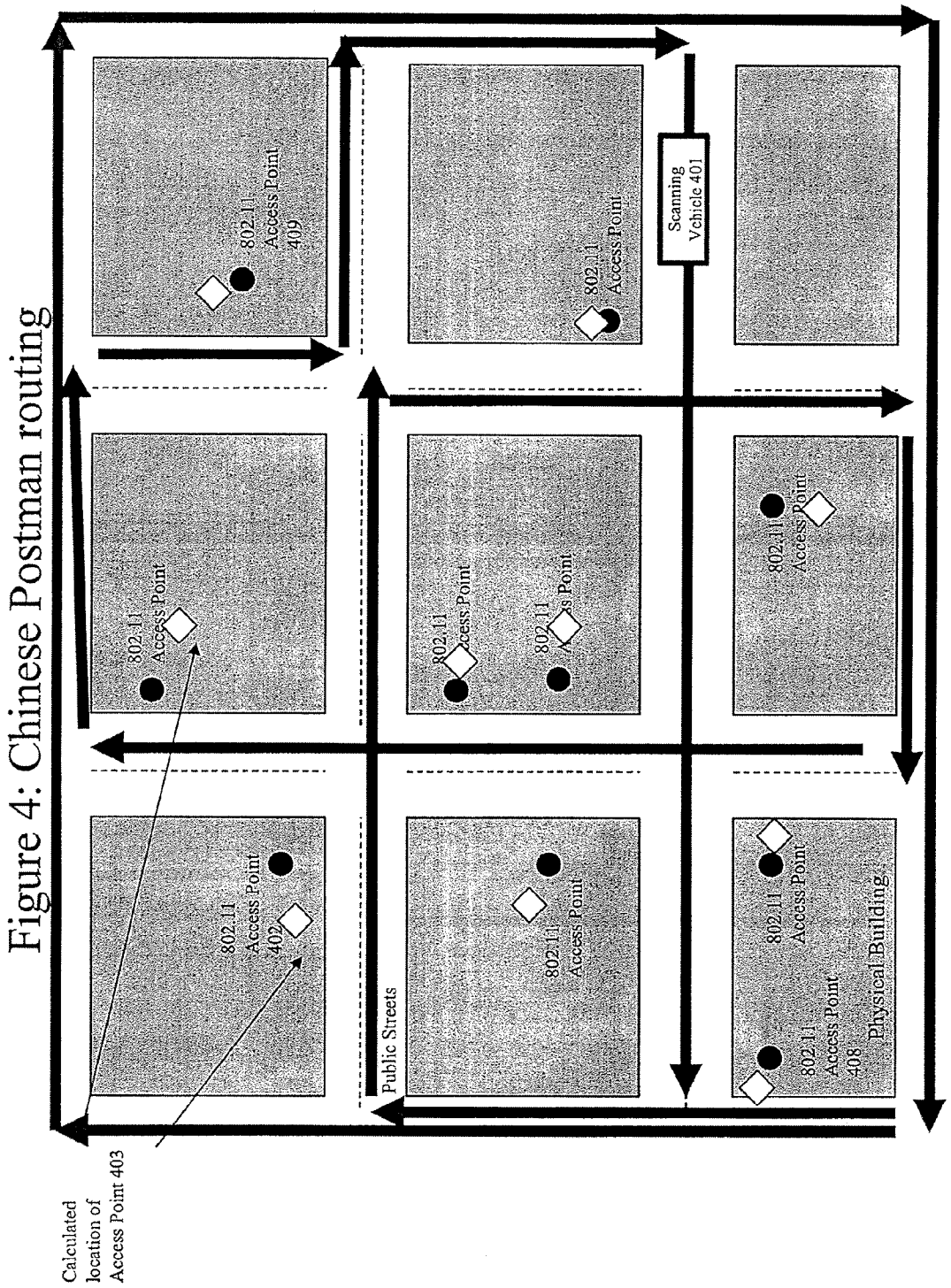


Figure 4: Chinese Postman routing



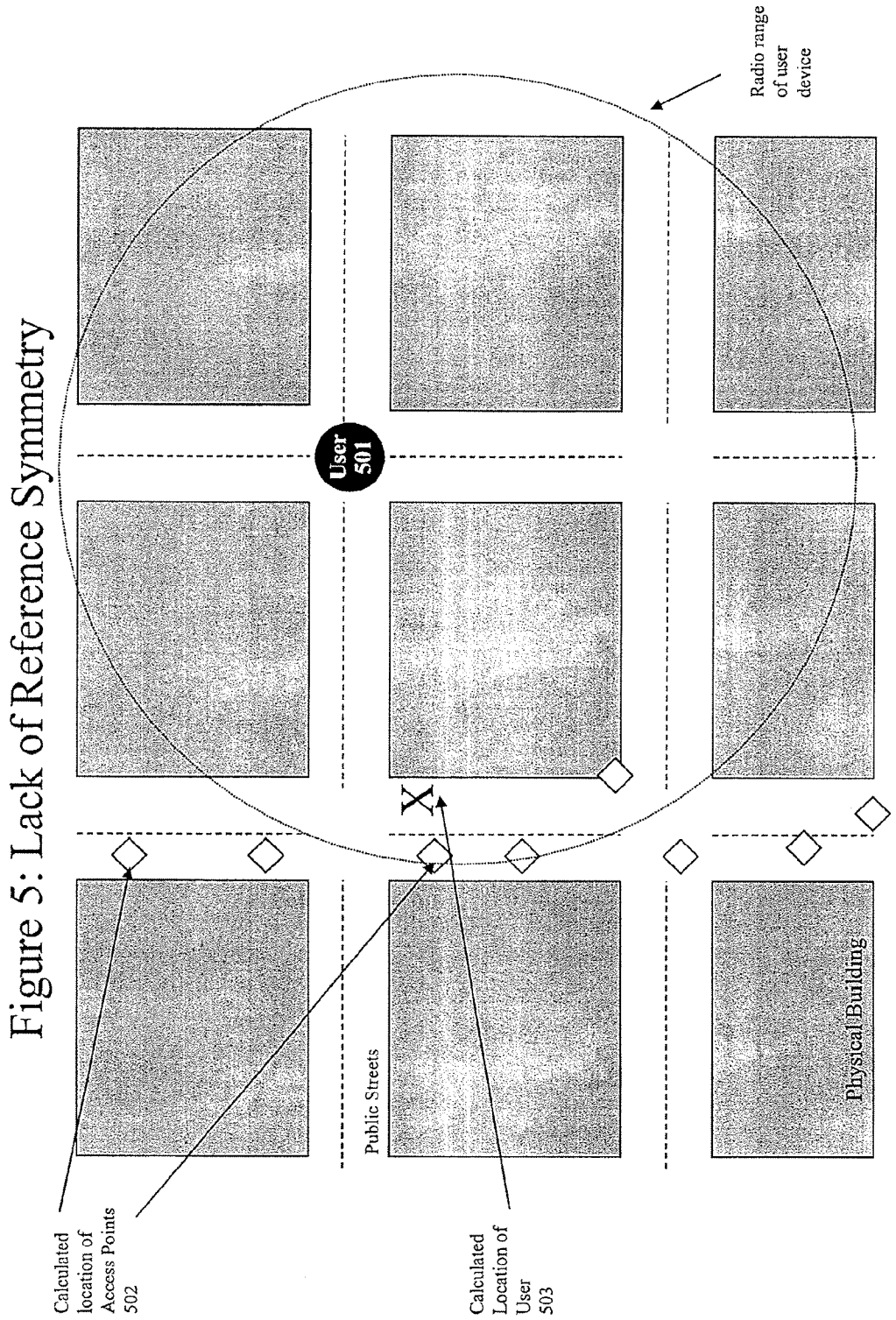
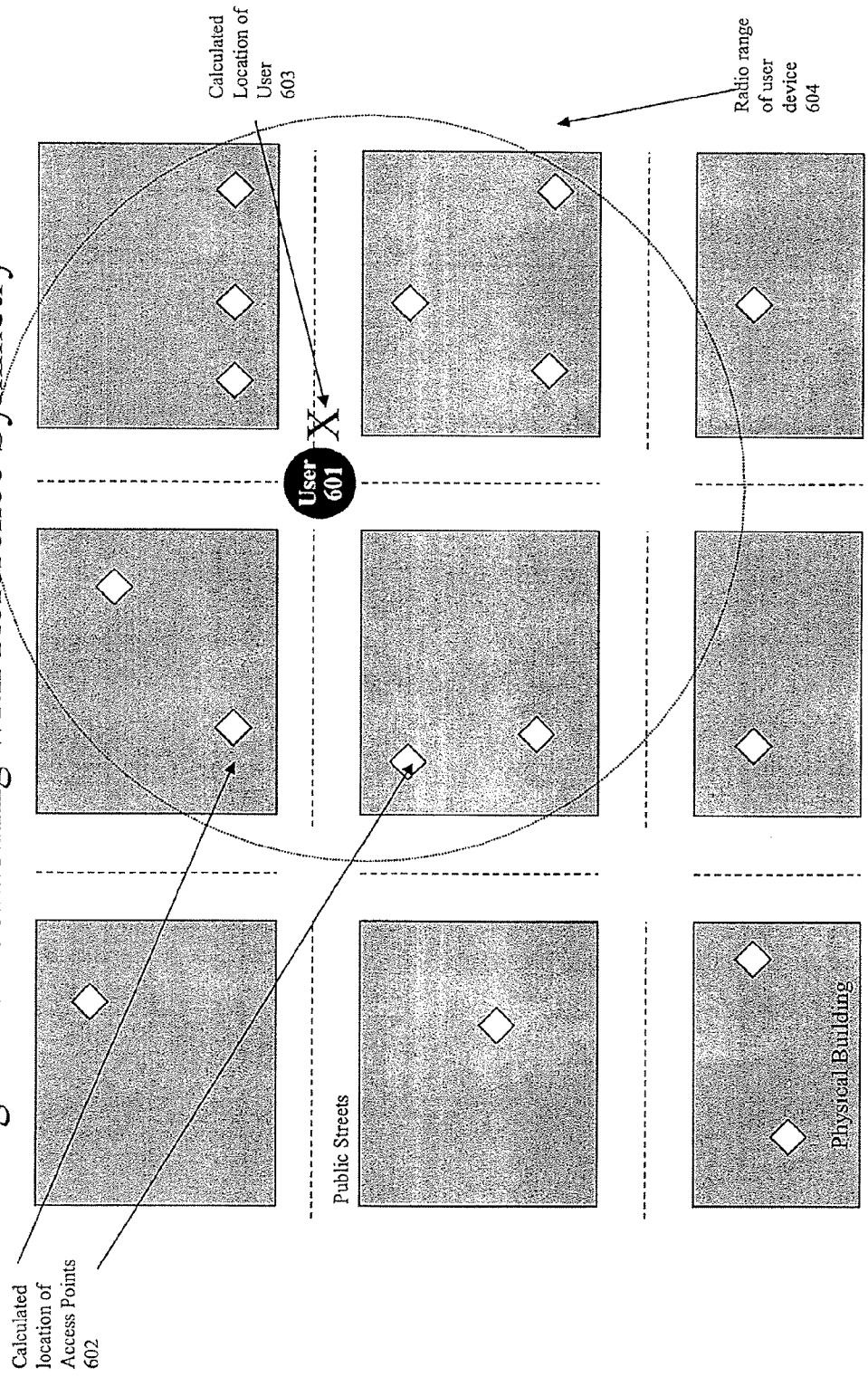


Figure 5: Lack of Reference Symmetry

Figure 6: Positioning with Reference Symmetry



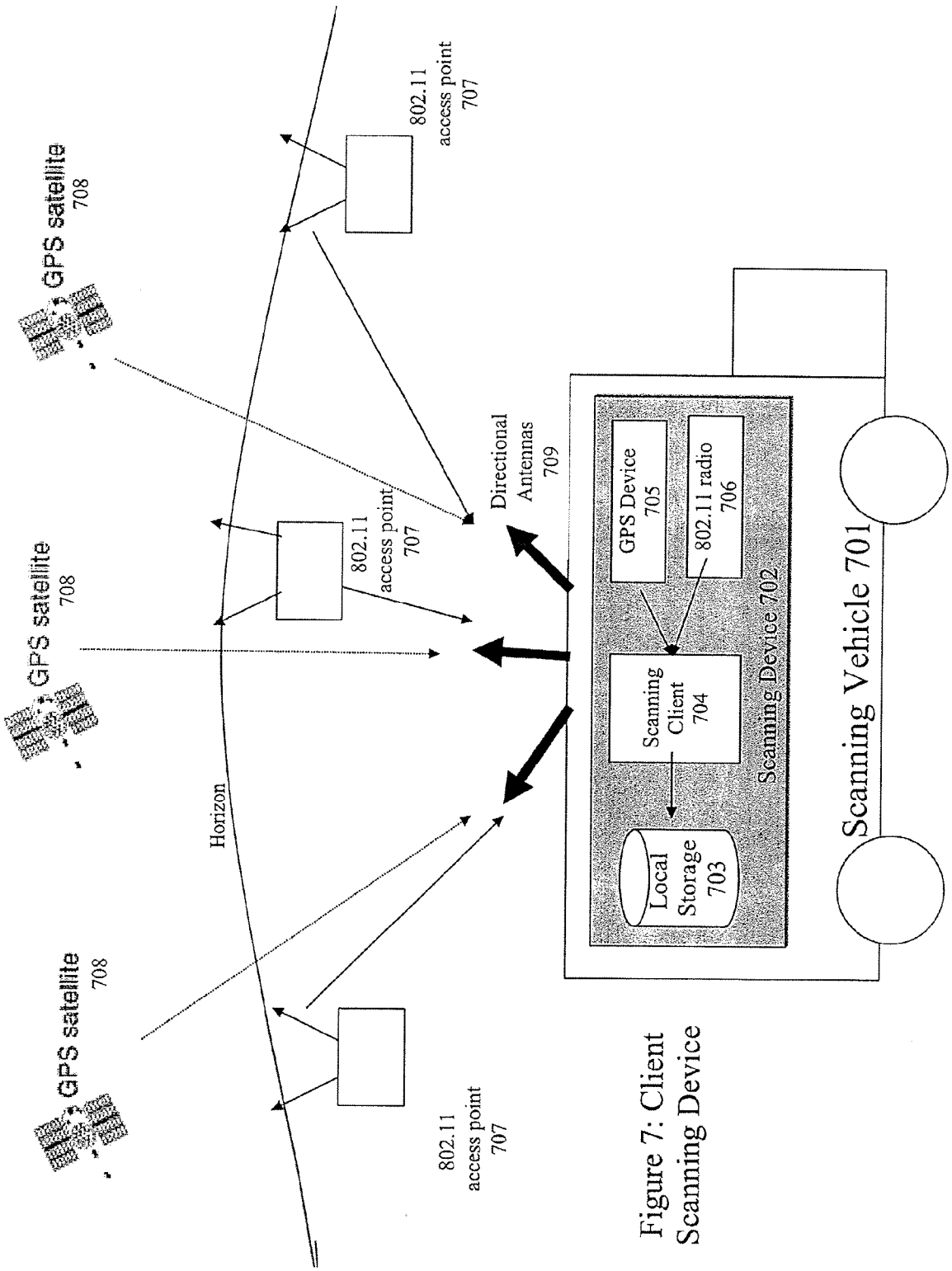
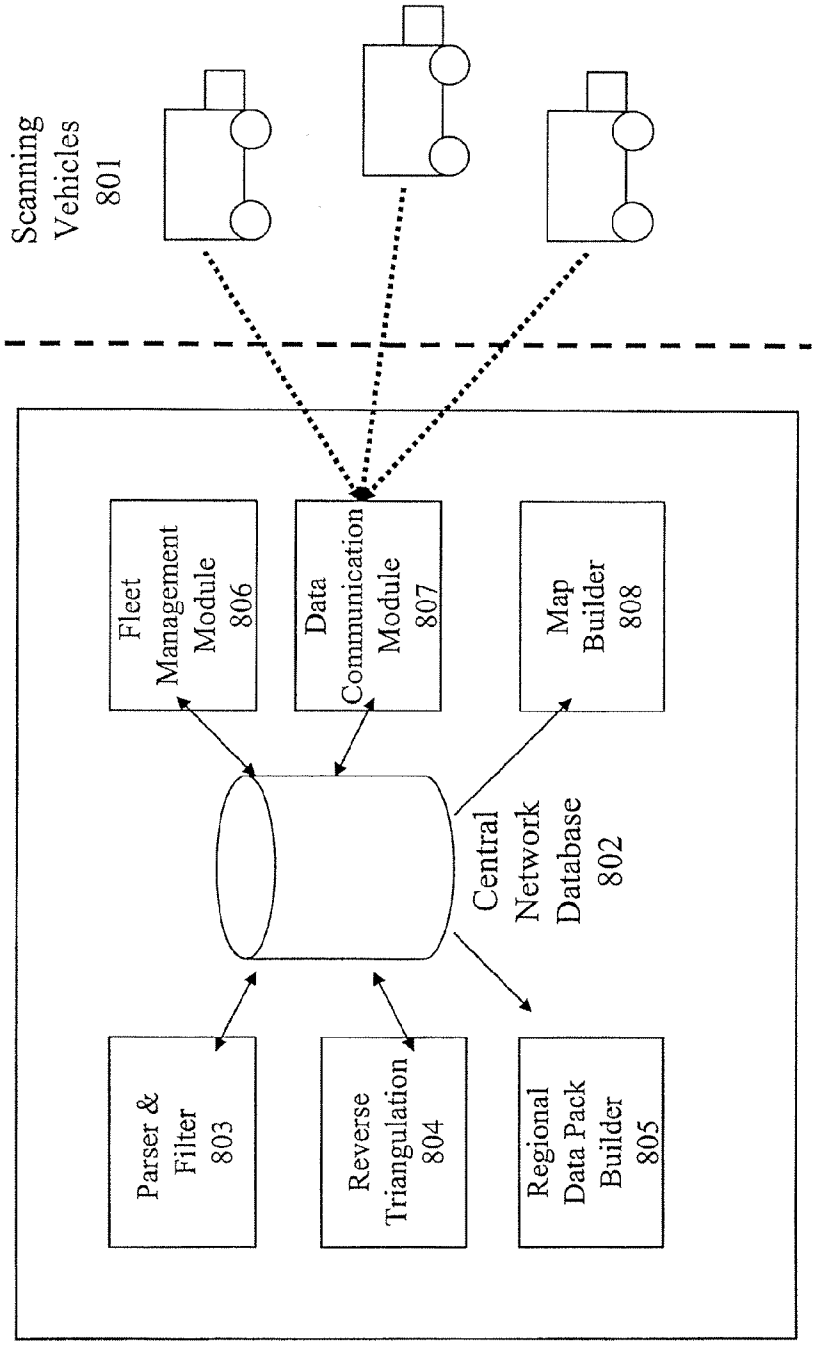


Figure 7: Client Scanning Device

Figure 8: Central Network Server



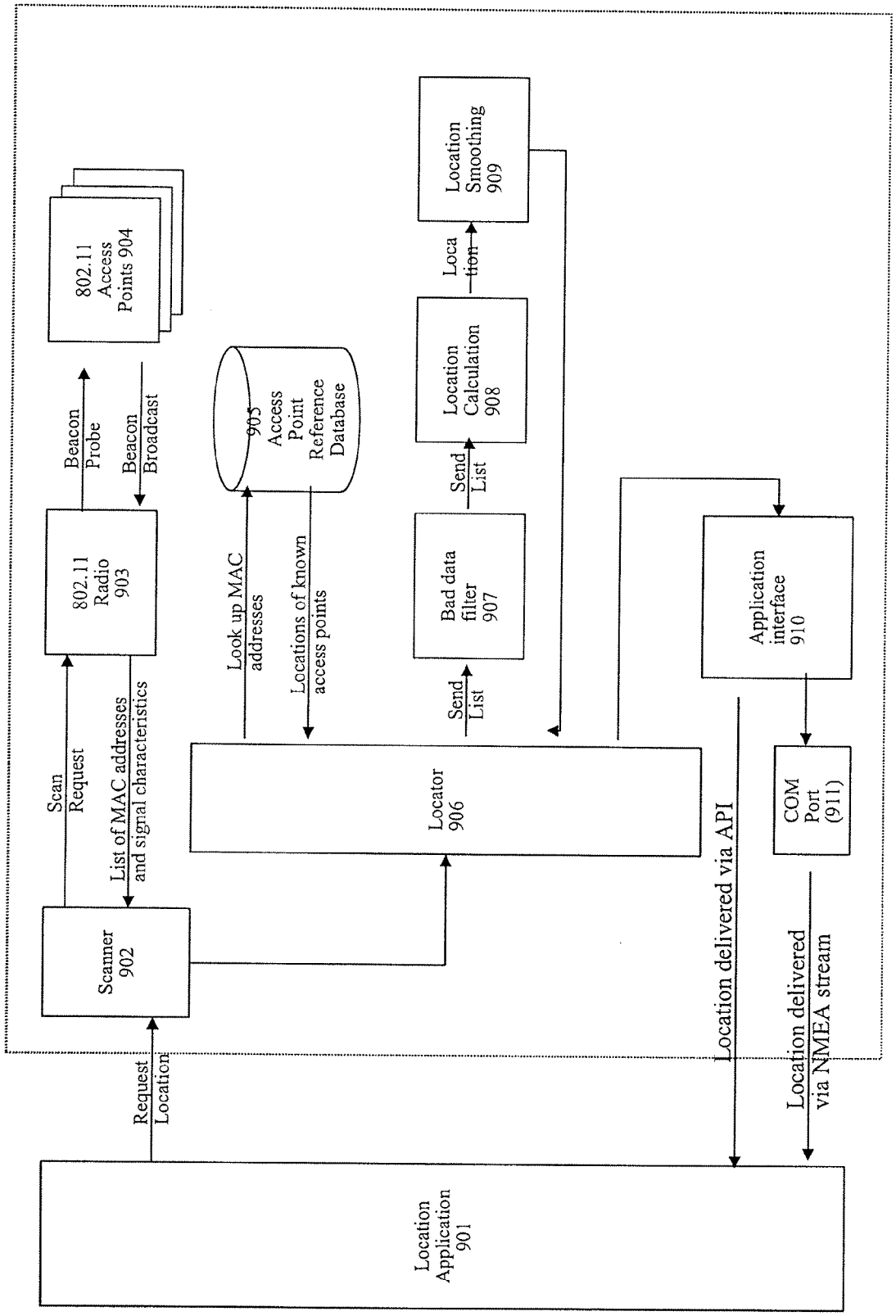


Figure 9: Positioning Software

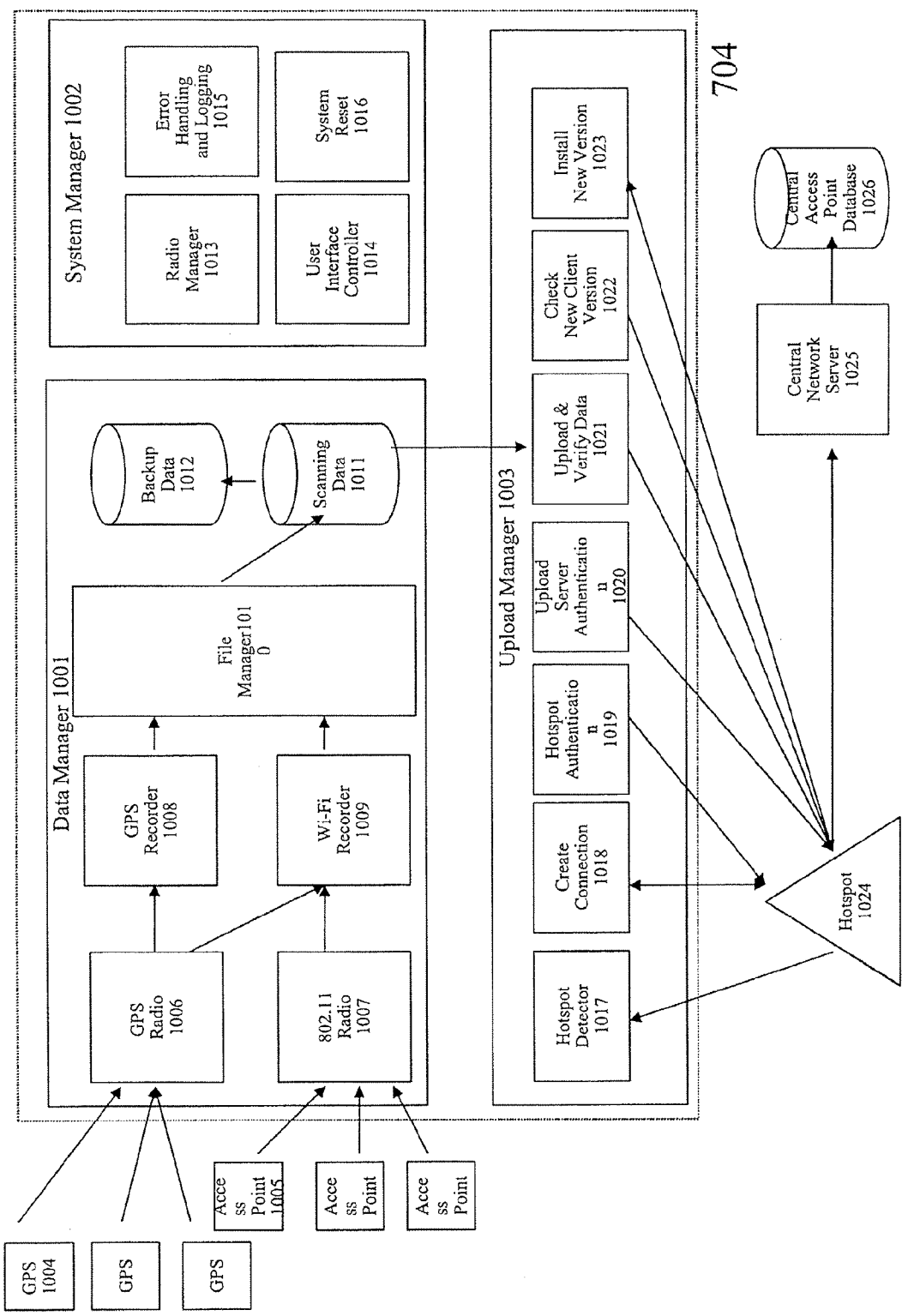


Figure 10: Scanning Client

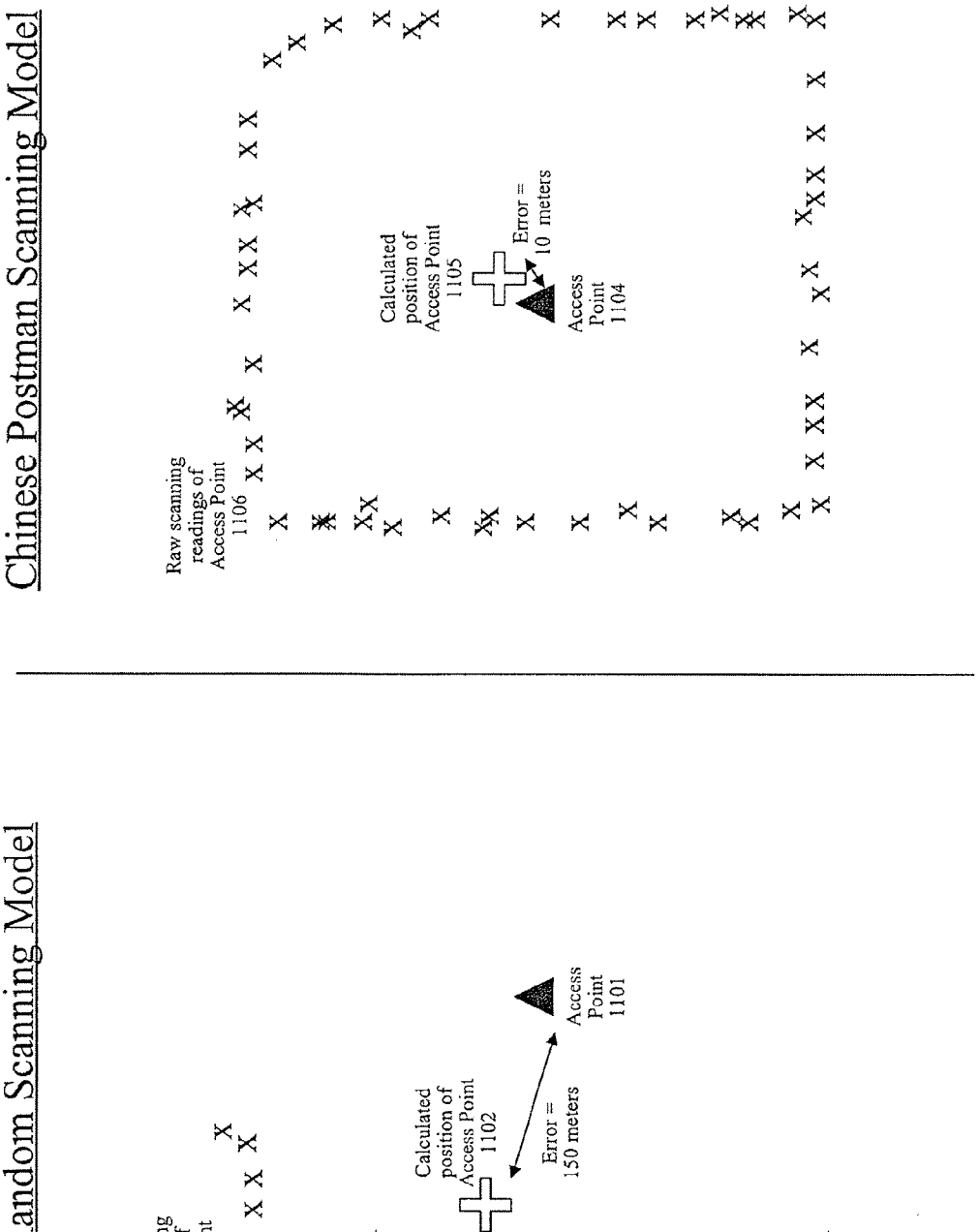


Figure 11: comparison of scanning models

FIGURE 12

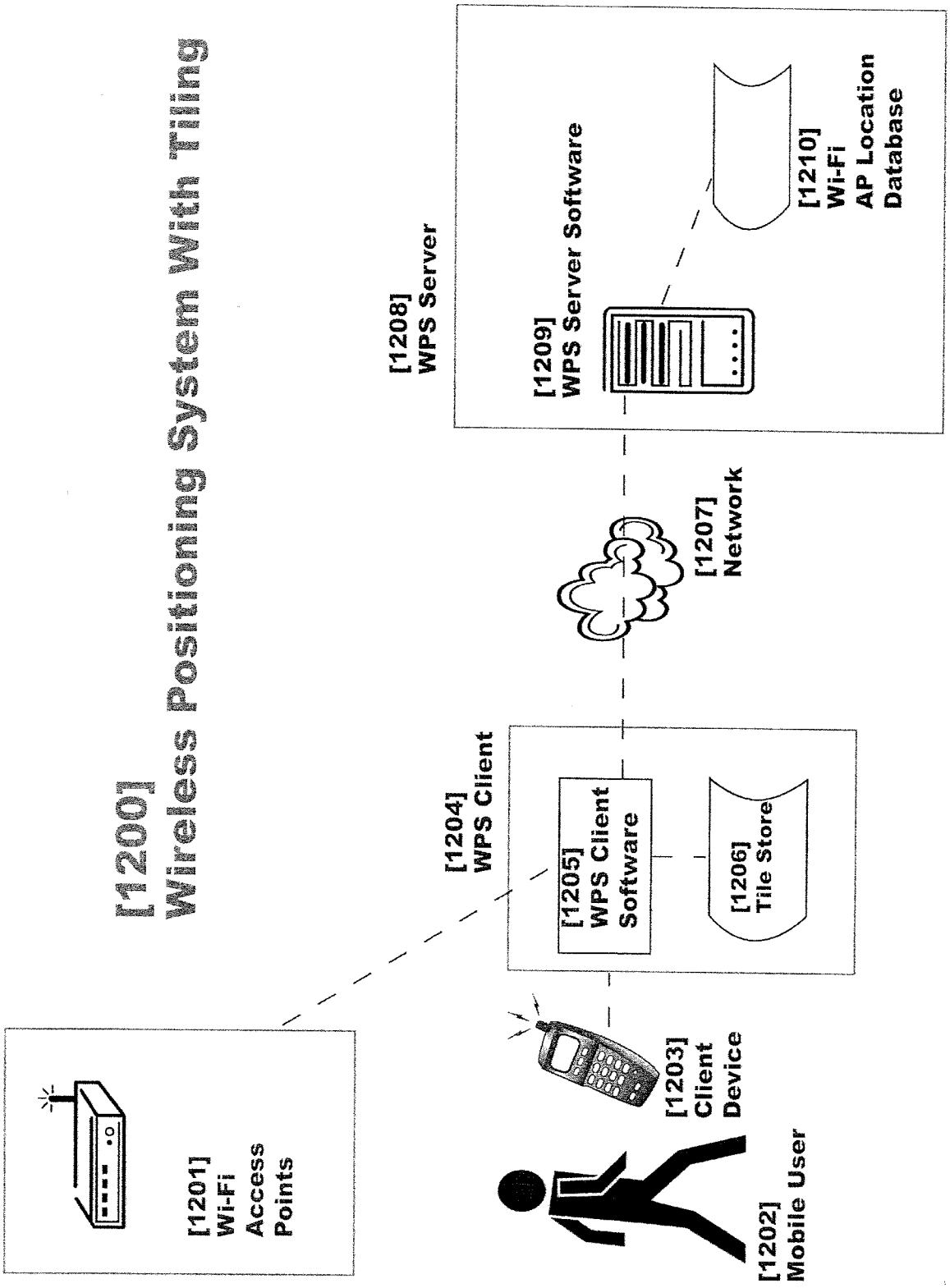

[1200]
Wireless Positioning System With Tiling
[1201]
Wi-Fi
Access
Points
[1202]
Mobile User
[1203]
Client
Device
[1204]
WPS Client
[1205]
WPS Client
Software
[1206]
Tile Store
[1207]
Network
[1208]
WPS Server
[1209]
WPS Server Software
[1210]
Wi-Fi
AP Location
Database

FIGURE 13

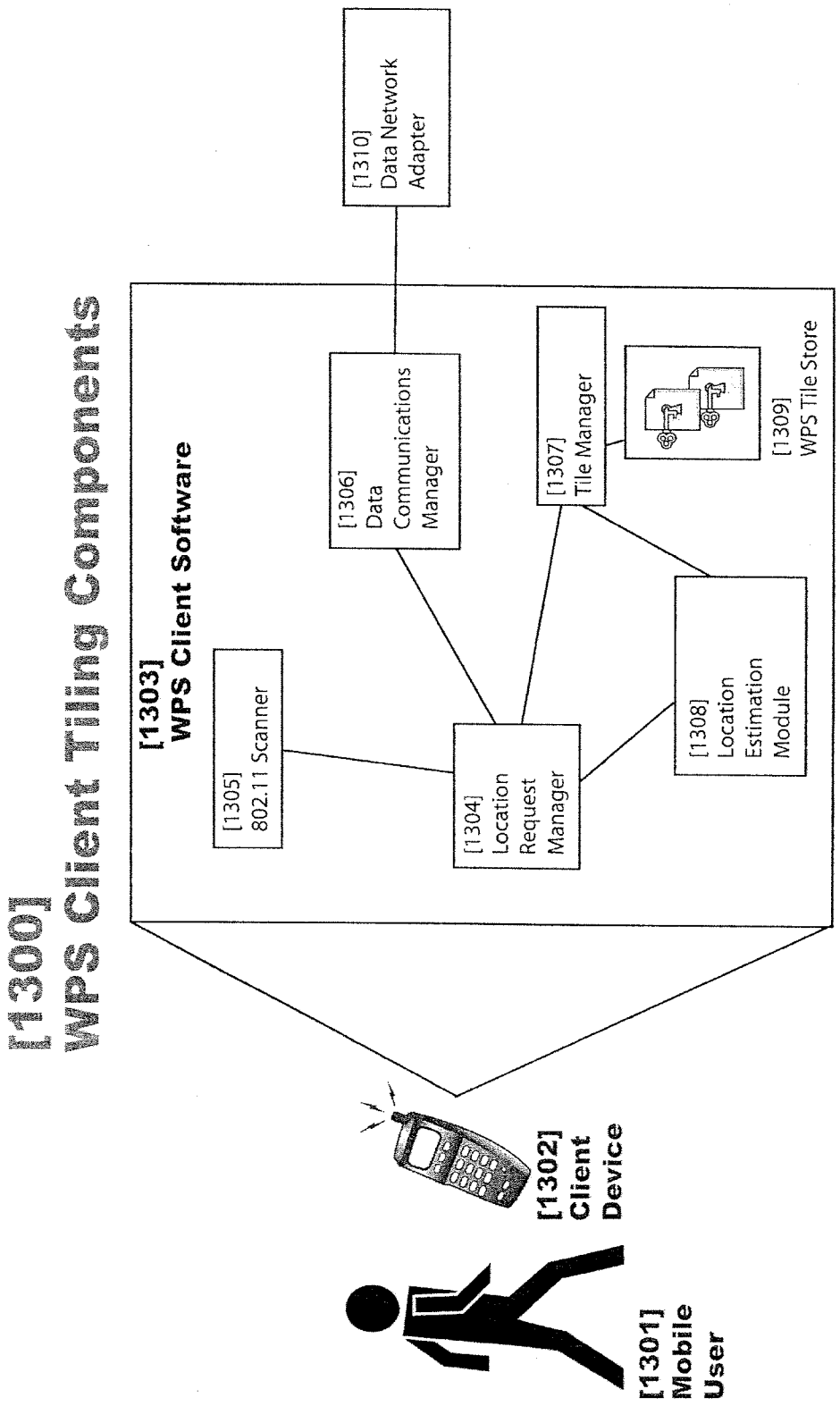

[1300]
WPS Client Tiling Components
[1303]
WPS Client Software
[1305]
802.11 Scanner
[1304]
Location
Request
Manager
[1306]
Data
Communications
Manager
[1307]
Tile Manager
[1308]
Location
Estimation
Module
[1309]
WPS Tile Store
[1310]
Data Network
Adapter
[1302]
Client
Device
[1301]
Mobile
User

FIGURE 14

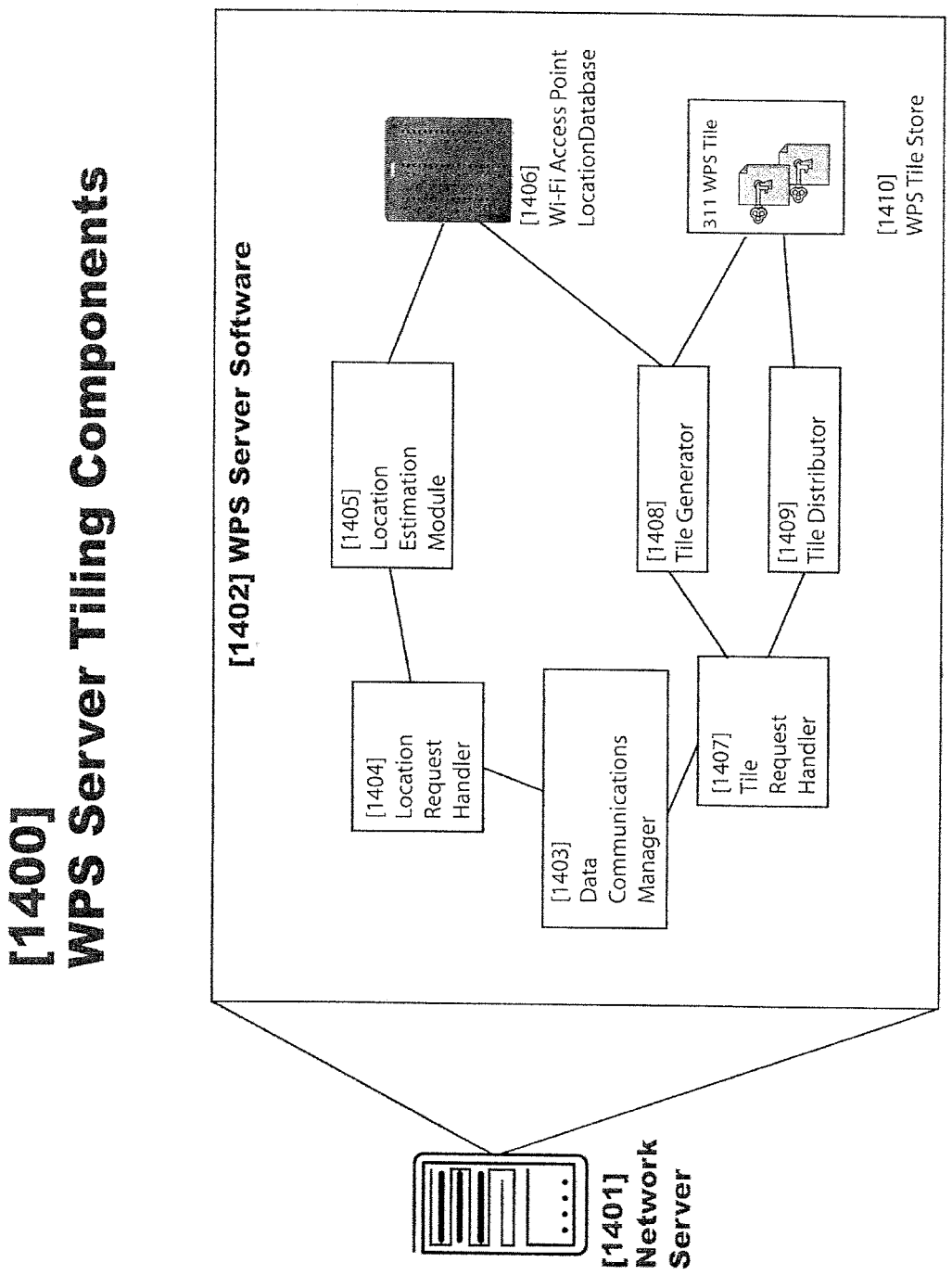

[1400]
WPS Server Tiling Components
[1402] WPS Server Software
[1401]
Network
Server
[1403]
Data
Communications
Manager
[1404]
Location
Request
Handler
[1405]
Location
Estimation
Module
[1406]
Wi-Fi Access Point
LocationDatabase
[1407]
Tile
Request
Handler
[1408]
Tile Generator
[1409]
Tile Distributor
311 WPS Tile
[1410]
WPS Tile Store

FIGURE 15

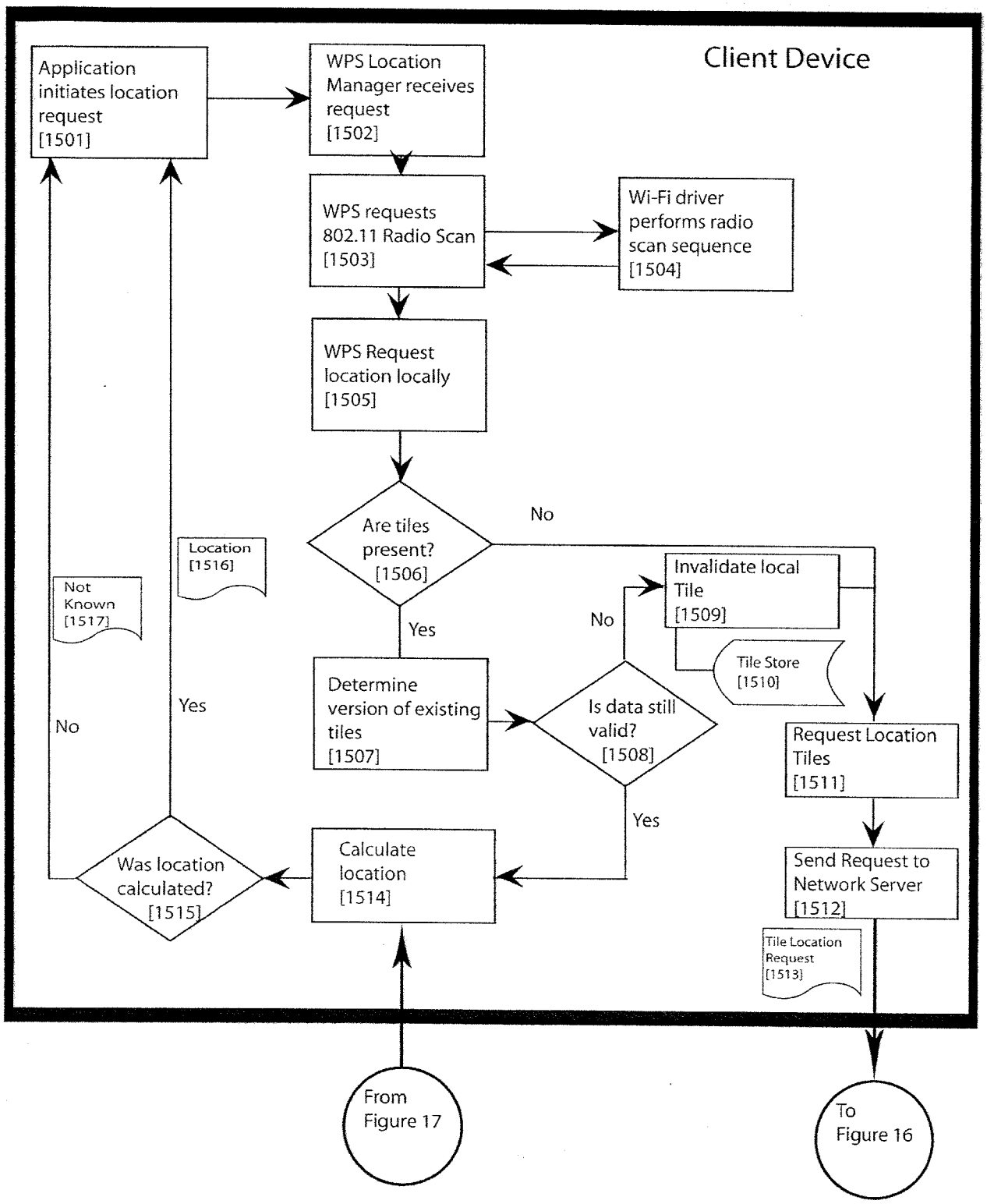

Client Device
Application initiates location request [1501]
WPS Location Manager receives request [1502]
WPS requests 802.11 Radio Scan [1503]
Wi-Fi driver performs radio scan sequence [1504]
WPS Request location locally [1505]
Are tiles present? [1506]
No
Yes
Invalidate local Tile [1509]
Tile Store [1510]
Determine version of existing tiles [1507]
Is data still valid? [1508]
No
Yes
Request Location Tiles [1511]
Send Request to Network Server [1512]
Tile Location Request [1513]
Calculate location [1514]
Was location calculated? [1515]
Yes
No
Location [1516]
Not Known [1517]
From Figure 17
To Figure 16

FIGURE 16

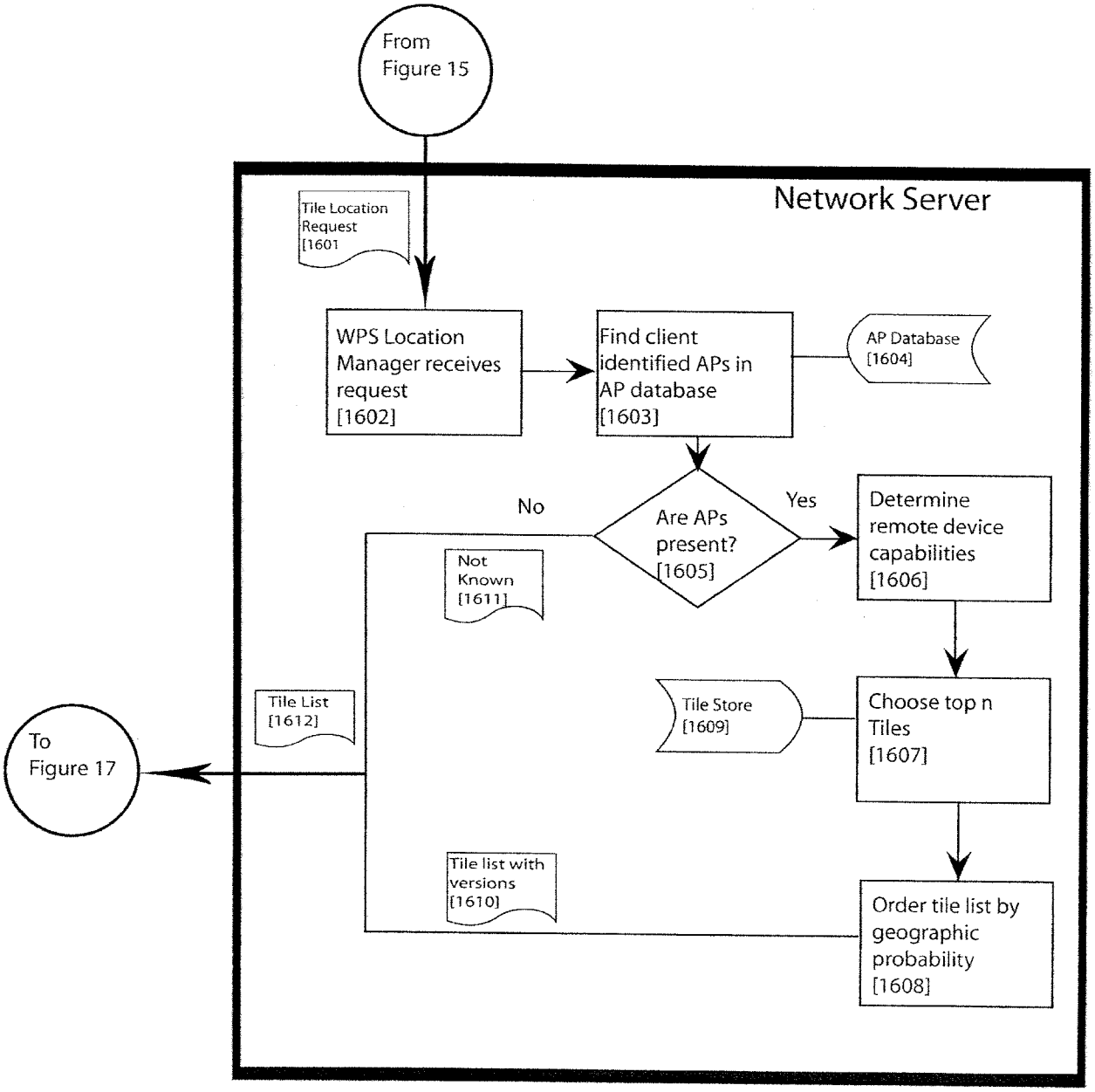

From Figure 15
Network Server
Tile Location Request [1601
WPS Location Manager receives request [1602]
Find client identified APs in AP database [1603]
AP Database [1604]
Are APs present? [1605]
No
Yes
Not Known [1611]
Determine remote device capabilities [1606]
Tile Store [1609]
Choose top n Tiles [1607]
Tile List [1612]
To Figure 17
Tile list with versions [1610]
Order tile list by geographic probability [1608]

FIGURE 17

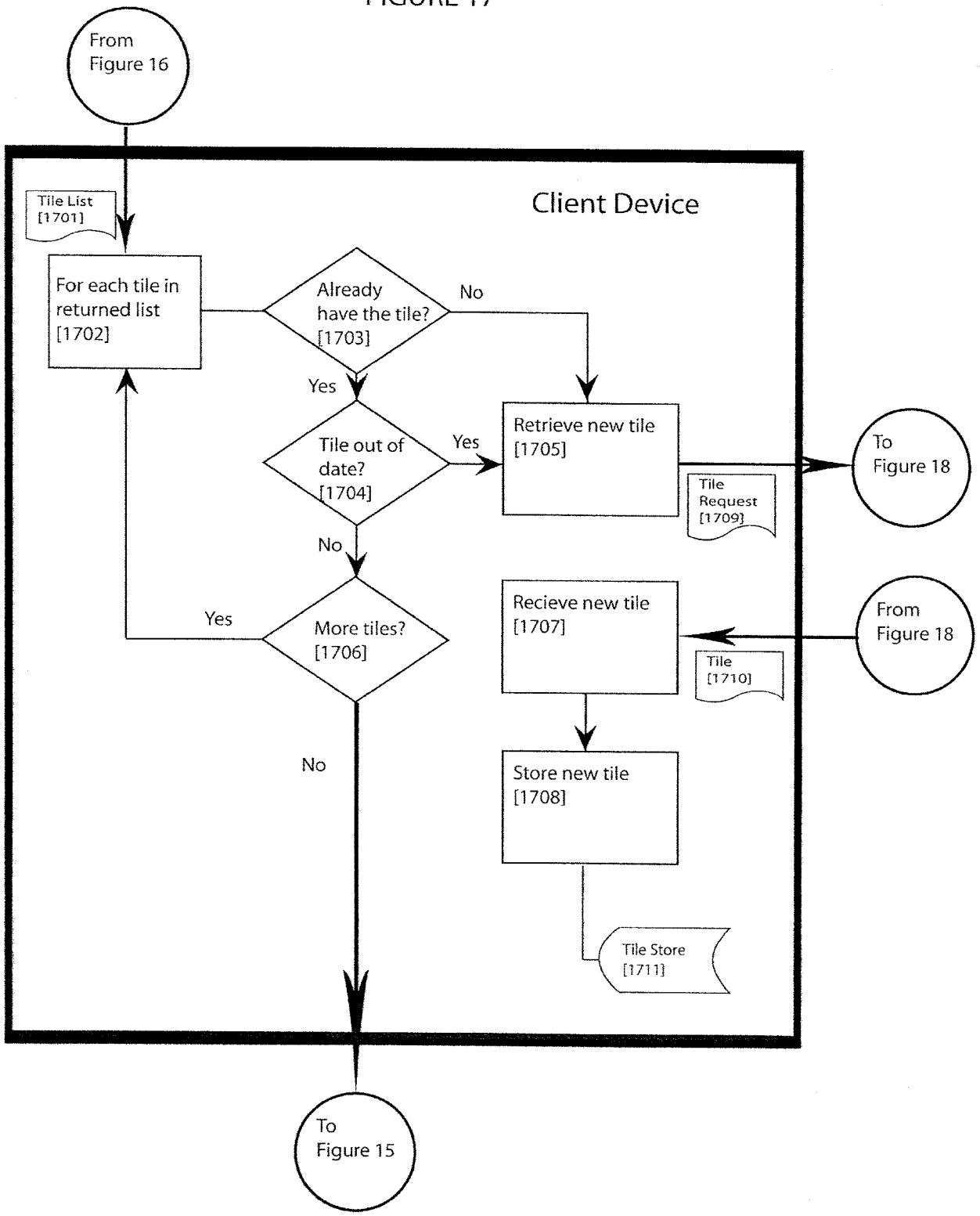

From Figure 16
Client Device
Tile List [1701]
For each tile in returned list [1702]
Already have the tile? [1703]
No
Yes
Tile out of date? [1704]
Yes
Retrieve new tile [1705]
Tile Request [1709]
To Figure 18
No
More tiles? [1706]
Yes
Recieve new tile [1707]
Tile [1710]
From Figure 18
No
Store new tile [1708]
Tile Store [1711]
To Figure 15

FIGURE 18

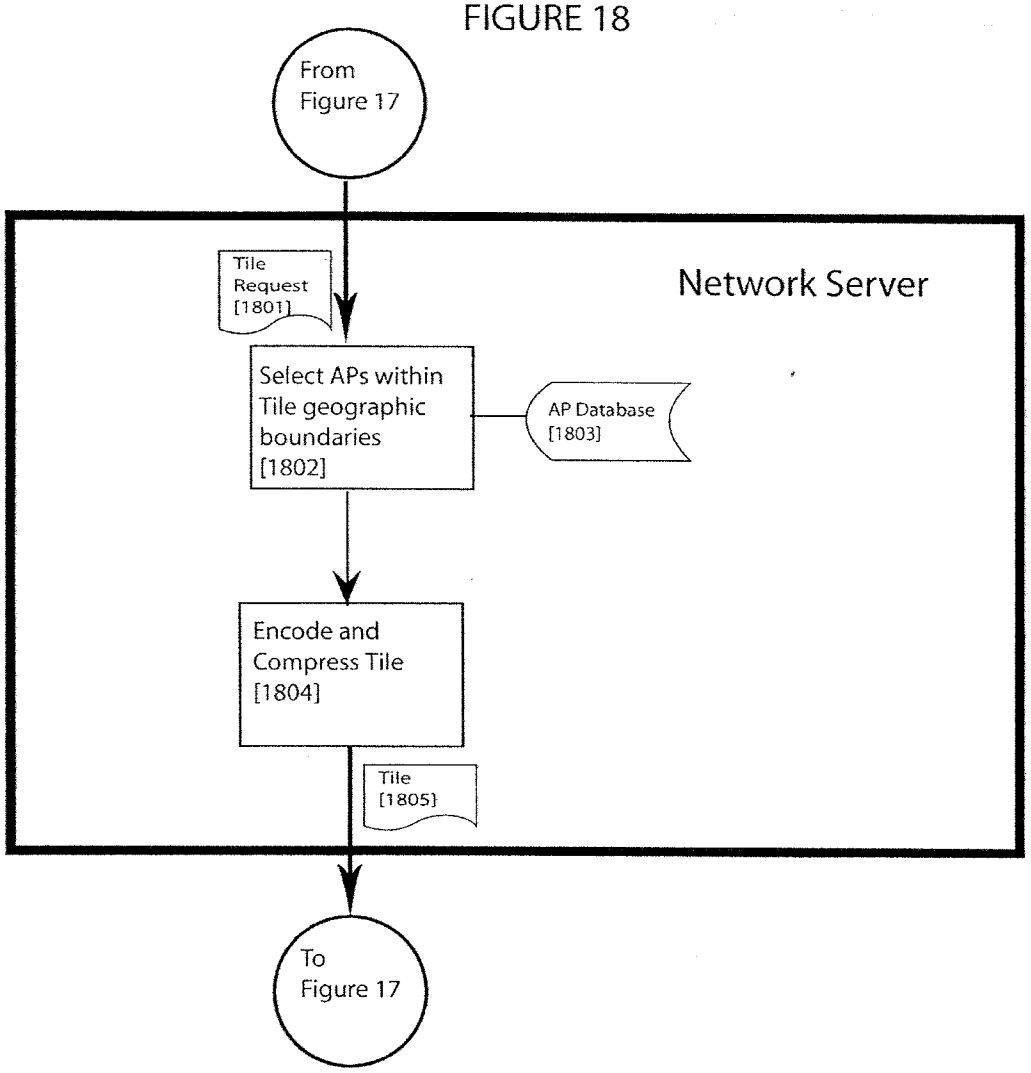

From Figure 17
Network Server
Tile Request [1801]
Select APs within Tile geographic boundaries [1802]
AP Database [1803]
Encode and Compress Tile [1804]
Tile [1805]
To Figure 17

FIGURE 19

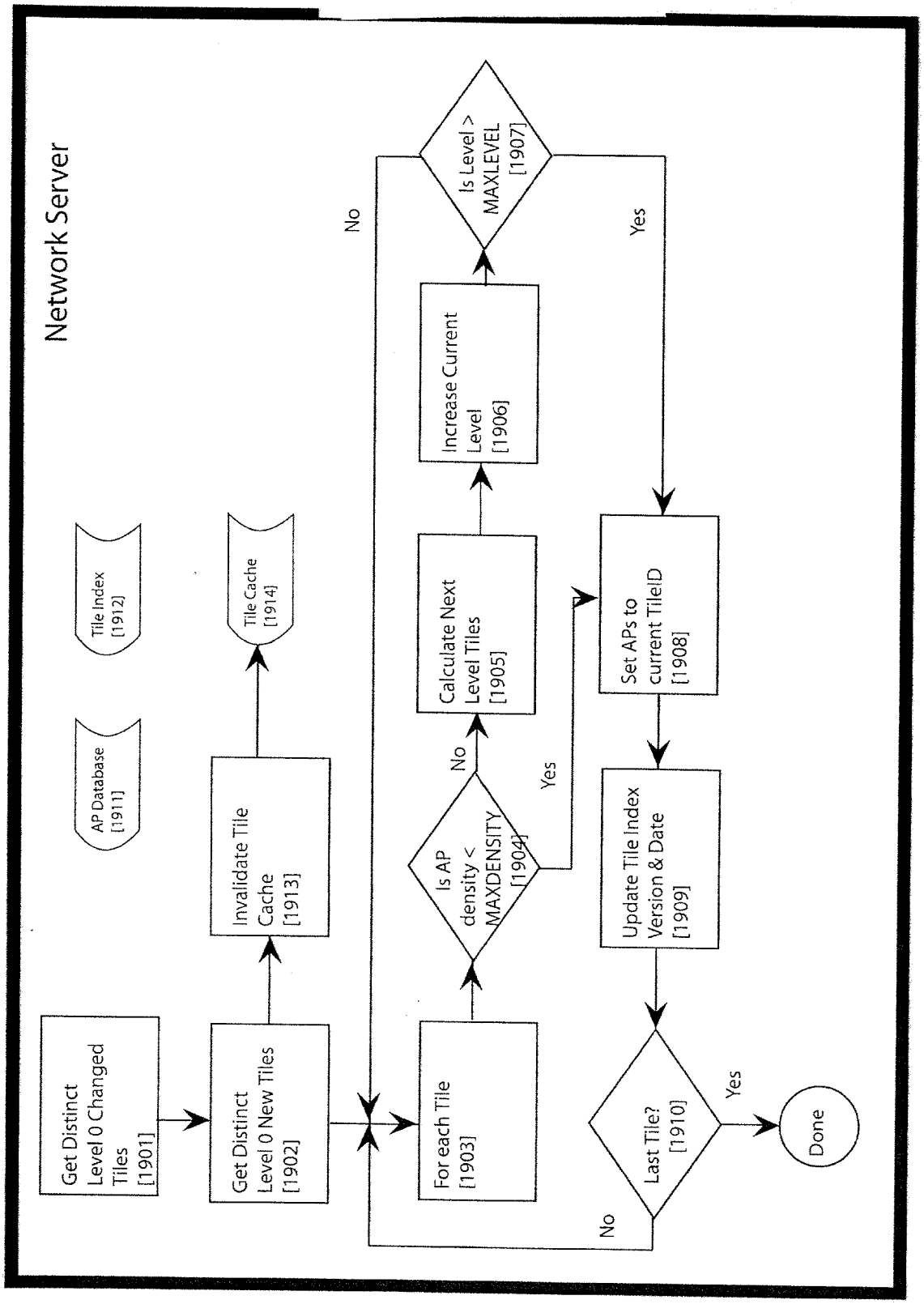

Network Server
Get Distinct Level 0 Changed Tiles [1901]
Get Distinct Level 0 New Tiles [1902]
For each Tile [1903]
Is AP density < MAXDENSITY [1904]
Calculate Next Level Tiles [1905]
Increase Current Level [1906]
Is Level > MAXLEVEL [1907]
Set APs to current TileID [1908]
Update Tile Index Version & Date [1909]
Last Tile? [1910]
Done
AP Database [1911]
Tile Index [1912]
Invalidate Tile Cache [1913]
Tile Cache [1914]
No
Yes
No
Yes
No
Yes

FIGURE 20

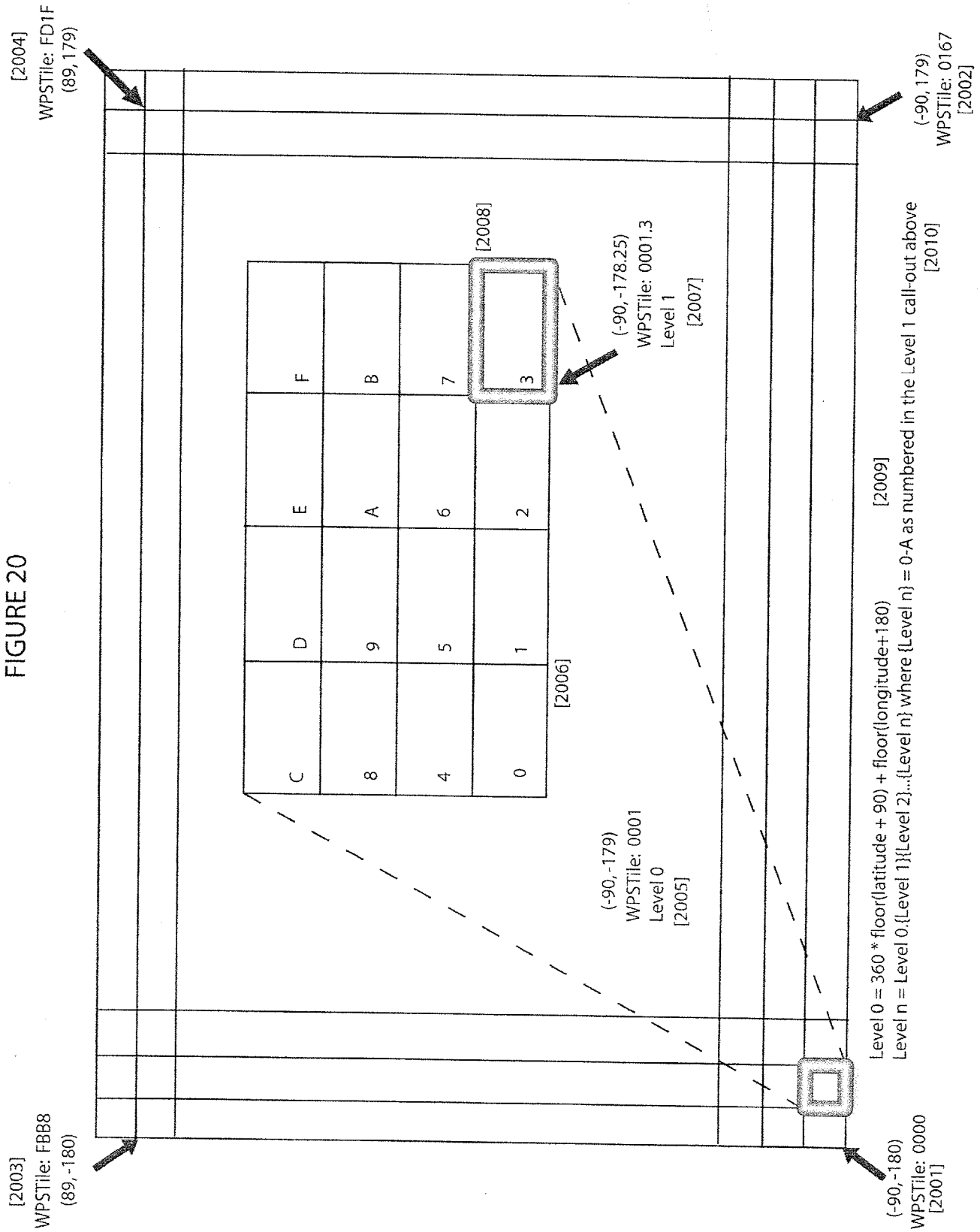

[2004]
WPSTile: FD1F
(89,179)
[2003]
WPSTile: FBB8
(89,-180)
(-90,179)
WPSTile: 0167
[2002]
(-90,-180)
WPSTile: 0000
[2001]
[2008]
(-90,-178.25)
WPSTile: 0001.3
Level 1
[2007]
[2006]
(-90,-179)
WPSTile: 0001
Level 0
[2005]
C D E F
8 9 A B
4 5 6 7
0 1 2 3
[2009]
Level 0 = 360 * floor(latitude + 90) + floor(longitude+180)
Level n = Level 0.{Level 1}{Level 2}...{Level n} where {Level n} = 0-A as numbered in the Level 1 call-out above
[2010]

FIGURE 21

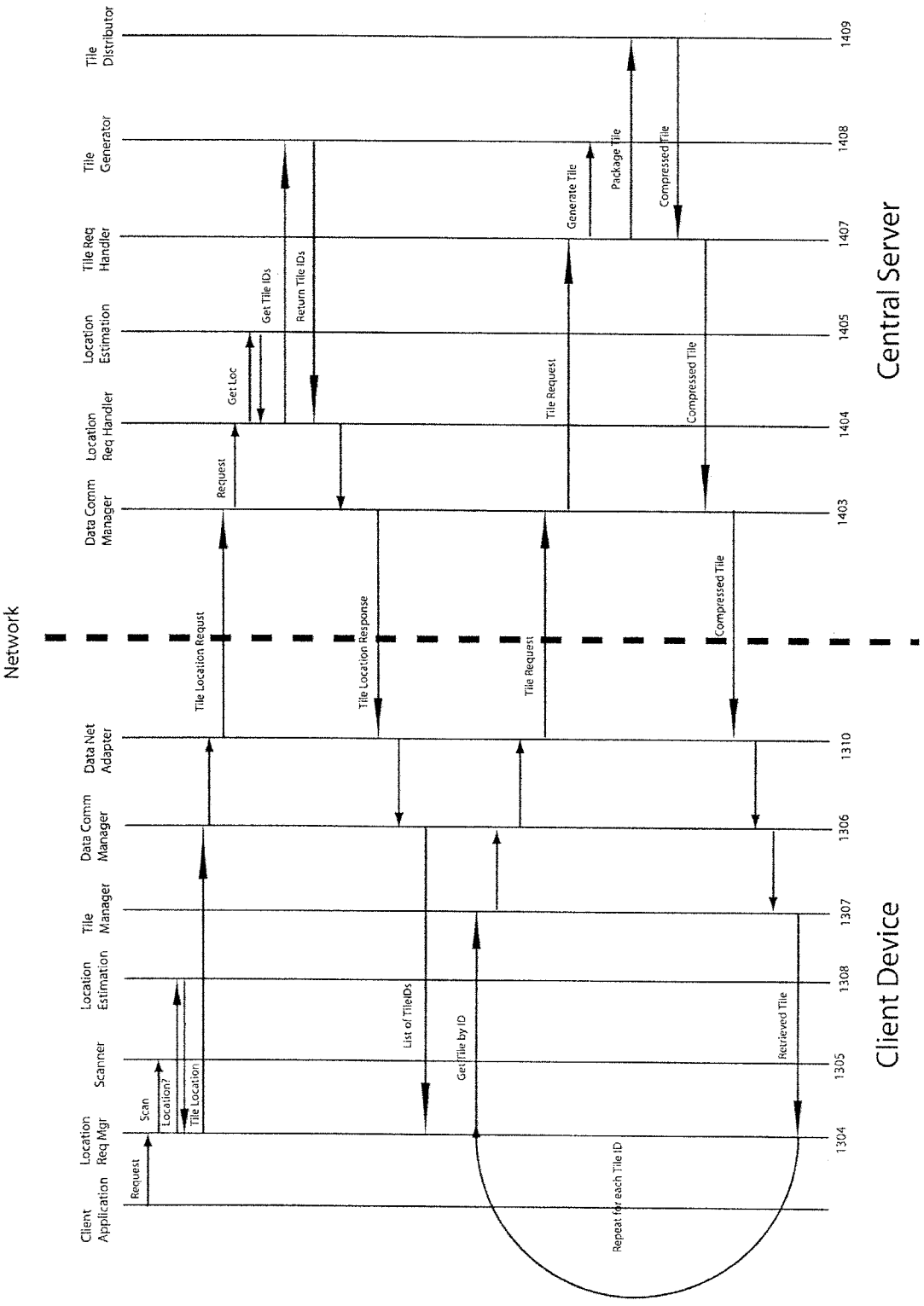
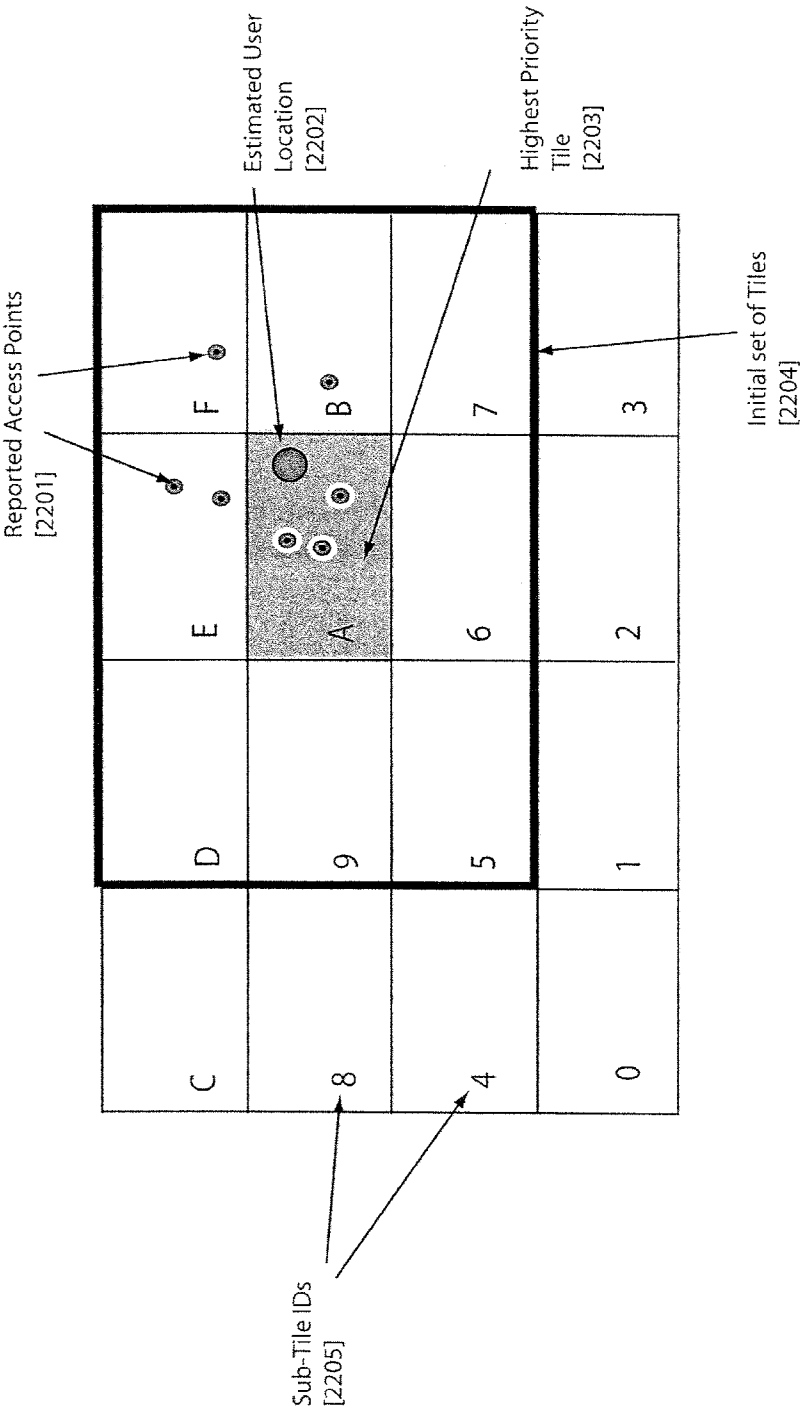

Client Application
Location Req Mgr
Scanner
Location Estimation
Tile Manager
Data Comm Manager
Data Net Adapter
Network
Data Comm Manager
Location Req Handler
Location Estimation
Tile Req Handler
Tile Generator
Tile Distributor
Client Device
Central Server
1304
1305
1308
1307
1306
1310
1403
1404
1405
1407
1408
1409
Request
Scan
Location?
Tile Location
Tile Location Requst
Tile Location Response
List of TileIDs
GetTile by ID
Tile Request
Compressed Tile
Retrieved Tile
Repeat for each Tile ID
Request
Get Loc
Get Tile IDs
Return Tile IDs
Tile Request
Generate Tile
Package Tile
Compressed Tile

FIGURE 22


Reported Access Points
[2201]
Estimated User Location
[2202]
Highest Priority Tile
[2203]
Initial set of Tiles
[2204]
Sub-Tile IDs
[2205]
C
D
E
F
8
9
A
B
4
5
6
7
0
1
2
3