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Havlark et al.

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(54) **WIRELESS TELECOMMUNICATIONS LOCATION BASED SERVICES SCHEME SELECTION**

(75) Inventors: **Arlene Havlark**, Seattle, WA (US); **Victor Burton**, Bellevue, WA (US); **John Ahrens**, Maple Valley, WA (US)

(73) Assignee: **TeleCommunication Systems, Inc.**, Annapolis, MD (US)

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Related U.S. Application Data

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(60) Provisional application No. 60/367,703, filed on Mar. 28, 2002.

(51) **Int. Cl.**

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G01S 5/02	(2010.01)
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(52) **U.S. Cl.**

CPC ***G01S 19/05*** (2013.01); ***G01S 5/0252*** (2013.01); ***G01S 5/0054*** (2013.01); ***G01S 5/0236*** (2013.01)

USPC **455/404.2**; 455/456.1

(58) **Field of Classification Search**

USPC 455/435.1, 435.2, 456.1, 456.3, 456.5, 455/433, 404.2, 440, 456.4, 456.6, 456.2

See application file for complete search history.

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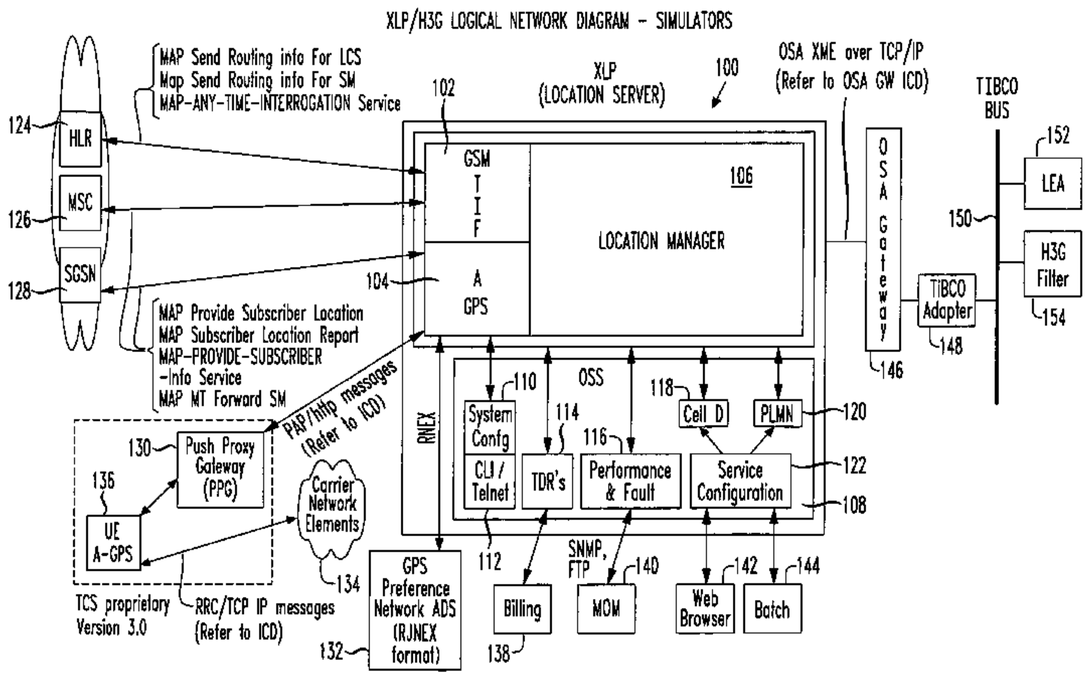
Primary Examiner — Myron K Wyche

(74) *Attorney, Agent, or Firm* — William H. Bollman

(57) **ABSTRACT**

An intelligent system for choosing selection schemes to be tried in a predetermined order for determining the location of a wireless mobile client, including retrieving a last known position record from a cache, checking serving network capability, choosing an initial selection scheme according to parameters including at least the required response time and the requested location method, including a method employing navigational satellites, attempting to retrieve a current position record, trying successive untried selection schemes in turn according to a predetermined algorithm if no current position record has been retrieved, and returning the current position record and updating the last known position record, or returning an error if no current position record has been retrieved, and returning the last known position record if an error has been returned, the last known position record exists in the cache and the last known position record has not expired.

15 Claims, 32 Drawing Sheets



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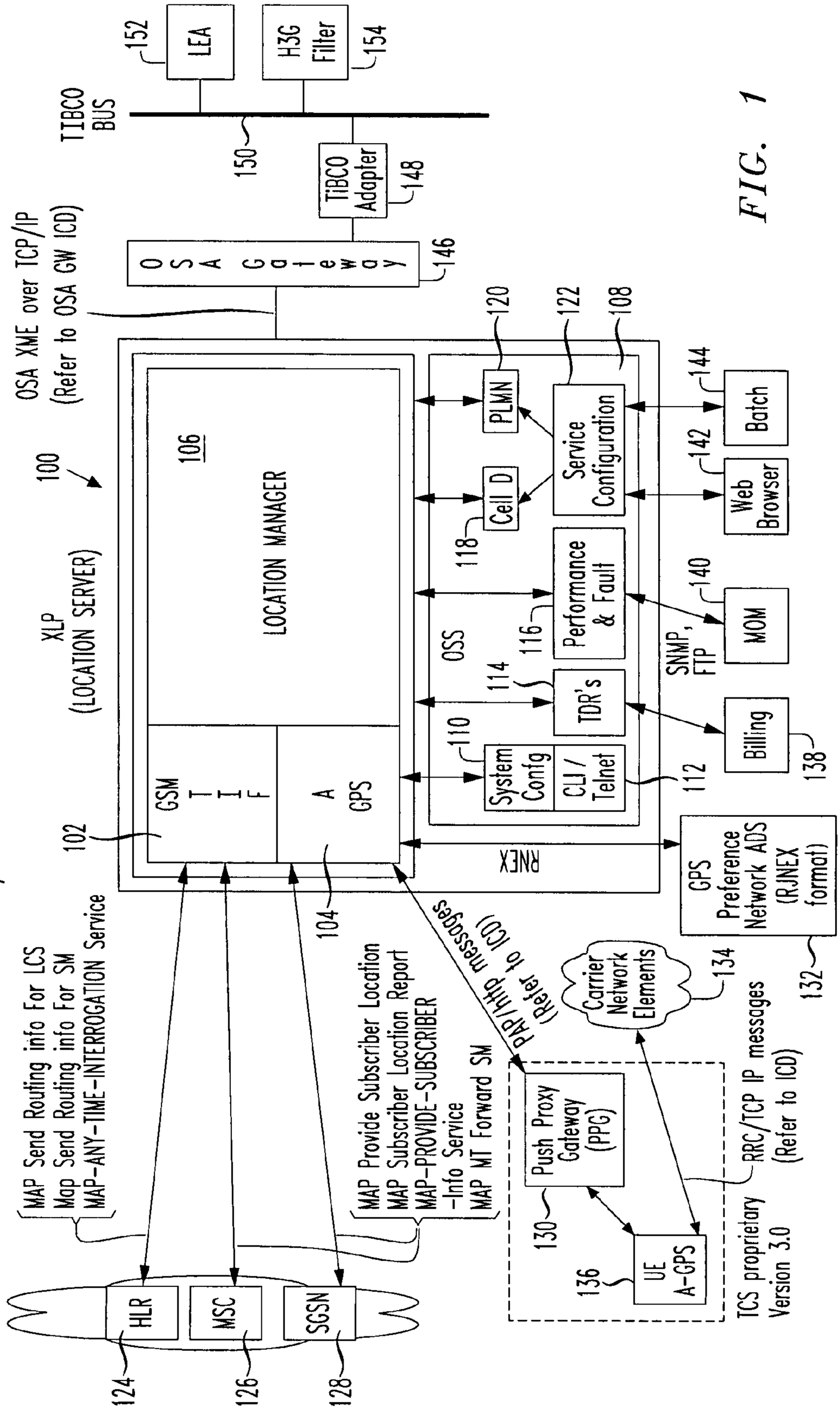

XLP/H3G LOGICAL NETWORK DIAGRAM - SIMULATORS
XLP
(LOCATION SERVER)
100
LOCATION MANAGER
106
GSM T I F
A GPS
102
104
OSS
RNEX
LEA
152
H3G Filter
154
TIBCO BUS
150
TiBCO Adapter
148
O S A G a t e w a y
146
OSA XME over TCP/IP
(Refer to OSA GW ICD)
PLMN
120
Cell D
118
Performance & Fault
116
System Config
CLI / Telnet
110
TDR's
114
Service Configuration
122
Batch
144
Web Browser
142
MOM
140
Billing
138
SNMP, FTP
112
GPS Preference Network ADS (RJNEX format)
108
Carrier Network Elements
134
RRC/TCP IP messages
(Refer to ICD)
132
TCS proprietary
Version 3.0
Push Proxy Gateway (PPG)
130
UE A-GPS
136
HLR
124
MSC
126
SGSN
128
MAP Send Routing info For LCS
Map Send Routing info For SM
MAP-ANY-TIME-INTERROGATION Service
MAP Provide Subscriber Location
MAP Subscriber Location Report
MAP-PROVIDE-SUBSCRIBER -Info Service
MAP MT Forward SM

FIG. 1

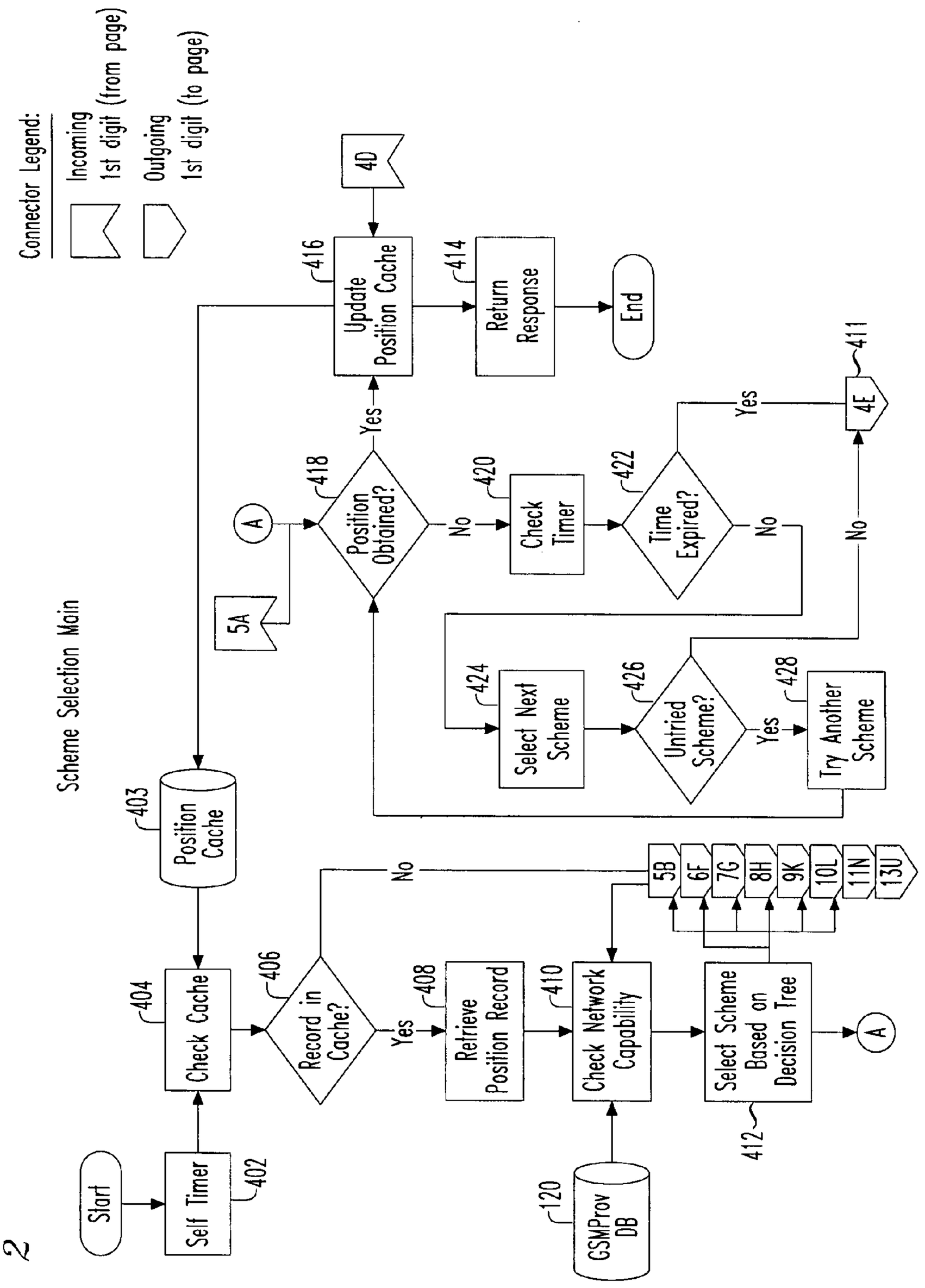

Connector Legend:
Incoming 1st digit (from page)
Outgoing 1st digit (to page)
Scheme Selection Main
Start
Self Timer
402
Check Cache
404
Record in Cache?
406
Yes
No
Retrieve Position Record
408
Check Network Capability
410
Select Scheme Based on Decision Tree
412
Position Cache
403
GSMProv DB
120
Update Position Cache
416
Return Response
414
End
Position Obtained?
418
Check Timer
420
Time Expired?
422
Select Next Scheme
424
Untried Scheme?
426
Try Another Scheme
428
4D
5A
A
4E
411
5B
6F
7G
8H
9K
10L
11N
13U

FIG. 2

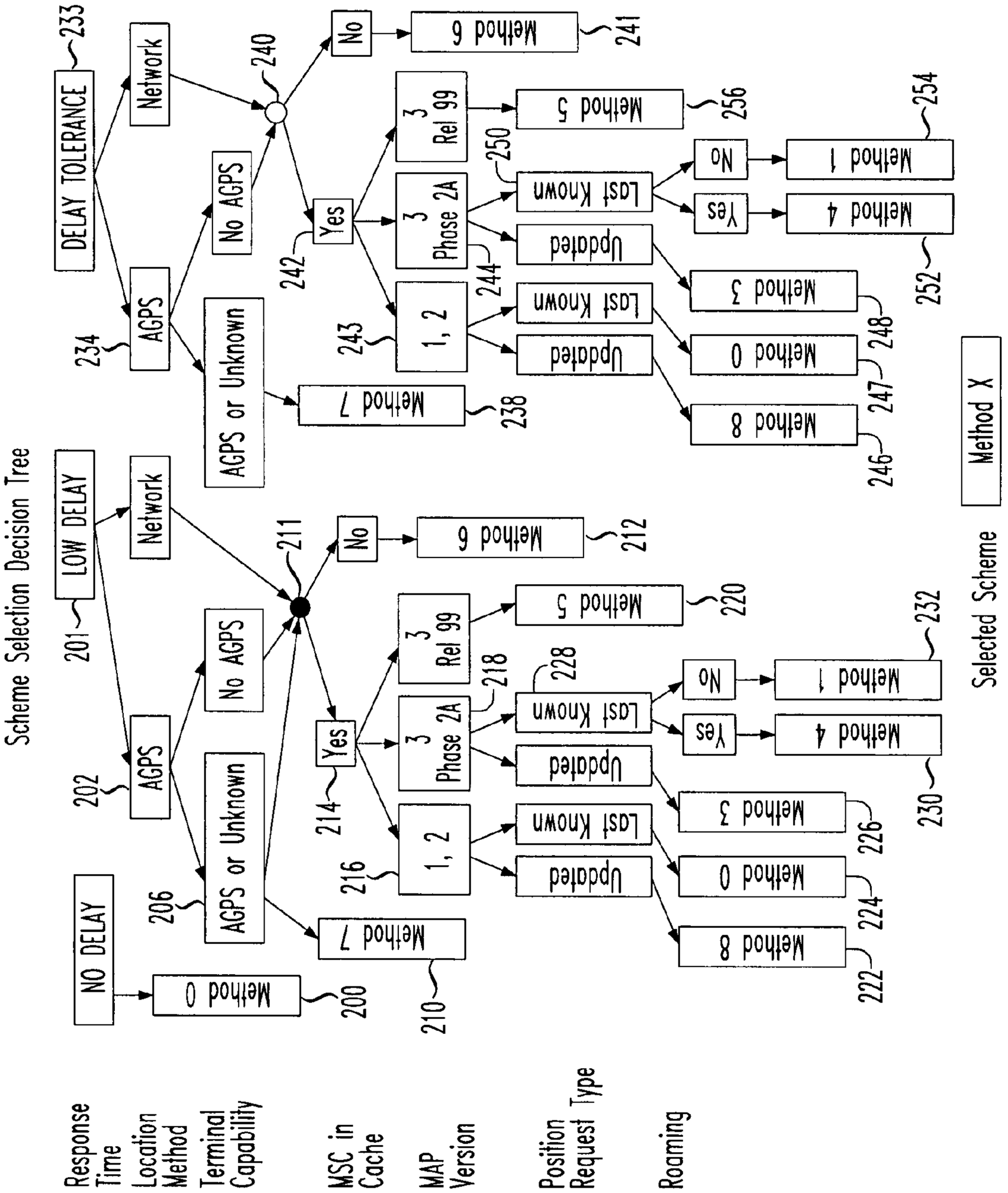

Scheme Selection Decision Tree
DELAY TOLERANCE
233
Network
AGPS
234
No AGPS
AGPS or Unknown
240
No
Method 6
241
Yes
242
3 Rel 99
3 Phase 2A
1, 2
243
250
Last Known
Updated
244
Method 5
256
No
Yes
Method 1
Method 4
254
252
Method 3
Method 0
Method 8
248
247
246
Method 7
238
LOW DELAY
201
202
206
211
212
214
216
220
218
228
232
230
226
224
222
NO DELAY
Method 0
200
210
Selected Scheme
Method X
Response Time
Location Method
Terminal Capability
MSC in Cache
MAP Version
Position Request Type
Roaming

FIG. 3

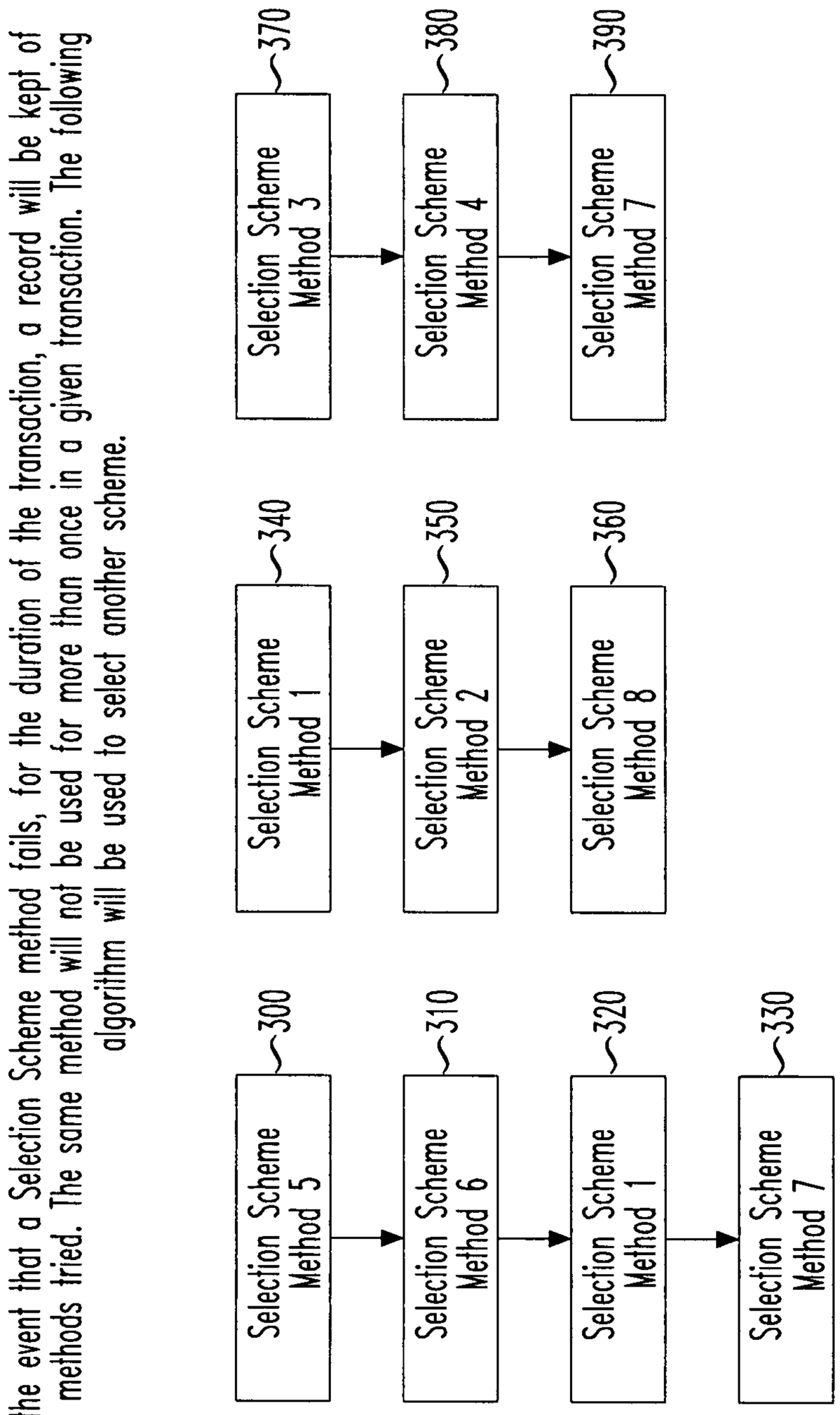

Alternate Schemes
In the event that a Selection Scheme method fails, for the duration of the transaction, a record will be kept of the methods tried. The same method will not be used for more than once in a given transaction. The following algorithm will be used to select another scheme.
Selection Scheme Method 5
300
Selection Scheme Method 6
310
Selection Scheme Method 1
320
Selection Scheme Method 7
330
Selection Scheme Method 1
340
Selection Scheme Method 2
350
Selection Scheme Method 8
360
Selection Scheme Method 3
370
Selection Scheme Method 4
380
Selection Scheme Method 7
390

FIG. 4

FIG. 5

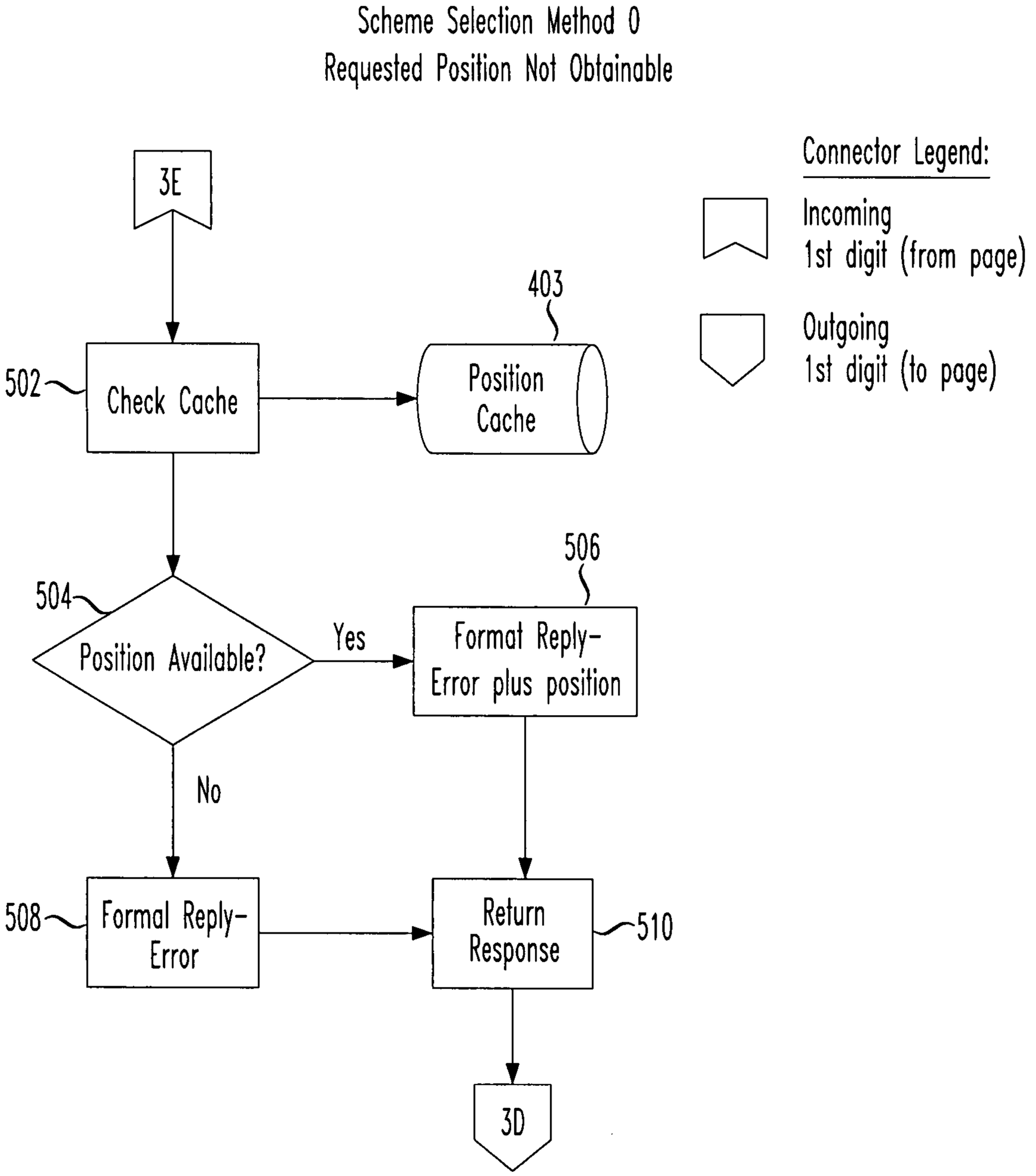

Scheme Selection Method 0
Requested Position Not Obtainable
Connector Legend:
Incoming
1st digit (from page)
Outgoing
1st digit (to page)
3E
403
502
Check Cache
Position
Cache
506
504
Position Available?
Yes
Format Reply-
Error plus position
No
508
Formal Reply-
Error
Return
Response
510
3D

FIG. 6

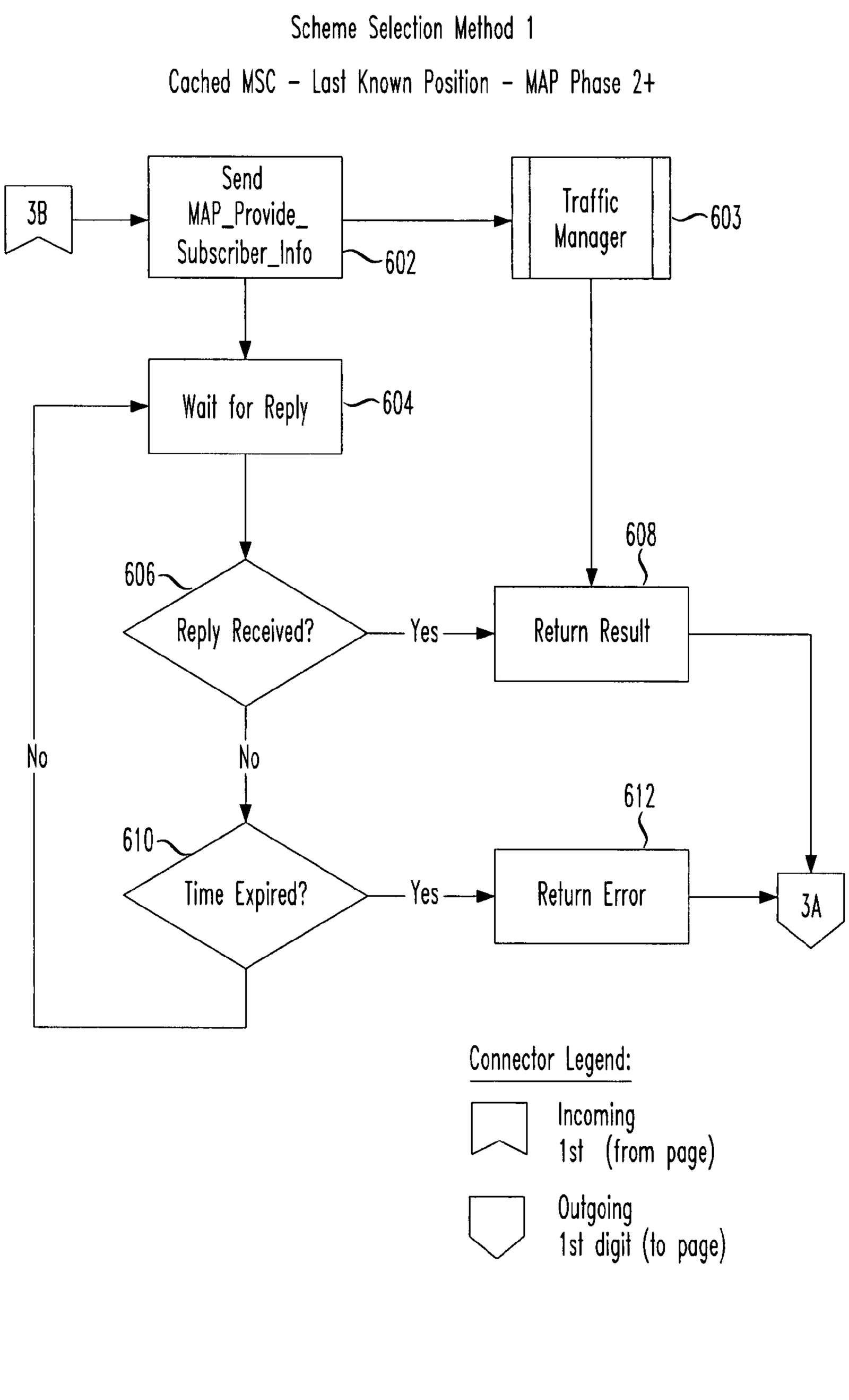

Scheme Selection Method 1
Cached MSC - Last Known Position - MAP Phase 2+
3B
Send MAP_Provide_ Subscriber_Info
602
Traffic Manager
603
Wait for Reply
604
606
Reply Received?
Yes
608
Return Result
No
No
610
Time Expired?
Yes
612
Return Error
3A
Connector Legend:
Incoming 1st (from page)
Outgoing 1st digit (to page)

FIG. 7

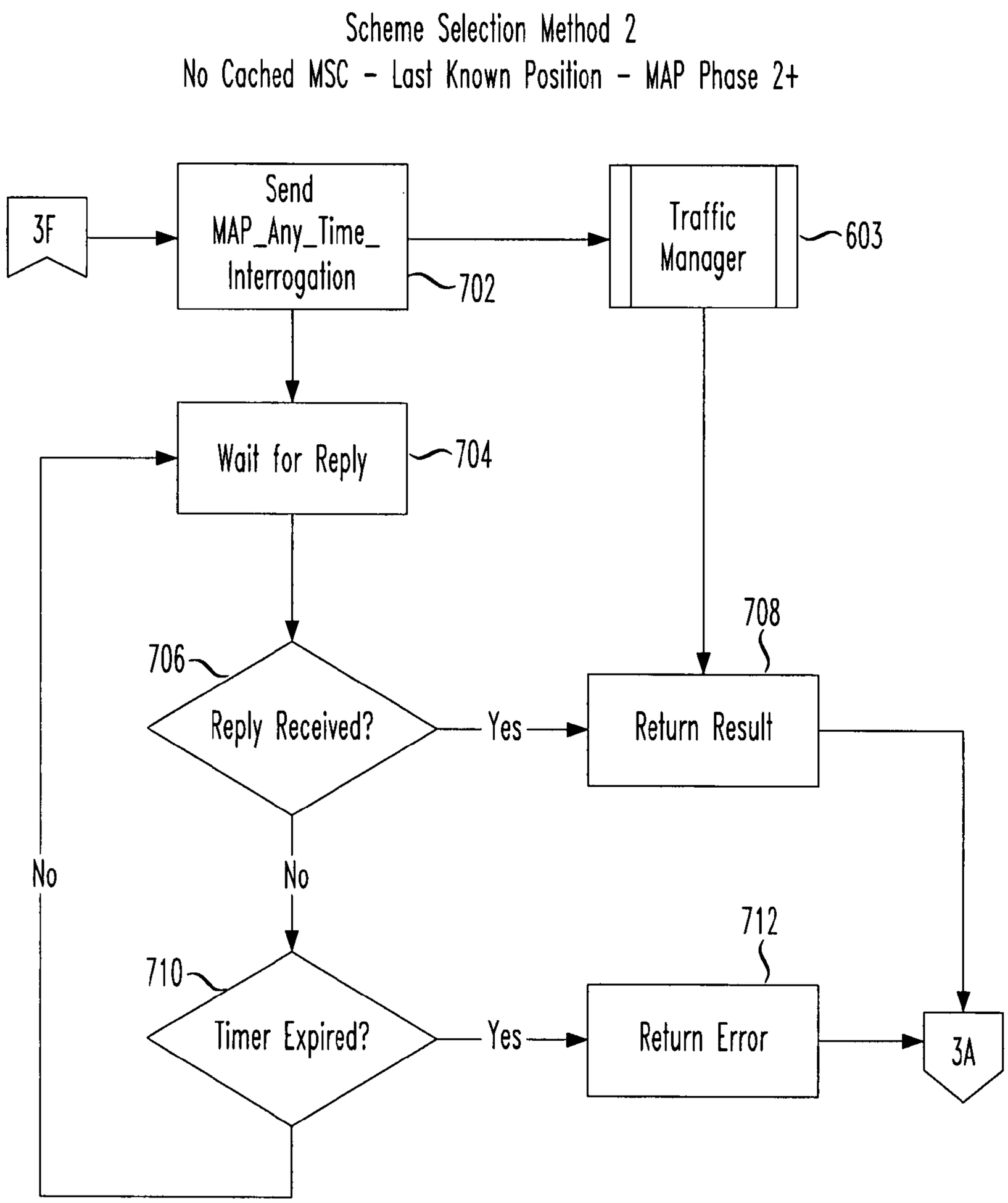
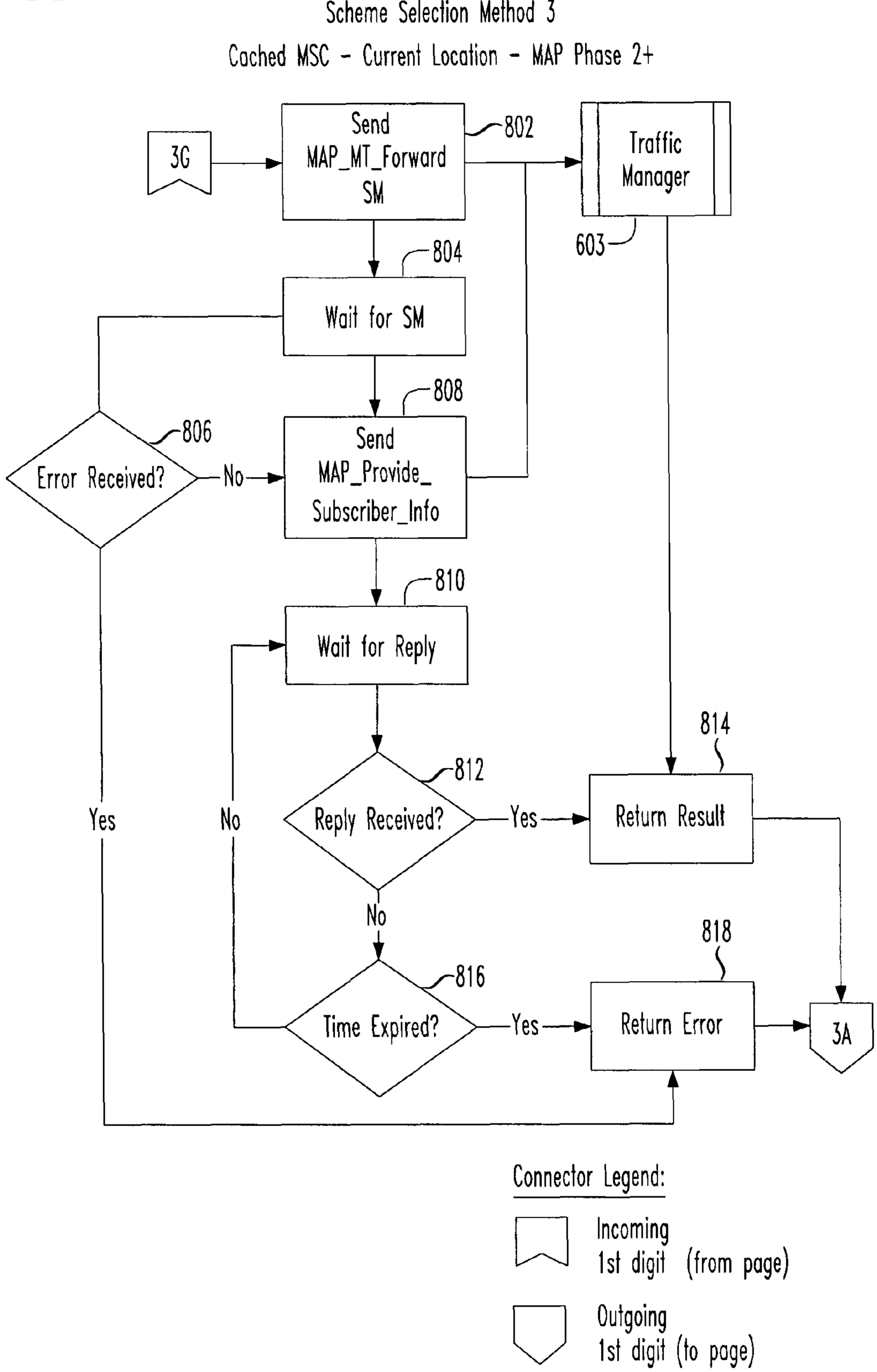

Scheme Selection Method 2
No Cached MSC - Last Known Position - MAP Phase 2+
3F
Send MAP_Any_Time_ Interrogation
702
Traffic Manager
603
Wait for Reply
704
706
Reply Received?
Yes
708
Return Result
No
No
710
Timer Expired?
Yes
712
Return Error
3A
Connector Legend:
Incoming 1st digit (from page)
Outgoing 1st digit (to page)

FIG. 8


Scheme Selection Method 3
Cached MSC - Current Location - MAP Phase 2+
3G
Send MAP_MT_Forward SM
802
Traffic Manager
603
804
Wait for SM
808
806
Error Received?
No
Send MAP_Provide_ Subscriber_Info
810
Wait for Reply
814
812
Reply Received?
Yes
Return Result
Yes
No
No
818
816
Time Expired?
Yes
Return Error
3A
Connector Legend:
Incoming 1st digit (from page)
Outgoing 1st digit (to page)

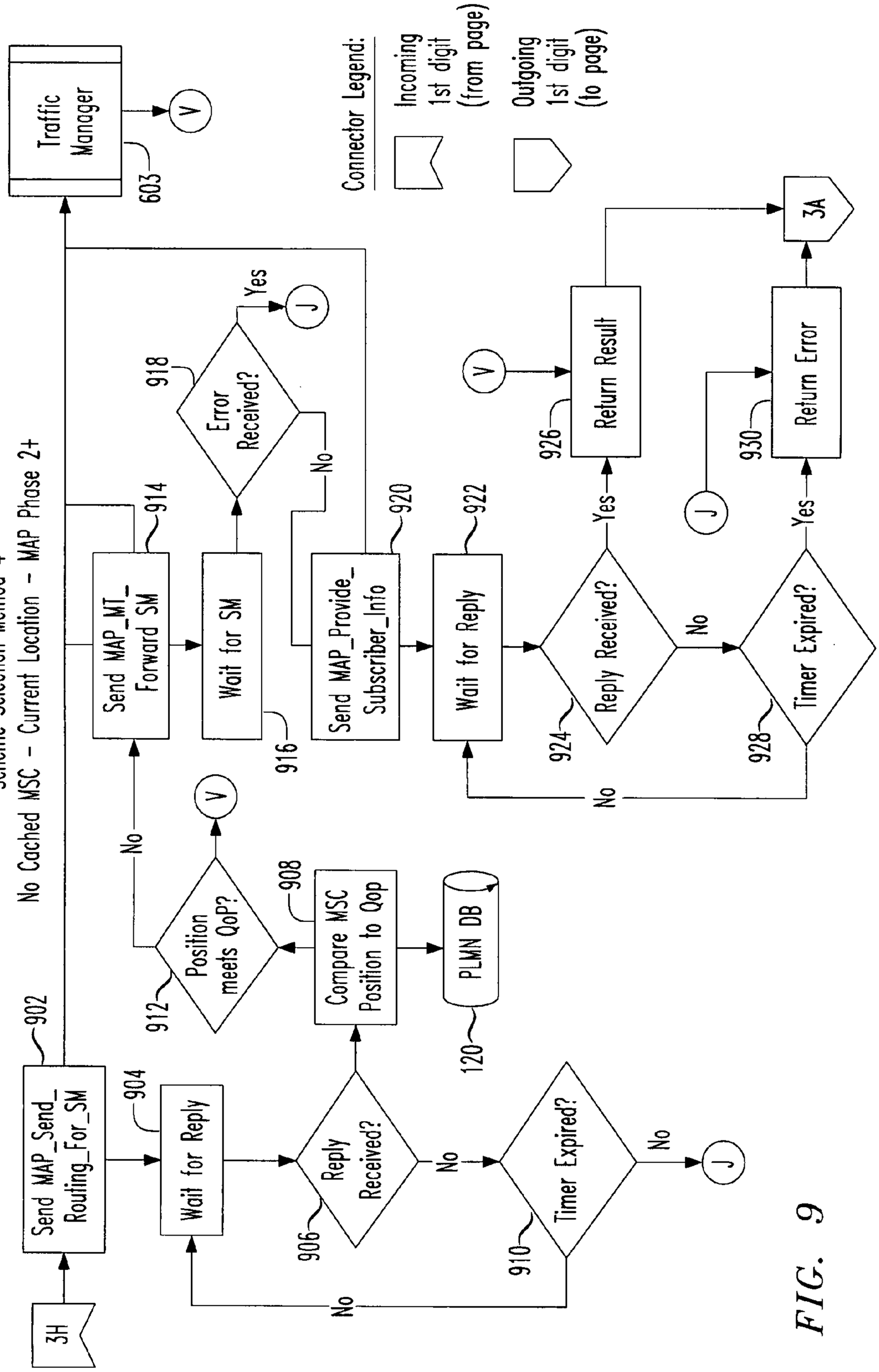
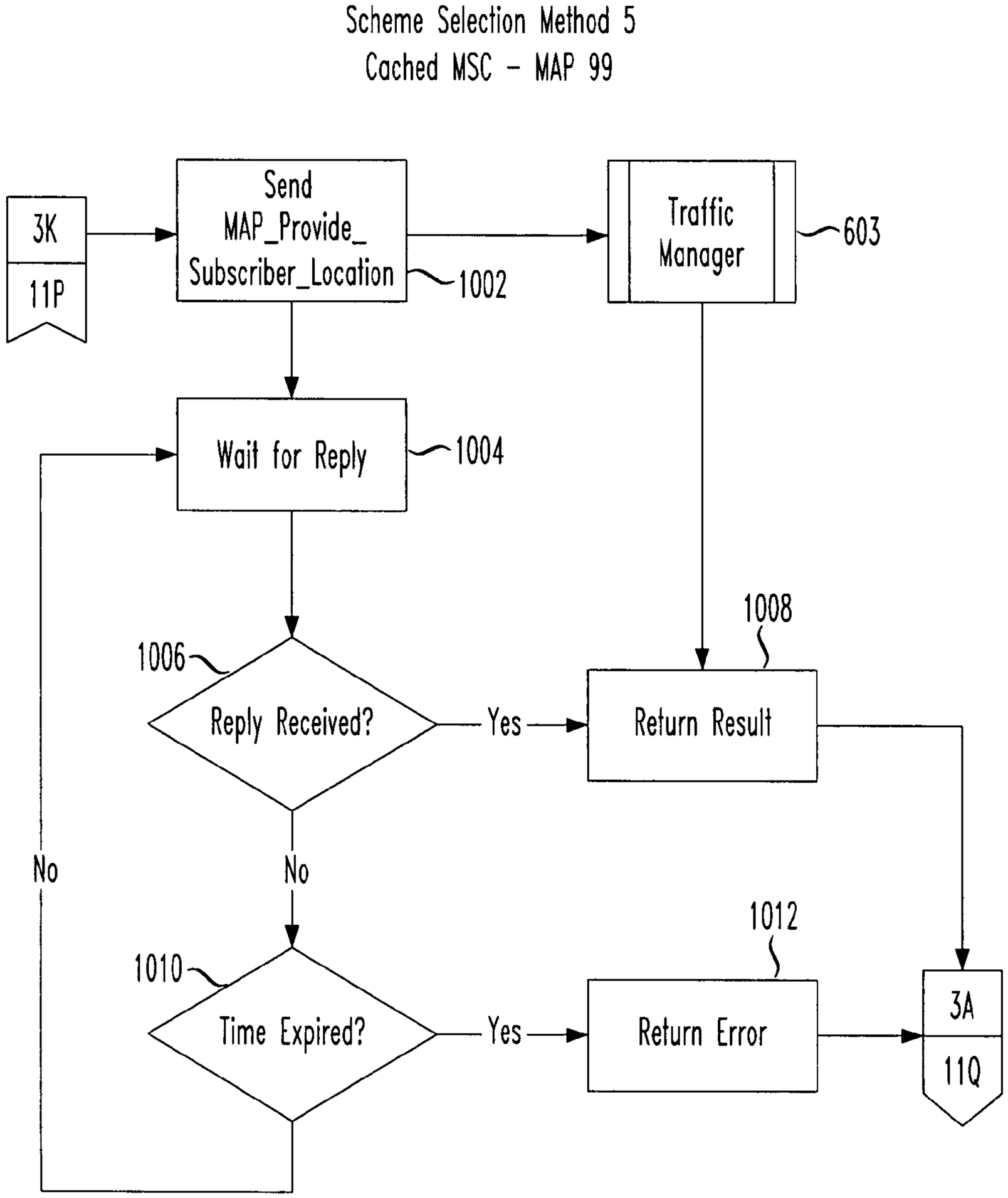

Scheme Selection Method 4
No Cached MSC - Current Location - MAP Phase 2+
Connector Legend:
Incoming 1st digit (from page)
Outgoing 1st digit (to page)
Traffic Manager
603
V
902
Send MAP_Send_ Routing_For_SM
904
Wait for Reply
906
Reply Received?
908
Compare MSC Position to Qop
910
Timer Expired?
912
Position meets QoP?
914
Send MAP_MT_ Forward SM
916
Wait for SM
918
Error Received?
920
Send MAP_Provide_ Subscriber_Info
922
Wait for Reply
924
Reply Received?
926
Return Result
928
Timer Expired?
930
Return Error
120
PLMN DB
3H
3A
J
Yes
No

FIG. 9

FIG. 10


Scheme Selection Method 5
Cached MSC – MAP 99
3K
11P
Send MAP_Provide_ Subscriber_Location
1002
Traffic Manager
603
Wait for Reply
1004
1006
Reply Received?
Yes
1008
Return Result
No
No
1010
Time Expired?
Yes
1012
Return Error
3A
11Q
Connector Legend:
Incoming 1st (from page)
Outgoing 1st digit (to page)

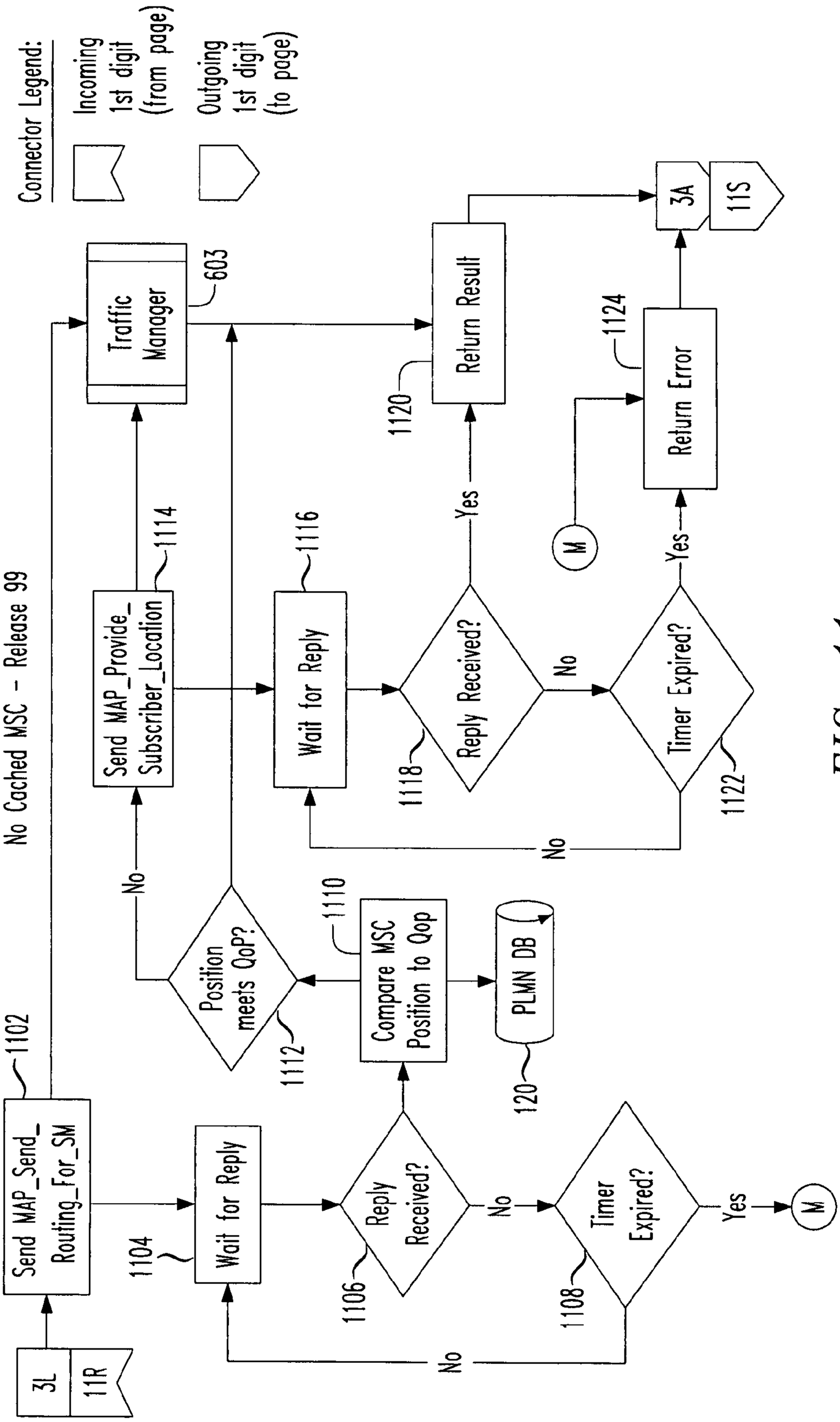

Connector Legend:
Incoming 1st digit (from page)
Outgoing 1st digit (to page)
Scheme Selection Method 6
No Cached MSC - Release 99
3L
11R
1102
Send MAP_Send_Routing_For_SM
1104
Wait for Reply
1106
Reply Received?
No
1108
Timer Expired?
Yes
M
1110
Compare MSC Position to Qop
120
PLMN DB
1112
Position meets QoP?
No
603
Traffic Manager
1114
Send MAP_Provide_Subscriber_Location
1116
Wait for Reply
1118
Reply Received?
Yes
1120
Return Result
3A
11S
1124
Return Error
No
Timer Expired?
1122
Yes
M

FIG. 11

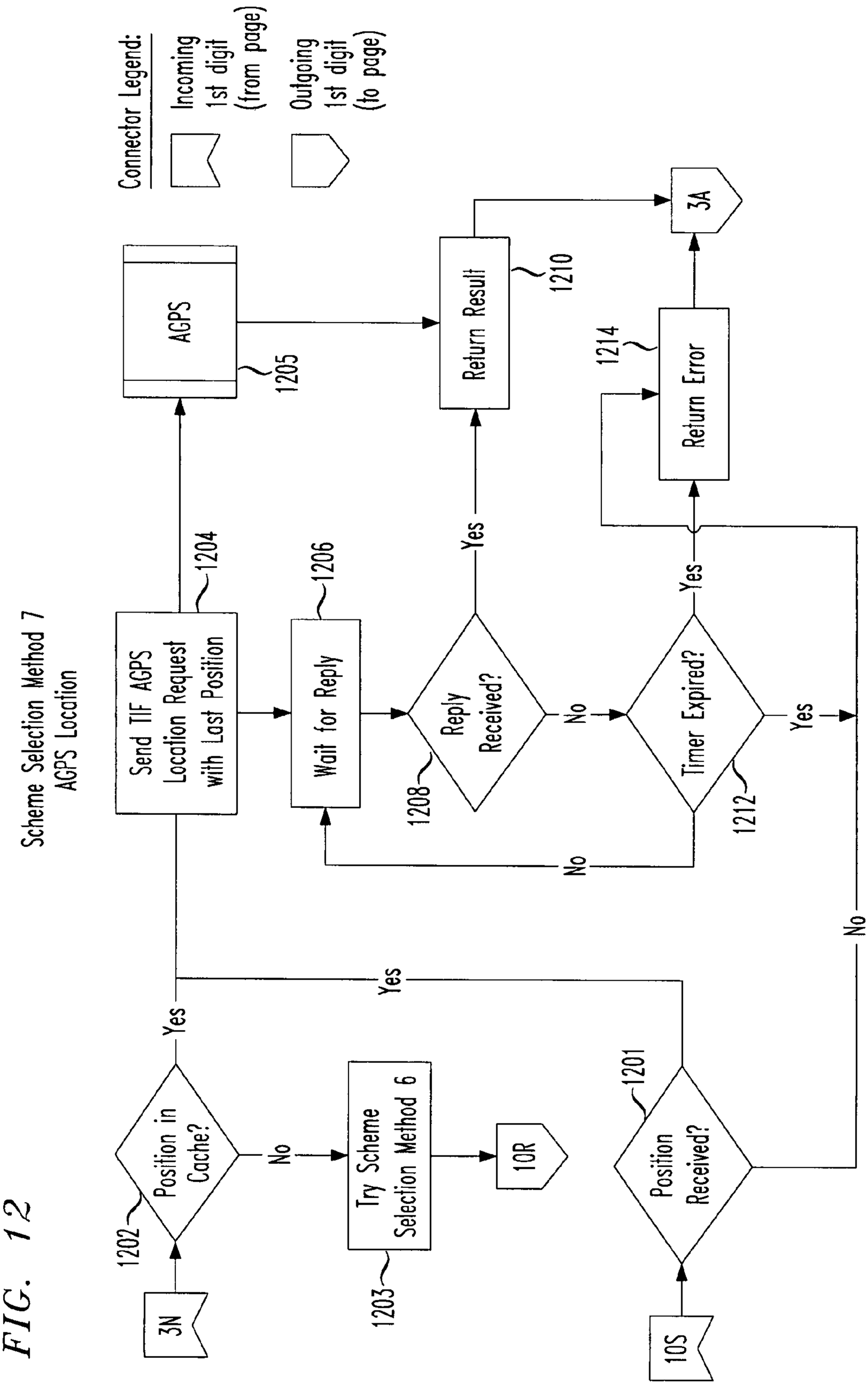

Connector Legend:
Incoming 1st digit (from page)
Outgoing 1st digit (to page)
Scheme Selection Method 7 AGPS Location
AGPS
1205
Return Result
1210
3A
Send TIF AGPS Location Request with Last Position
1204
Wait for Reply
1206
Reply Received?
1208
Yes
No
Timer Expired?
1212
Yes
No
Return Error
1214
Yes
No
Position in Cache?
1202
No
Try Scheme Selection Method 6
1203
10R
3N
Yes
Position Received?
1201
10S

FIG. 12

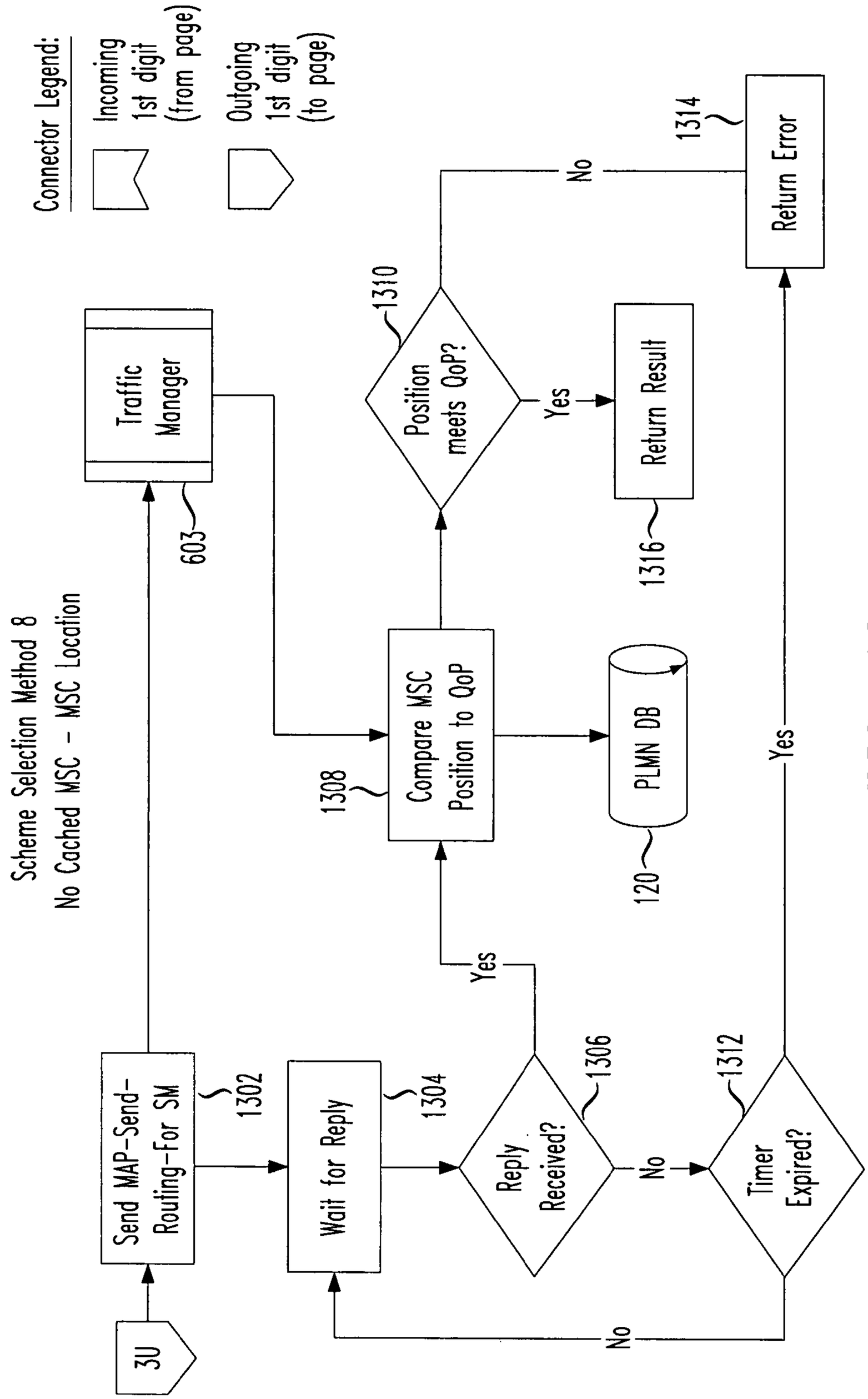

Connector Legend:
Incoming 1st digit (from page)
Outgoing 1st digit (to page)
Scheme Selection Method 8
No Cached MSC – MSC Location
3U
Send MAP-Send-Routing-For SM
1302
Wait for Reply
1304
Reply Received?
1306
No
Timer Expired?
1312
No
Yes
Position meets QoP?
1310
No
1314
Return Error
Yes
Return Result
1316
Compare MSC Position to QoP
1308
Yes
PLMN DB
120
Traffic Manager
603

FIG. 13

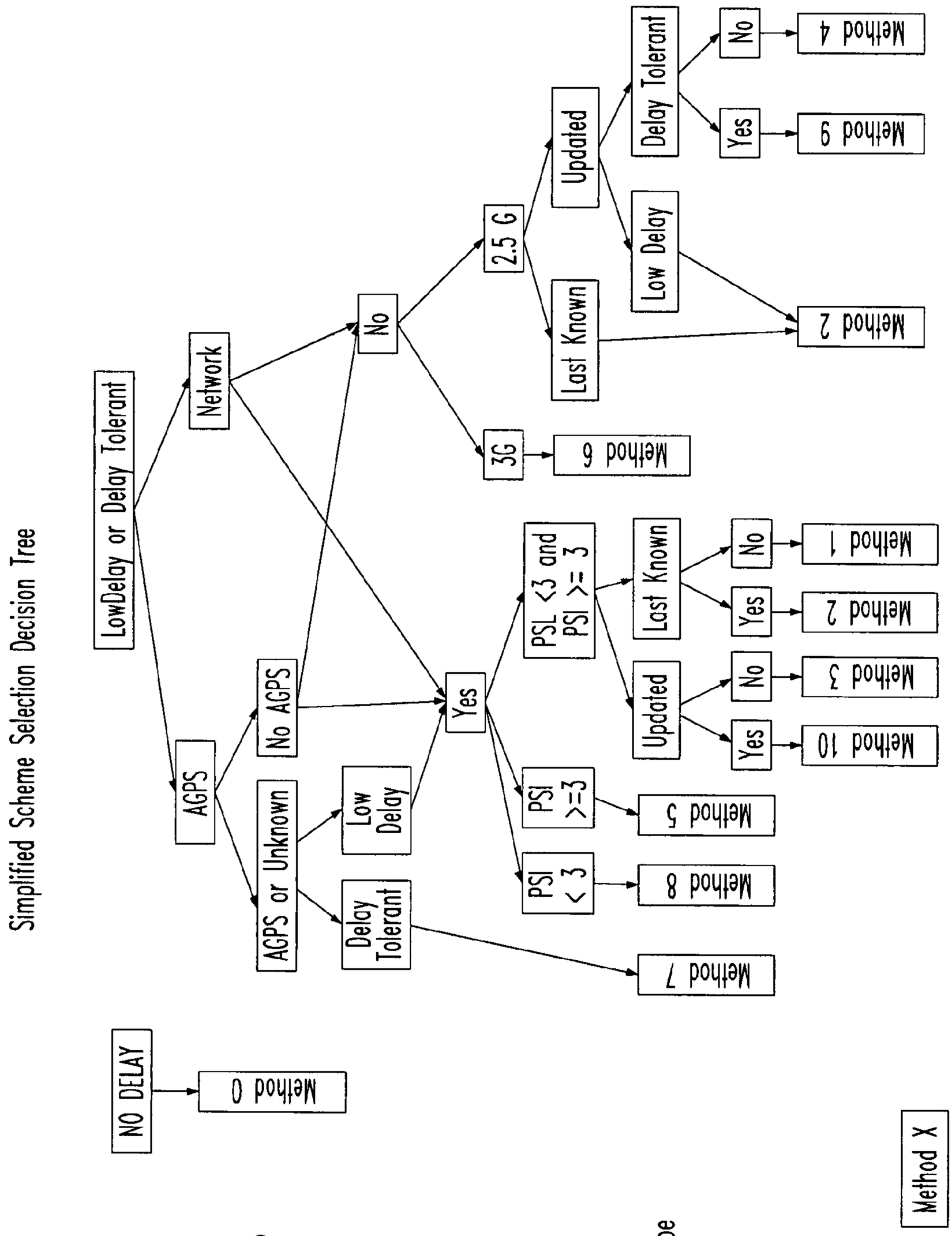
FIG. 14

Method 0	Return Error -- this request cannot be satisfied. If there is an entry in the PositionXLPDB, NetworkCache, return it.
Method 1	MAP_ProvideSubscriberInfo
Method 2	MAP_AnyTimeInterrogation
Method 3	MAP_MT_ForwardShortMessage MAP_ProvideSubscriberInfo
Method 4	MAP_SendRoutingForShortMessage MAP_MT_ForwardShortMessage MAP_ProvideSubscriberInfo
Method 5	MAP_ProvideSubscriberLocation
Method 6	MAP_SendRoutingForLCS MAP_ProvideSubscriberLocation
Method 7	A-GPS
Method 8	If (HomeCarrierNetworkType == 3G) then MAP_SendRoutingForLCS; Else then MAP_SendingRoutingforSM;
Method 9	MAP_SendRoutingForShortMessage MAP_MT_ForwardShortMessage MAP_AnyTimeInterrogation
Method 10	MAP_MT_ForwardShortMessage MAP_AnyTimeInterrogation

FIG. 15

Response Time	This parameter comes from the Usher_TIF_LocationRequest.
Location Method	This parameter comes from the Usher_TIF_LocationRequest.
Terminal Capability	This parameter comes from the Usher_TIF_LocationRequest, but will not be used by H3G at product launch.
Position Request Type	This parameter comes from the Usher_TIF_LocationRequest.
MSC in Cache	This parameter comes from the Position XLPDB, NetworkCache table.
MSC MAP Version Home	This parameter is derived from the MSC message version numbers in the GSMProvDB, MSC table for the provSubLoc (MAP_Provide_Subscriber_Location_message).
Network Type	This parameter comes a configurable in TIF.cfg
MSC Network Type	This parameter comes from the GSMProvDB. First the MSC table is queried for the PLMN ID. Then the PLMN table is queried for Network type. If the Network type is HOME_CARRIER, then the configurable is checked. This is the default network type for the MSC. However, this can be overridden by the following logic: -if the values for the versions of all messages are zero, it is assumed the versioning for this MSC is not provisioned -- the default is used. If version numbers are supplied for at least some of the MAP messages: -if provSubLocVersion >=3, msc network type = 3G. -if 0 < provSubInfoVersion < 3, msc network type = 2G. - else, msc network type = 2.5G.
Roaming	This parameter comes from the GSMProvDB. First the MSC table is queried for the PLMN ID. Then the PLMN table is queried for Network Type. If the Network Type is HOME_CARRIER, roaming is false. If the Network Type is anything other than HOME_CARRIER, Roaming is true. Note that this decision can only be made once the MSC is obtained, that is, after the MAP_SendRoutingInfo_for_SM has been sent.

FIG. 16


Simplified Scheme Selection Decision Tree
Response Time?
NO DELAY
Method 0
Location Method?
LowDelay or Delay Tolerant
Network
No
2.5 G
Updated
Delay Tolerant
No
Method 4
Yes
Method 9
Low Delay
Last Known
Method 2
3G
Method 6
Terminal Capability?
AGPS
No AGPS
AGPS or Unknown
Low Delay
Delay Tolerant
Yes
PSL <3 and PSI >= 3
Last Known
No
Method 1
Yes
Method 2
Updated
No
Method 3
Yes
Method 10
PSI >=3
Method 5
PSI < 3
Method 8
Method 7
Response Time
MSC in Cache?
MSC MAP Version?
Home Network Type
Position Request Type
Response Time
Roaming
Selected Scheme
Method X

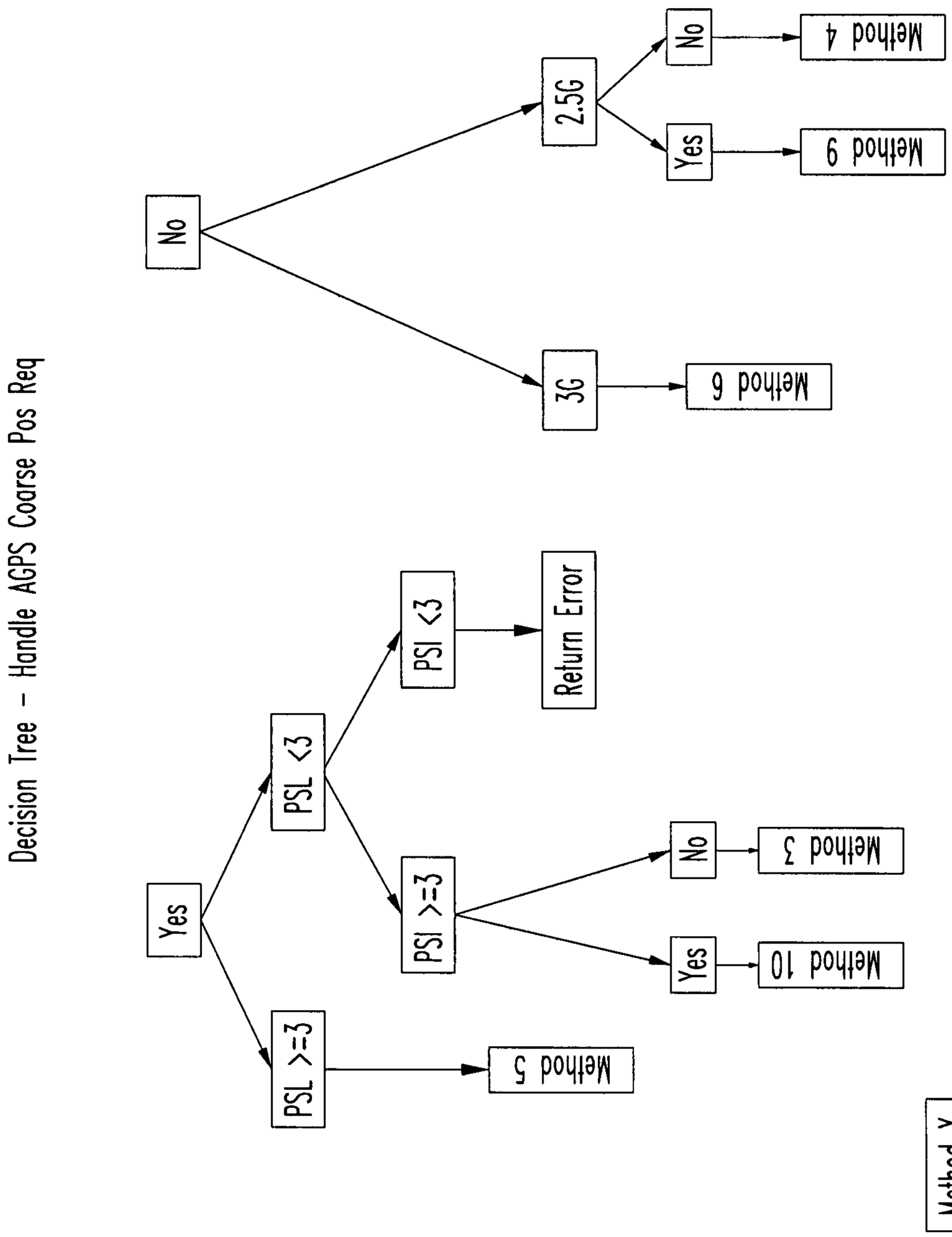
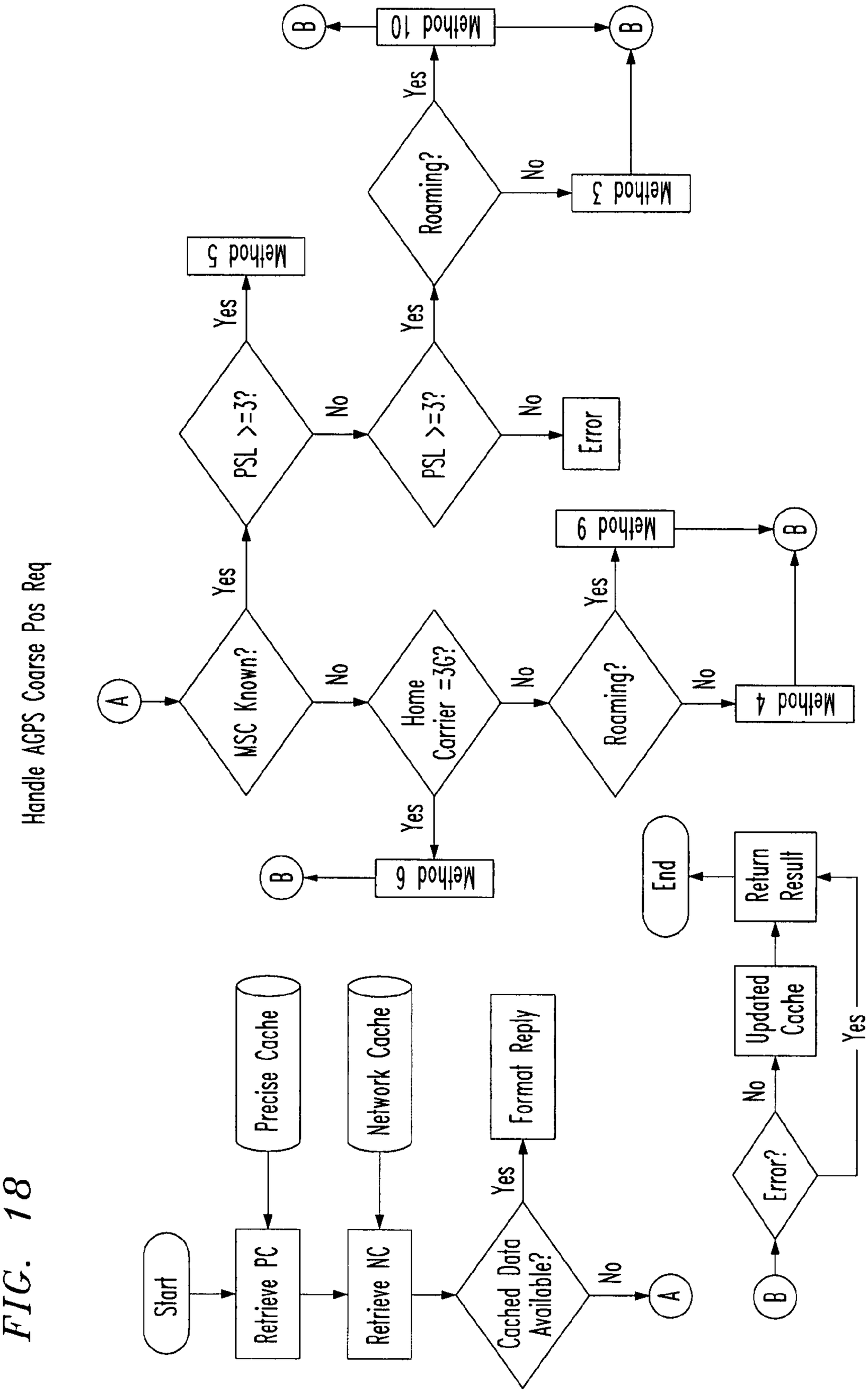

Decision Tree – Handle AGPS Coarse Pos Req
MSC in Cache?
No
2.5G
No
Method 4
Yes
Method 9
3G
Method 6
Yes
PSL <3
PSI <3
Return Error
PSI >=3
No
Method 3
Yes
Method 10
PSL >=3
Method 5
PSL
PSI
Home Network Type
Roaming
Selected Scheme
Method X

FIG. 17

FIG. 18


Start
Retrieve PC
Precise Cache
Retrieve NC
Network Cache
Cached Data Available?
Yes
No
Format Reply
A
Handle AGPS Coarse Pos Req
MSC Known?
Yes
No
PSL >=3?
Yes
No
Method 5
Home Carrier =3G?
Yes
No
Method 6
Roaming?
Yes
No
Method 9
Method 4
Roaming?
Yes
No
Method 3
Method 10
B
Error
End
Return Result
Error?
No
Yes
Updated Cache

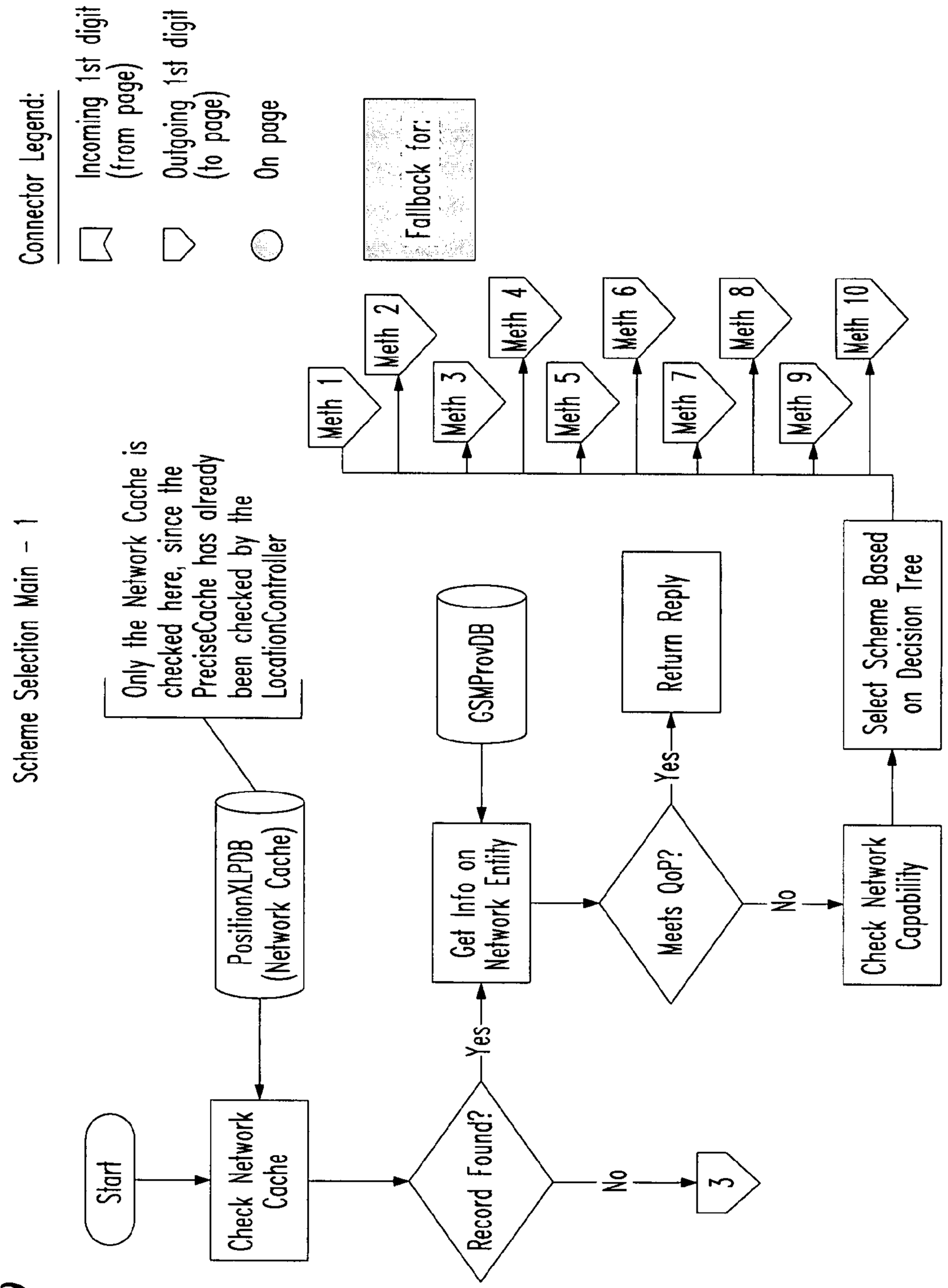

Scheme Selection Main - 1
Connector Legend:
Incoming 1st digit (from page)
Outgoing 1st digit (to page)
On page
Fallback for:
Meth 1
Meth 2
Meth 3
Meth 4
Meth 5
Meth 6
Meth 7
Meth 8
Meth 9
Meth 10
Only the Network Cache is checked here, since the PreciseCache has already been checked by the LocationController
PositionXLPDB (Network Cache)
GSMProvDB
Get Info on Network Entity
Meets QoP?
Yes
Return Reply
No
Check Network Capability
Select Scheme Based on Decision Tree
Start
Check Network Cache
Record Found?
Yes
No
3

FIG. 19

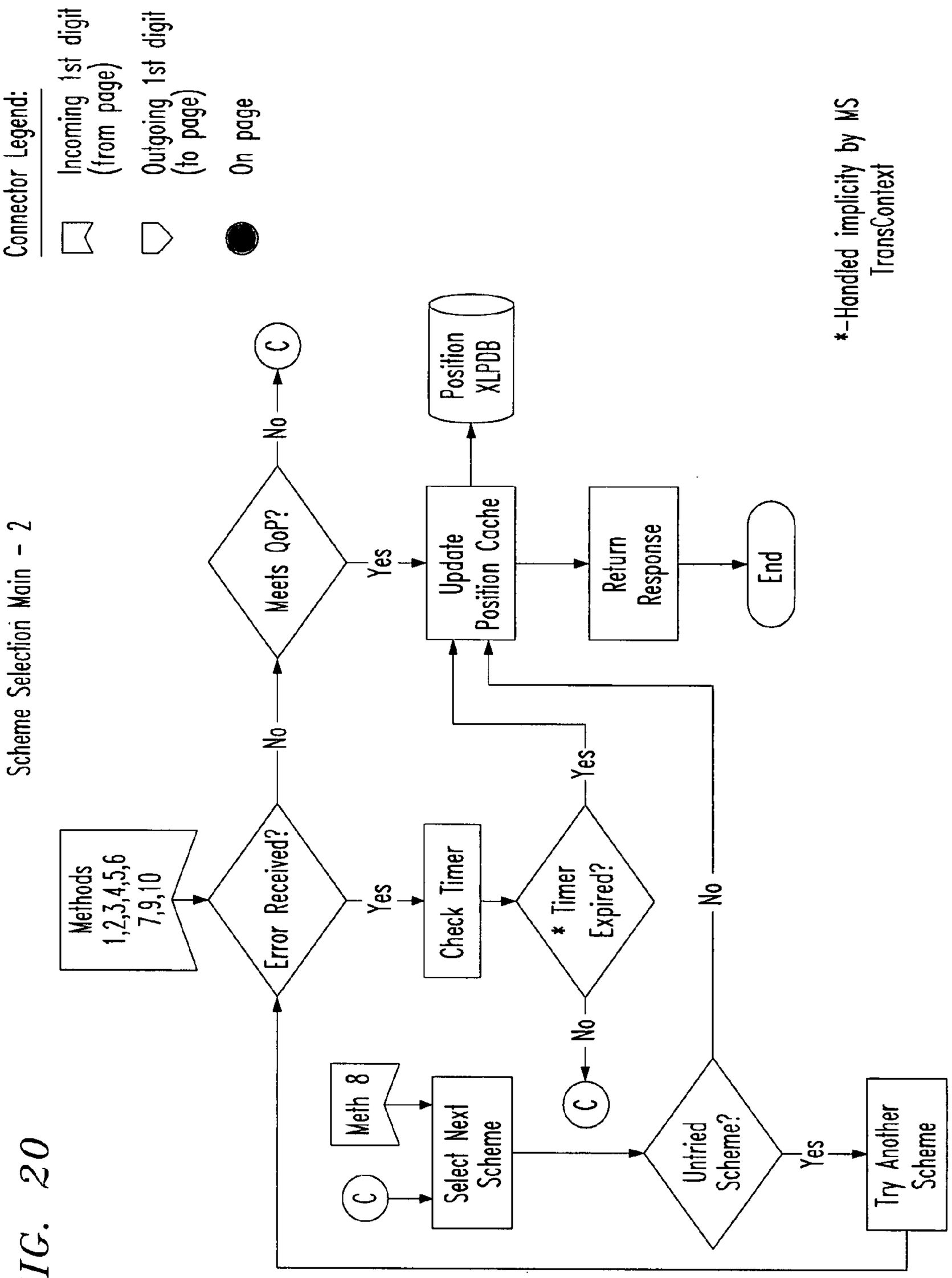

Scheme Selection Main - 2
Connector Legend:
Incoming 1st digit (from page)
Outgoing 1st digit (to page)
On page
Methods 1,2,3,4,5,6 7,9,10
Error Received?
No
Yes
Meets QoP?
No
C
Yes
Update Position Cache
Position XLPDB
Return Response
End
Check Timer
* Timer Expired?
Yes
No
C
No
Meth 8
C
Select Next Scheme
Untried Scheme?
Yes
Try Another Scheme
*-Handled implicity by MS TransContext

FIG. 20

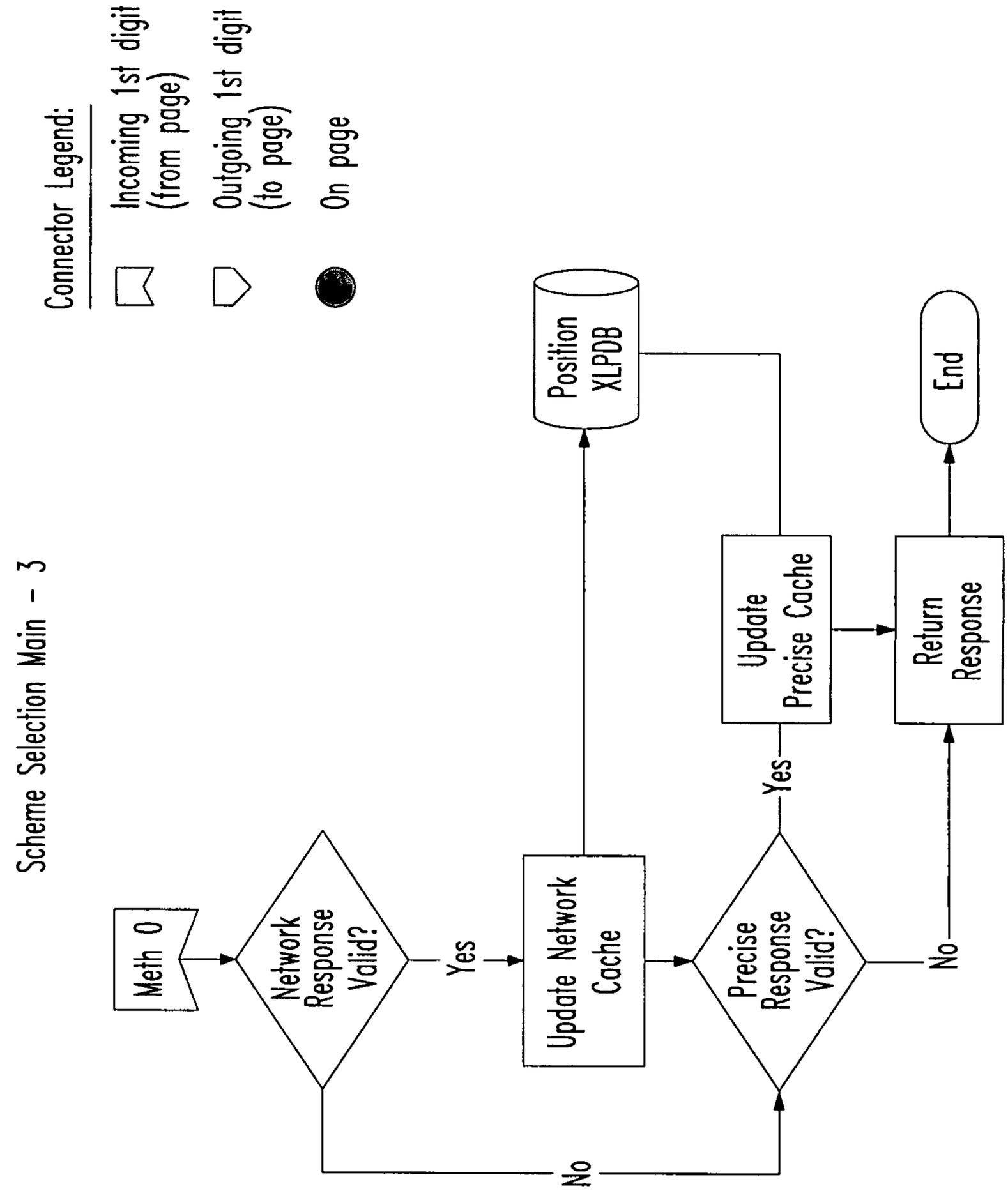

Scheme Selection Main - 3
Connector Legend:
Incoming 1st digit (from page)
Outgoing 1st digit (to page)
On page
Meth 0
Network Response Valid?
Yes
No
Update Network Cache
Position XLPDB
Precise Response Valid?
Yes
No
Update Precise Cache
Return Response
End

FIG. 21

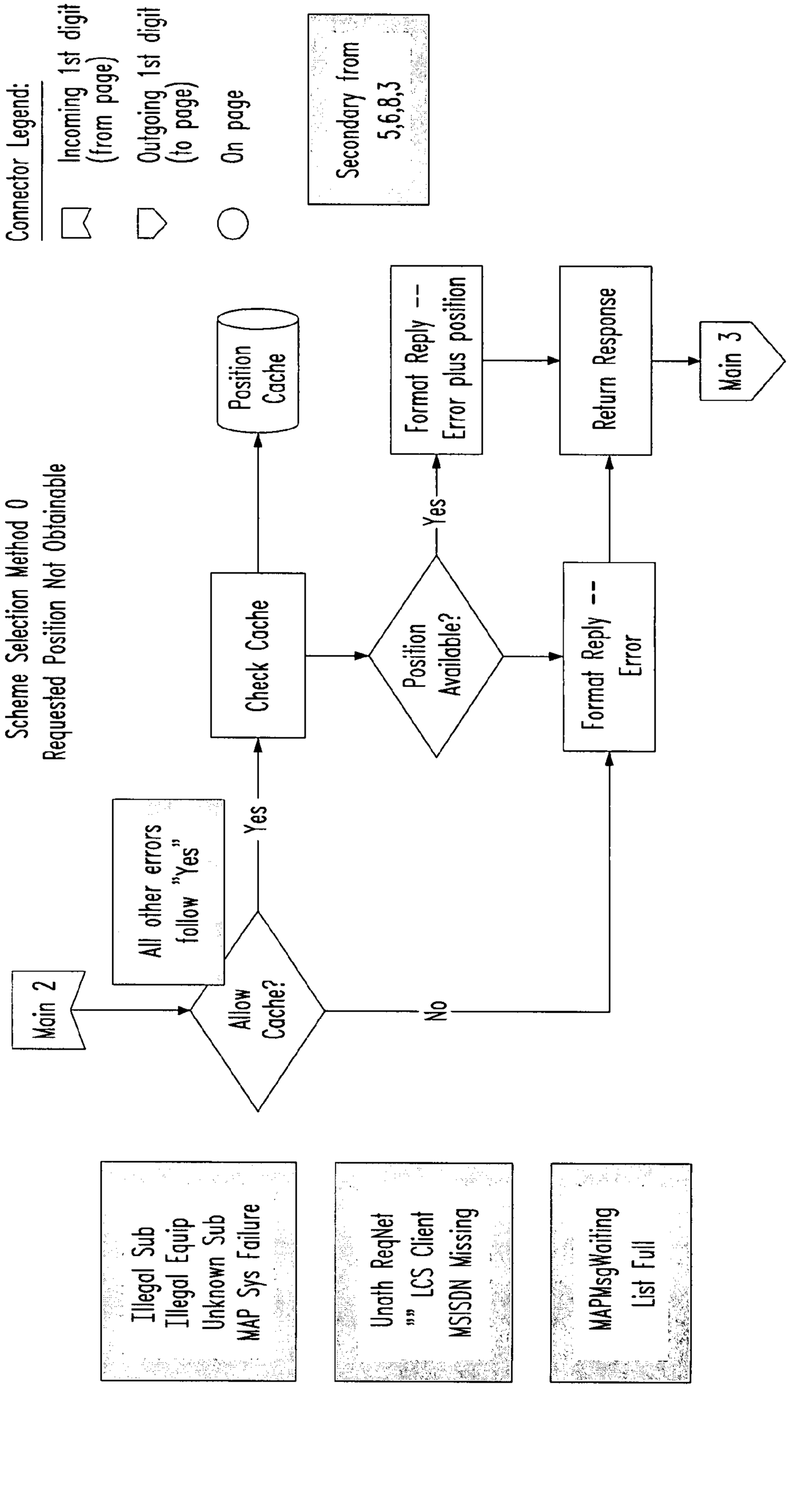

Connector Legend:
Incoming 1st digit (from page)
Outgoing 1st digit (to page)
On page
Secondary from 5,6,8,3
Scheme Selection Method 0
Requested Position Not Obtainable
Main 2
All other errors follow "Yes"
Allow Cache?
No
Yes
Check Cache
Position Cache
Position Available?
Yes
Format Reply -- Error plus position
Format Reply -- Error
Return Response
Main 3
Illegal Sub
Illegal Equip
Unknown Sub
MAP Sys Failure
Unath ReqNet
"" LCS Client
MSISDN Missing
MAPMsgWaiting
List Full

FIG. 22

Scheme Selection Method 1

Cached MSC – Last Known Position – MAP Phase 2+

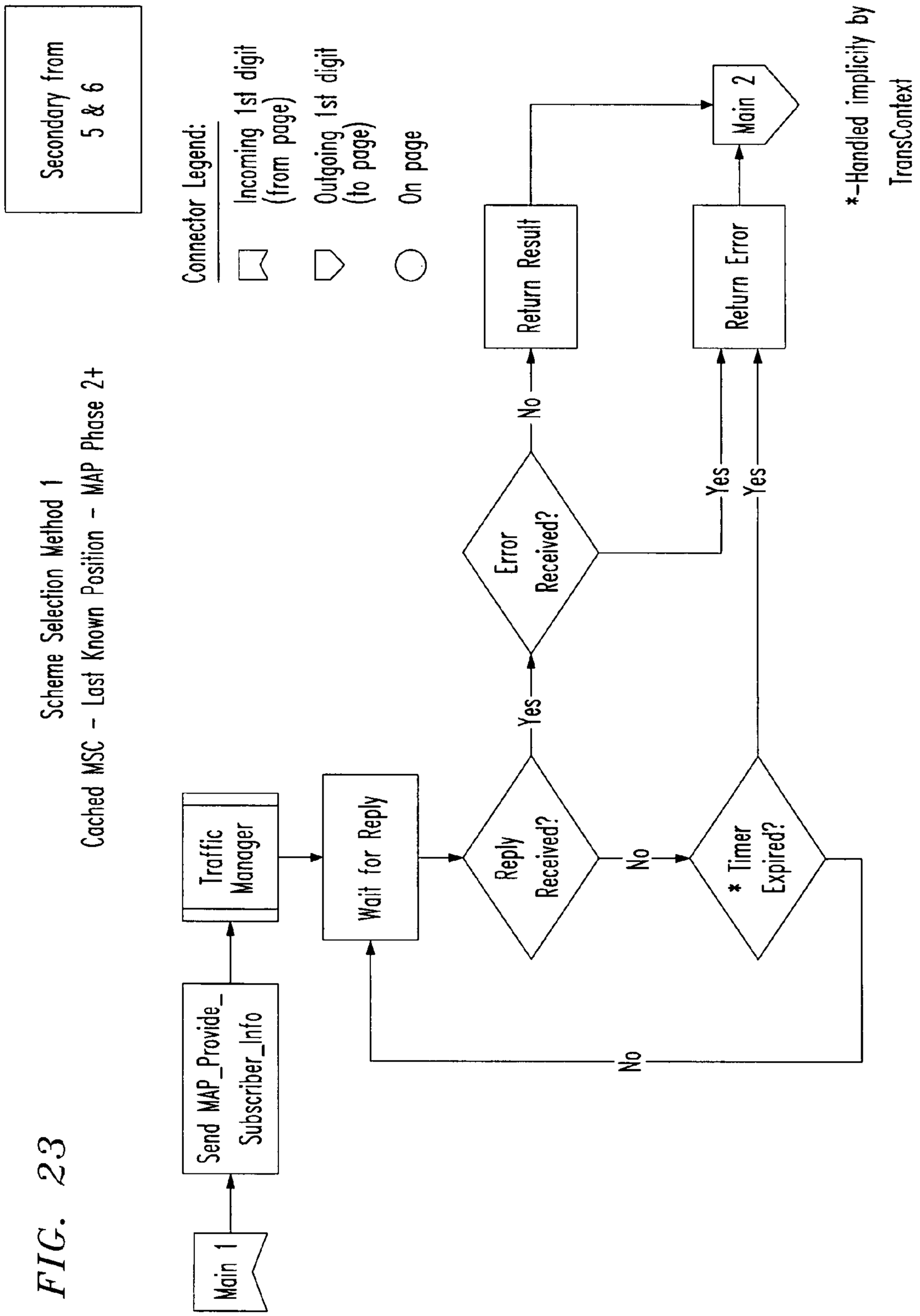


FIG. 23

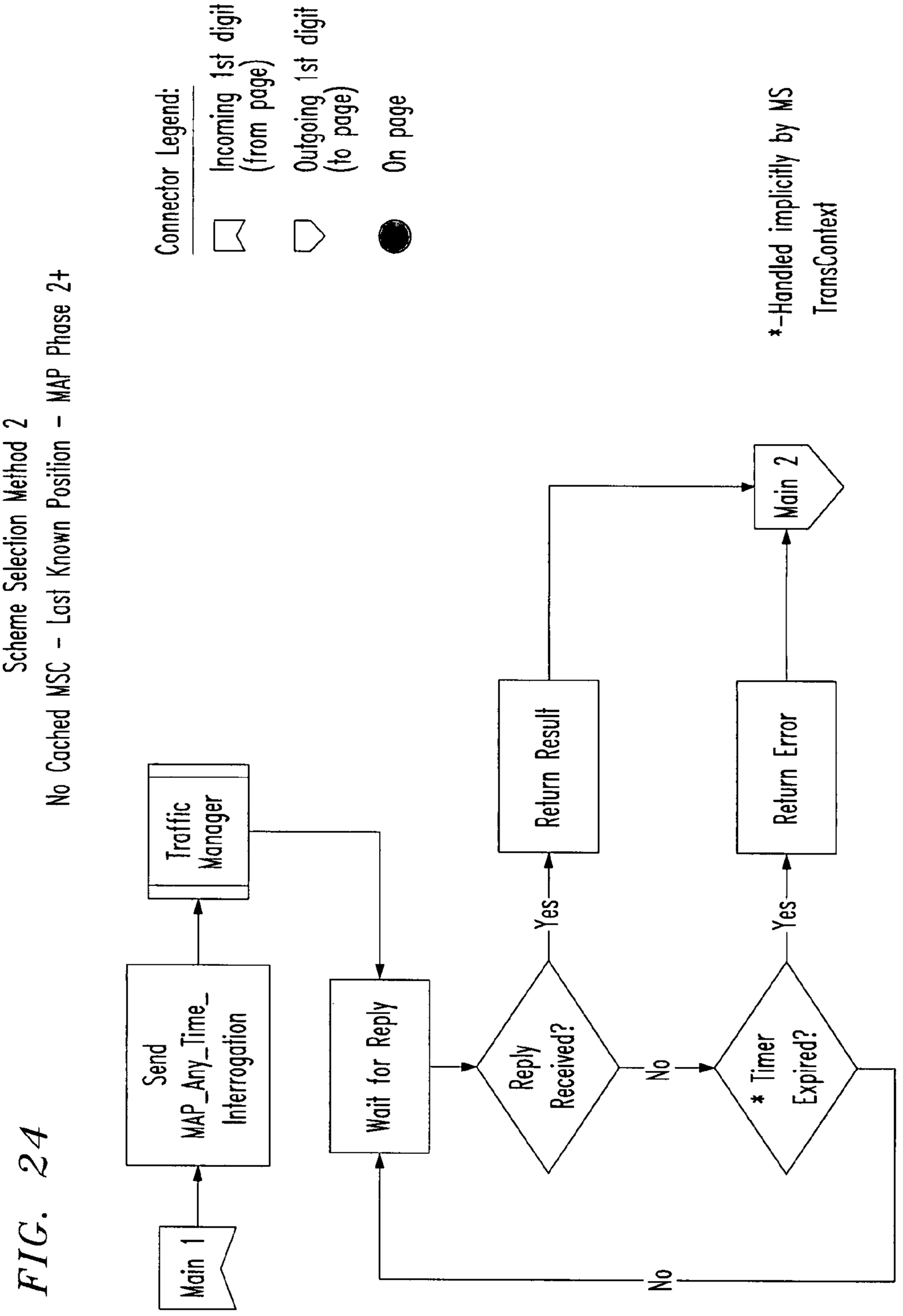

Scheme Selection Method 2
No Cached MSC - Last Known Position - MAP Phase 2+
Connector Legend:
Incoming 1st digit (from page)
Outgoing 1st digit (to page)
On page
*-Handled implicitly by MS TransContext
Main 1
Send MAP_Any_Time_ Interrogation
Traffic Manager
Wait for Reply
Reply Received?
Yes
No
* Timer Expired?
Yes
No
Return Result
Return Error
Main 2

FIG. 24

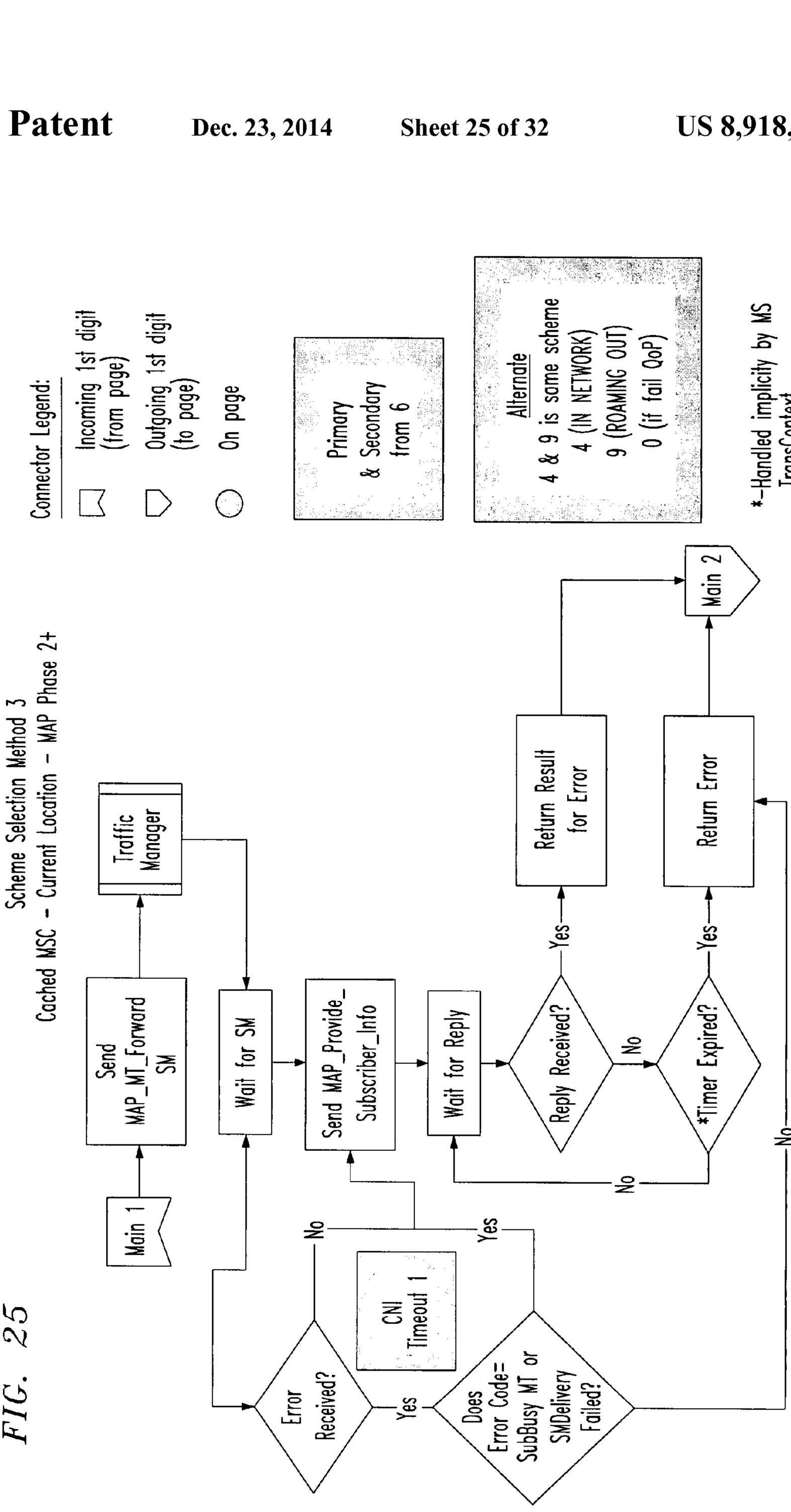

Scheme Selection Method 3
Cached MSC - Current Location - MAP Phase 2+
Connector Legend:
Incoming 1st digit (from page)
Outgoing 1st digit (to page)
On page
Primary & Secondary from 6
Alternate
4 & 9 is same scheme
4 (IN NETWORK)
9 (ROAMING OUT)
0 (if fail QoP)
*-Handled implicitly by MS TransContext
Main 1
Traffic Manager
Send MAP_MT_Forward SM
Wait for SM
Send MAP_Provide_Subscriber_Info
Wait for Reply
Reply Received?
Yes
No
Return Result for Error
*Timer Expired?
Yes
No
Return Error
Main 2
CNI Timeout 1
Error Received?
No
Yes
Does Error Code= SubBusy MT or SMDelivery Failed?
No

FIG. 25

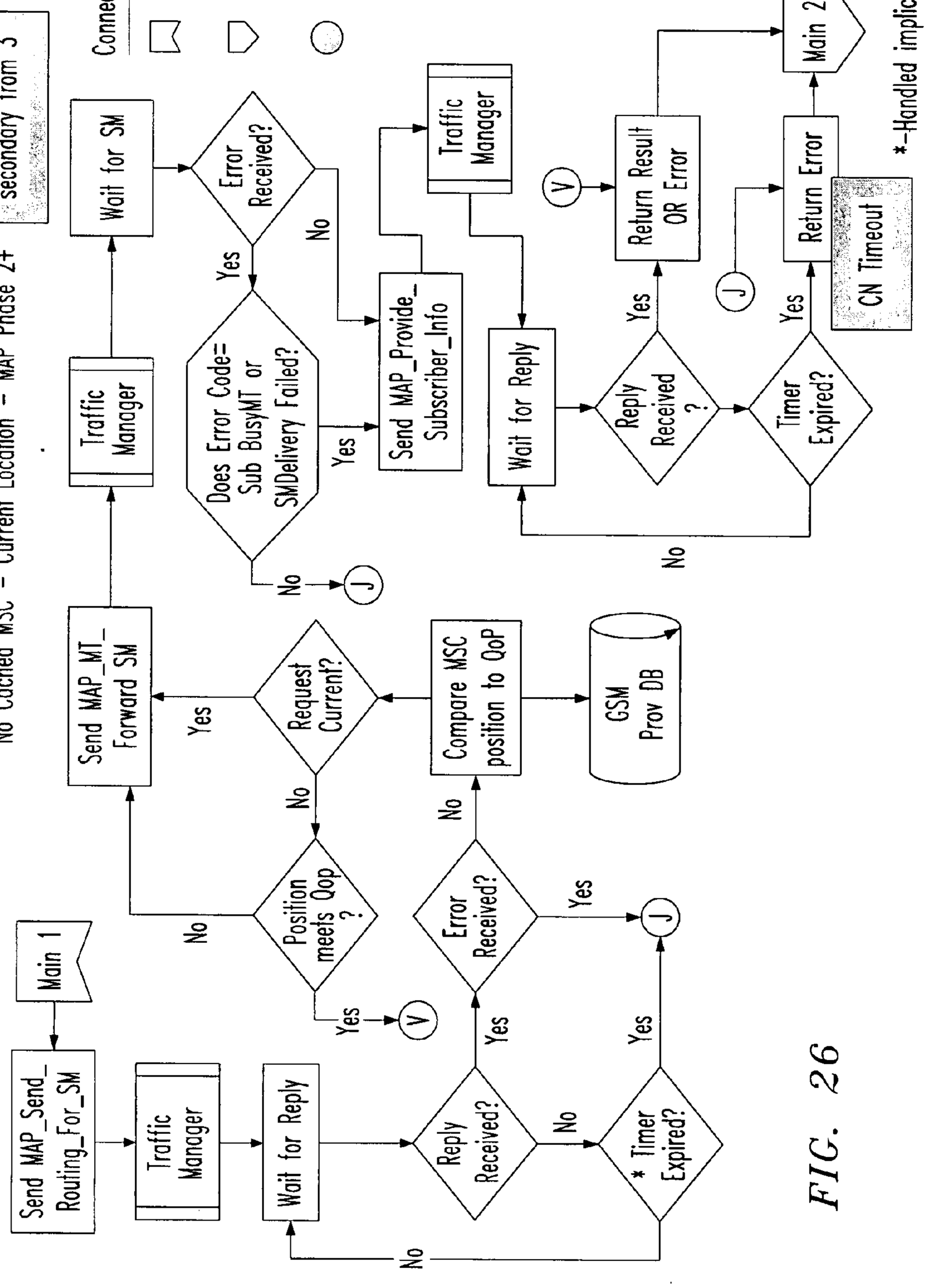

Scheme Selection Method 4
No Cached MSC – Current Location – MAP Phase 2+
Connector Legend:
Incoming 1st digit (from page)
Outgoing 1st digit (to page)
On page
Main 1
Send MAP_Send_ Routing_For_SM
Traffic Manager
Wait for Reply
Reply Received?
No
* Timer Expired?
Yes
Error Received?
Yes
No
Position meets Qop ?
No
Yes
V
J
Send MAP_MT_ Forward SM
Request Current?
Yes
No
Compare MSC position to QoP
GSM Prov DB
Wait for SM
Traffic Manager
Error Received?
Yes
No
Does Error Code= Sub BusyMT or SMDelivery Failed?
Yes
No
J
Send MAP_Provide_ Subscriber_Info
Traffic Manager
Wait for Reply
Reply Received ?
Yes
No
V
Return Result OR Error
Timer Expired?
Yes
No
J
Return Error
CN Timeout
*–Handled implicity by MS TransContext
Main 2
secondary from 3

FIG. 26

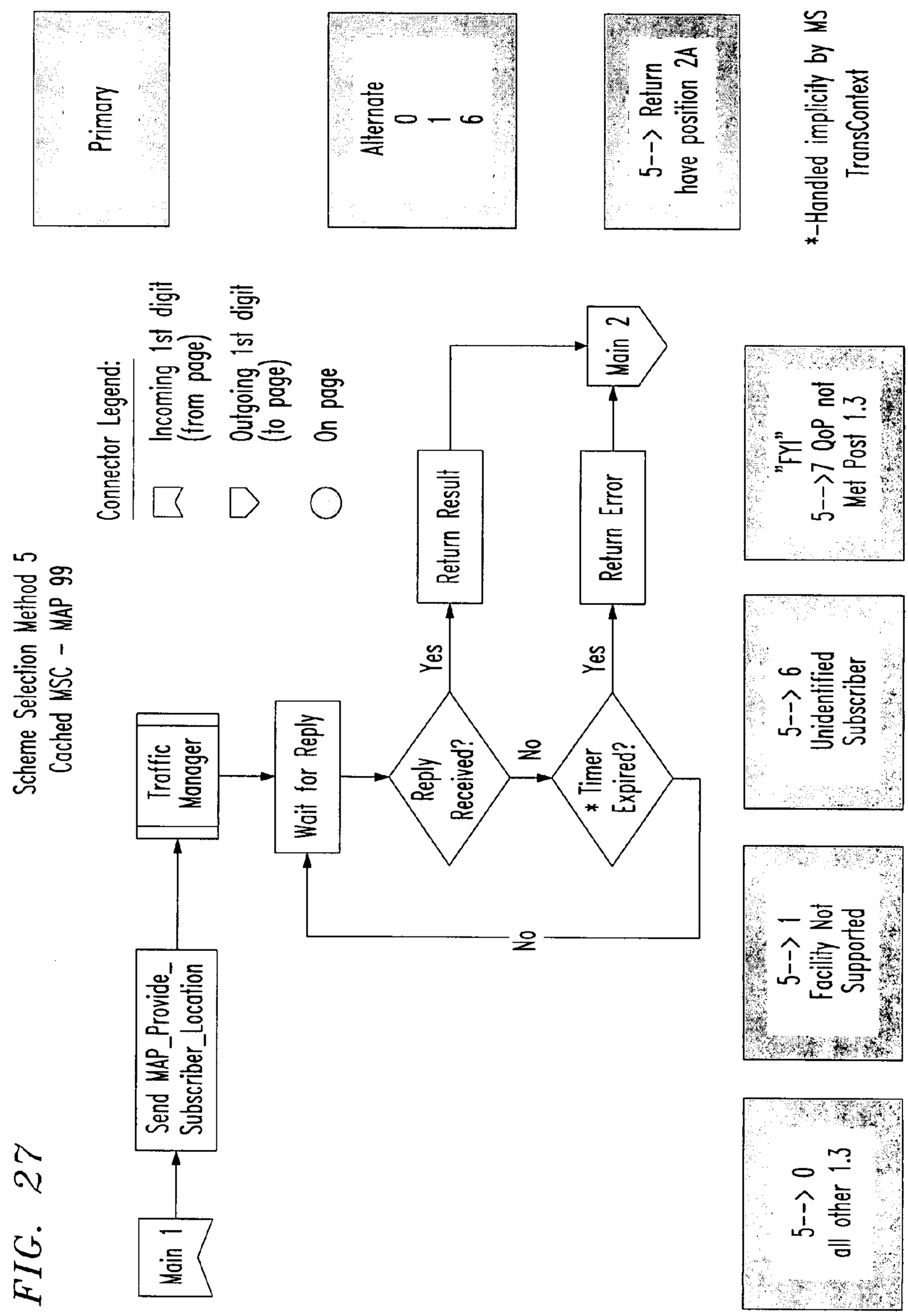

Scheme Selection Method 5
Cached MSC - MAP 99
Connector Legend:
Incoming 1st digit (from page)
Outgoing 1st digit (to page)
On page
Main 1
Send MAP_Provide_Subscriber_Location
Traffic Manager
Wait for Reply
Reply Received?
No
Yes
* Timer Expired?
No
Yes
Return Result
Return Error
Main 2
Primary
Alternate
0
1
6
5--> Return have position 2A
*-Handled implicity by MS TransContext
5--> 6 Unidentified Subscriber
"FYI" 5-->7 QoP not Met Post 1.3
5--> 1 Facility Not Supported
5--> 0 all other 1.3

FIG. 27

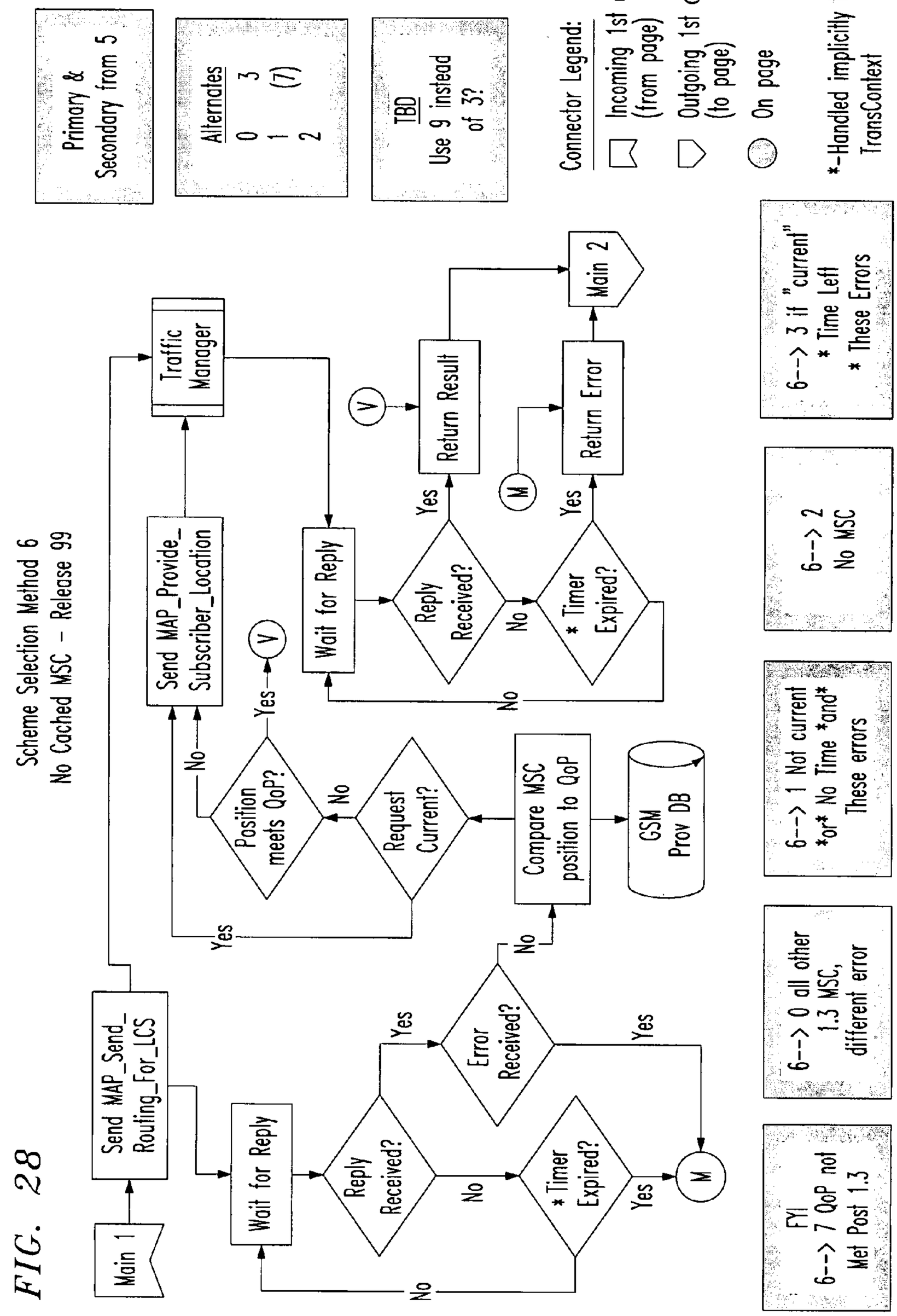

Primary & Secondary from 5
Alternates
0 3
1 (7)
2
TBD
Use 9 instead of 3?
Connector Legend:
Incoming 1st digit (from page)
Outgoing 1st digit (to page)
On page
*-Handled implicitly by MS TransContext
Scheme Selection Method 6
No Cached MSC – Release 99
Traffic Manager
Send MAP_Provide_Subscriber_Location
Wait for Reply
Reply Received?
Yes
No
Return Result
Main 2
* Timer Expired?
Yes
No
Return Error
Position meets QoP?
Yes
No
Request Current?
Yes
No
Compare MSC position to QoP
GSM Prov DB
Send MAP_Send_Routing_For_LCS
Main 1
Wait for Reply
Reply Received?
Yes
No
Error Received?
Yes
No
* Timer Expired?
Yes
No
M
V
M
6--> 3 if "current"
* Time Left
* These Errors
6--> 2
No MSC
6--> 1 Not current
or No Time *and*
These errors
6--> 0 all other
1.3 MSC,
different error
FYI
6--> 7 QoP not
Met Post 1.3

FIG. 28

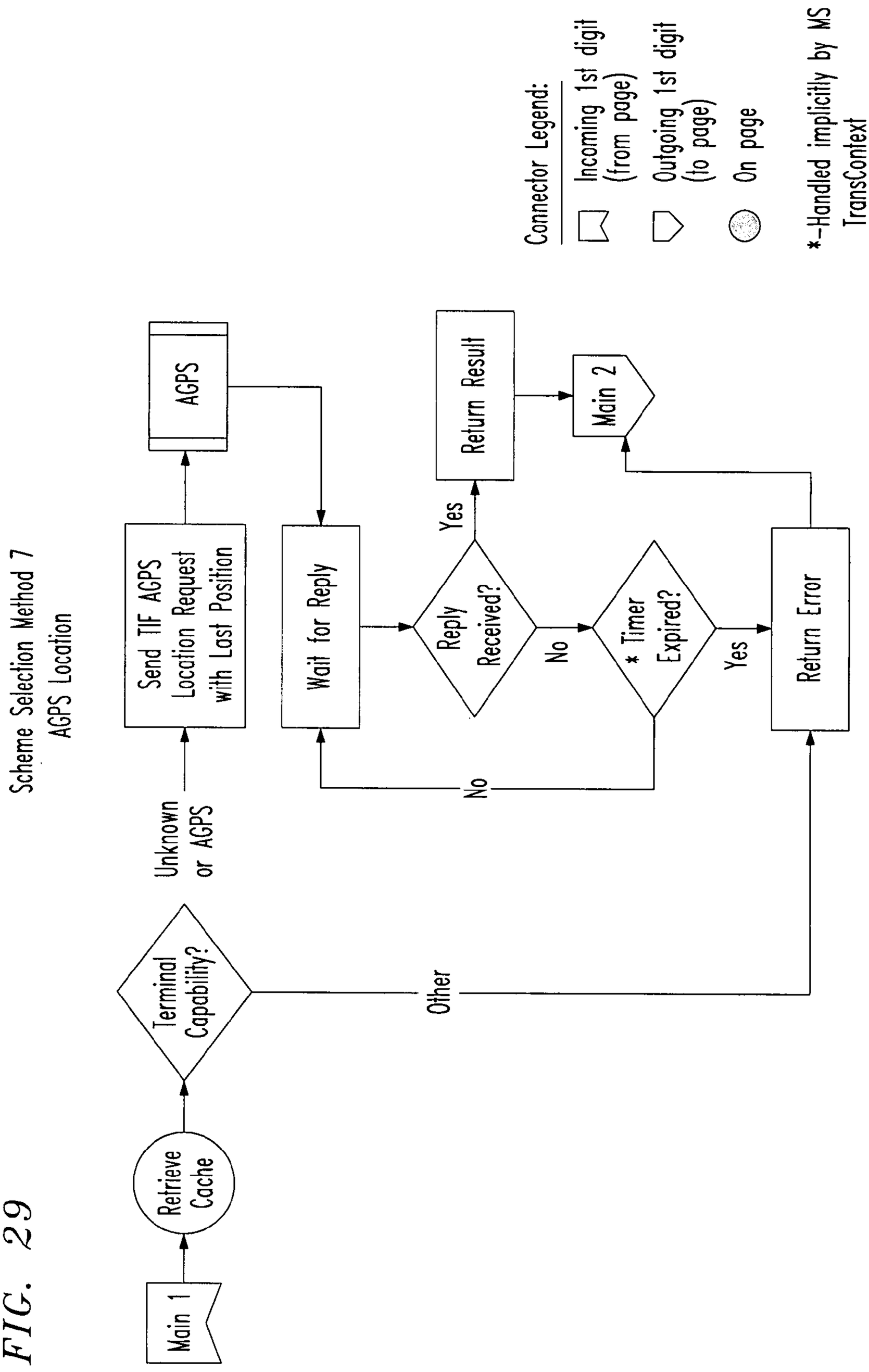

Scheme Selection Method 7
AGPS Location
Connector Legend:
Incoming 1st digit (from page)
Outgoing 1st digit (to page)
On page
*-Handled implicitly by MS TransContext
Main 1
Retrieve Cache
Terminal Capability?
Other
Unknown or AGPS
Send TIF AGPS Location Request with Last Position
AGPS
Wait for Reply
Reply Received?
Yes
No
* Timer Expired?
Yes
No
Return Result
Main 2
Return Error

FIG. 29

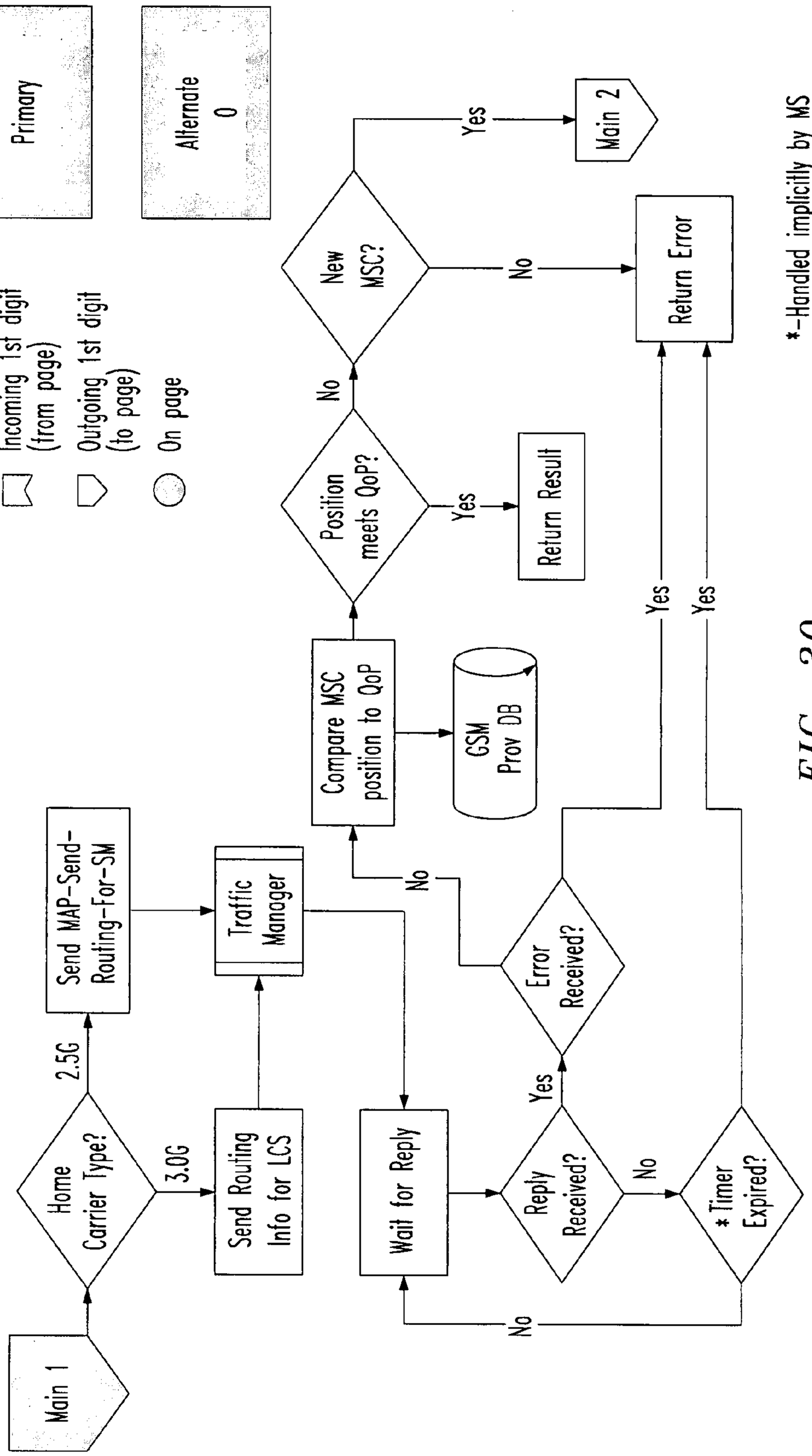

Primary
Alternate 0
Connector Legend:
Incoming 1st digit (from page)
Outgoing 1st digit (to page)
On page
Scheme Selection Method 8
MSC Location
Main 1
Home Carrier Type?
2.5G
3.0G
Send MAP-Send-Routing-For-SM
Send Routing Info for LCS
Traffic Manager
Wait for Reply
Reply Received?
Yes
No
* Timer Expired?
No
Compare MSC position to QoP
GSM Prov DB
Position meets QoP?
Yes
No
Return Result
Error Received?
Yes
Yes
New MSC?
Yes
No
Main 2
Return Error
*-Handled implicitly by MS TransContext

FIG. 30

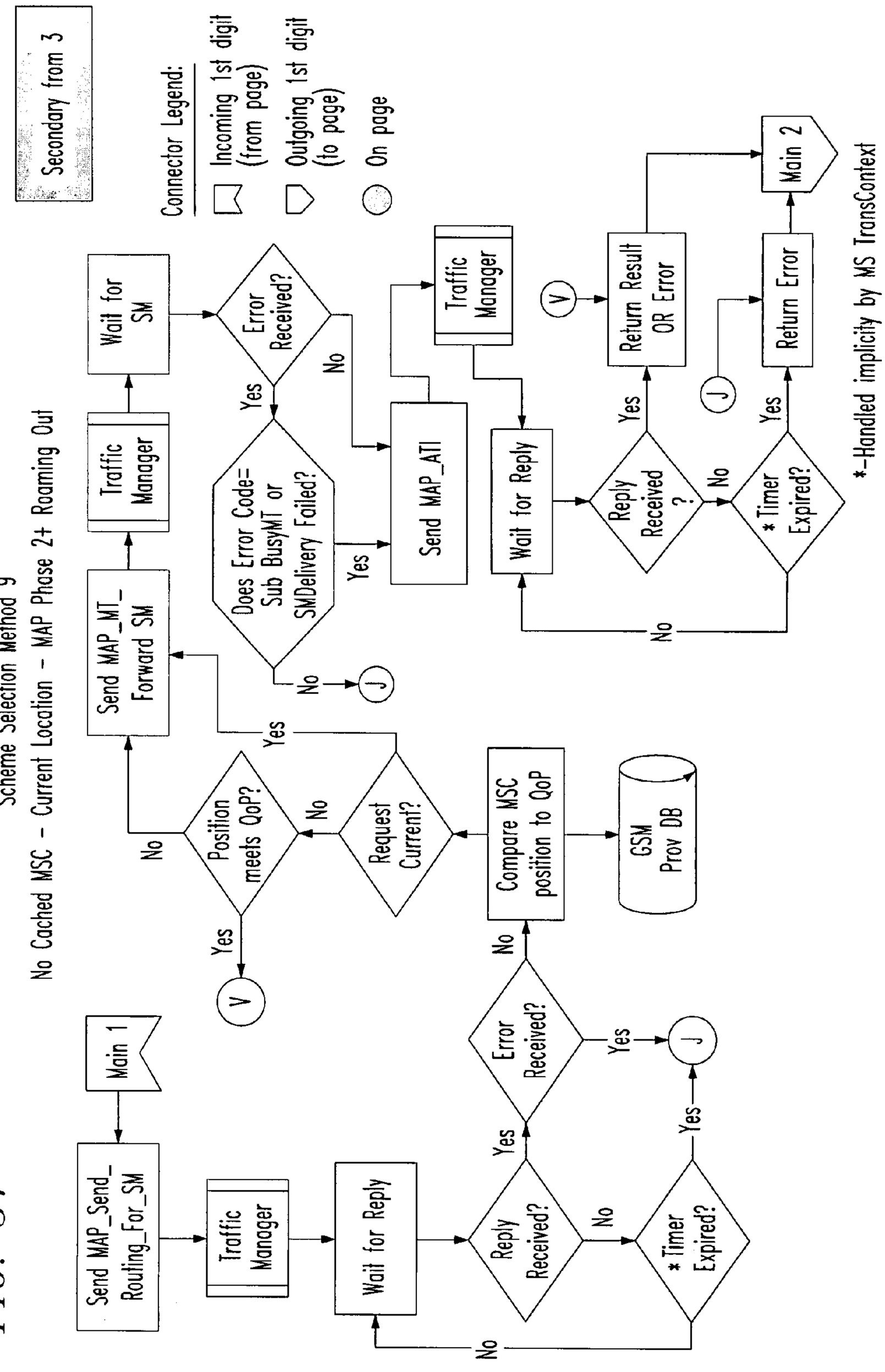

Secondary from 3
Connector Legend:
Incoming 1st digit (from page)
Outgoing 1st digit (to page)
On page
Wait for SM
Error Received?
Yes
No
Traffic Manager
Send MAP_MT_ Forward SM
Traffic Manager
Does Error Code= Sub BusyMT or SMDelivery Failed?
Yes
Send MAP_ATI
No
J
Position meets QoP?
No
Yes
Request Current?
No
Compare MSC position to QoP
GSM Prov DB
No
Yes
V
V
Return Result OR Error
Return Error
Main 2
Wait for Reply
Reply Received ?
Yes
No
* Timer Expired?
Yes
J
No
*-Handled implicity by MS TransContext
Scheme Selection Method 9
No Cached MSC - Current Location - MAP Phase 2+ Roaming Out
Main 1
Send MAP_Send_ Routing_For_SM
Traffic Manager
Wait for Reply
Reply Received?
Yes
No
* Timer Expired?
Yes
No
Error Received?
Yes
J
No

FIG. 31

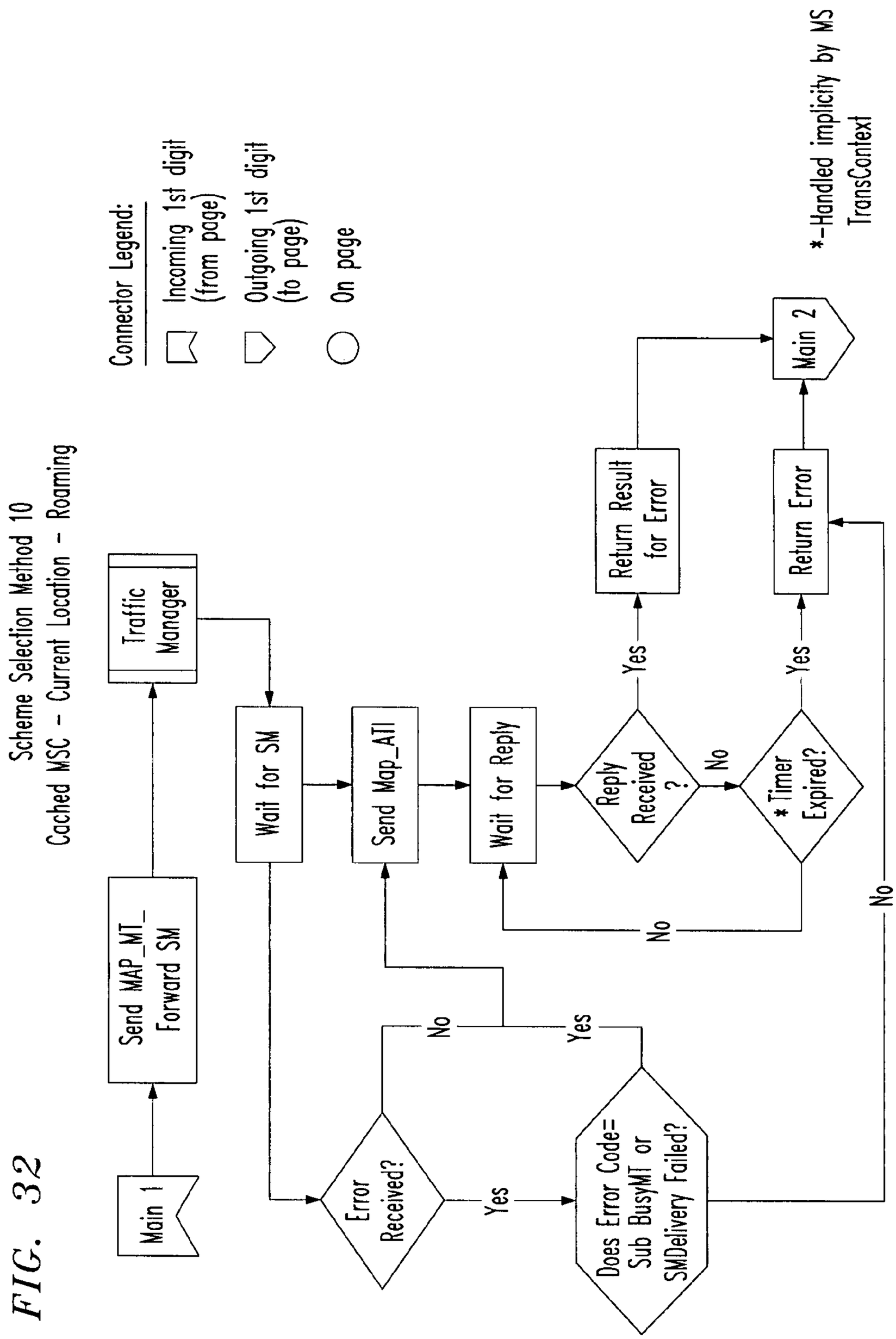

Connector Legend:
Incoming 1st digit (from page)
Outgoing 1st digit (to page)
On page
*-Handled implicity by MS TransContext
Scheme Selection Method 10
Cached MSC - Current Location - Roaming
Main 1
Send MAP_MT_ Forward SM
Traffic Manager
Wait for SM
Send Map_ATI
Wait for Reply
Reply Received ?
Yes
No
Return Result for Error
* Timer Expired?
Yes
No
Return Error
Main 2
Error Received?
No
Yes
Does Error Code= Sub BusyMT or SMDelivery Failed?
Yes
No

FIG. 32

WIRELESS TELECOMMUNICATIONS LOCATION BASED SERVICES SCHEME SELECTION

This application is a continuation-in-part application of U.S. application Ser. No. 10/379,940, filed Mar. 6, 2003, entitled "Wireless Telecommunications Location Based Services Scheme Selection", now U.S. Pat. No. 7,200,380; which is a continuation application of co-pending U.S. application Ser. No. 10/339.403, filed Jan. 10, 2003, entitled "Wireless Telecommunications Location Based Services Scheme Selection"; which in turn claims priority to U.S. Provisional Appl. No. 60/367,707, filed Mar. 28, 2002, entitled "Wireless Telecommunications Location Based Services Scheme Selection" the entirety of which are expressly incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to wireless communication carriers. More particularly, it relates to wireless telecommunications location-based services.

2. Background of Related Art

The position of a wireless client may be used for a variety of different purposes. The position of a mobile client may be provided in response to a request for the same via a wireless network. Position or location of a wireless device (e.g., a cell phone) may be used, e.g., in a vehicle-based navigation system, or to otherwise generally display or inform a requesting party of the position of a particular wireless device.

SUMMARY OF THE INVENTION

In accordance with the principles of the present invention, a method of responding in a wireless network to a location request comprises determining a sensitivity of delay to a response to the location request. Based on the determined sensitivity, a selection is made between a cached last known position of a relevant subscriber, and newly determined position information.

In accordance with another aspect of the present invention, a method of responding in a wireless network to a location request comprises determining a sensitivity of delay to a response to the location request. Based on the determined sensitivity, a selection is made between retrieval of a cached last known position record of a relevant subscriber, if available, and a next untried selection scheme if no current position record has been retrieved.

BRIEF DESCRIPTION OF THE DRAWINGS

Features and advantages of the present invention will become apparent to those skilled in the art from the following description with reference to the drawings, in which:

FIG. **1** shows exemplary network architecture of scheme selection in a location platform, in accordance with the principles of the present invention.

FIG. **2** shows an exemplary scheme selection main process, in accordance with the principles of the present invention.

FIG. **3** shows an exemplary scheme selection decision tree, in accordance with one aspect of the present invention.

FIG. **4** shows a strategy for selecting an alternate scheme for a retry, in accordance with the principles of the present invention.

FIG. **5** shows exemplary scheme selection method 0 wherein a requested position is not obtainable, in accordance with the principles of the present invention.

FIG. **6** shows exemplary scheme selection method 1 wherein a Telecommunication InterFace (TIF) determines that position information was previously cached, in accordance with the principles of the present invention.

FIG. **7** shows exemplary scheme selection method 2 wherein position information of the target user equipment is not available, in accordance with the principles of the present invention.

FIG. **8** shows exemplary scheme selection method 3 wherein position information of a target user equipment is available from a cache database, in accordance with the principles of the present invention.

FIG. **9** shows exemplary scheme selection method 4 wherein no cached position information regarding a target user equipment is available, in accordance with the principles of the present invention.

FIG. **10** shows exemplary scheme selection method 5 wherein position information is available in a cache database, in accordance with the principles of the present invention.

FIG. **11** shows exemplary scheme selection method 6 wherein no cached position information regarding a target subscriber is available, in accordance with the principles of the present invention.

FIG. **12** shows exemplary scheme selection method 7 wherein an Assisted Global Positioning Satellite (AGPS) system mechanism is used to retrieve accurate position information regarding a target user equipment, in accordance with the principles of the present invention.

FIG. **13** shows exemplary scheme selection method 8 wherein cached position information is available, in accordance with the principles of the present invention.

FIG. **14** shows method definitions of another embodiment of the present invention.

FIG. **15** exemplary scheme selection parameters of the embodiment shown in FIG. **14**.

FIG. **16** shows a simplified scheme selection decision tree for the embodiment shown in FIG. **14**.

FIGS. **17** and **18** show an exemplary decision tree for handling an assisted GPS coarse position request.

FIGS. **19-21** show an exemplary main scheme selection routine of the embodiment shown in FIG. **14**.

FIG. **22** shows an exemplary routine for method 0 of the scheme selection where the requested position is not obtainable.

FIG. **23** shows an exemplary routine for method 1 of the scheme selection for cached MSC-last known position-MAP phase 2+.

FIG. **24** shows an exemplary routine for method 2 of the scheme selection for no cached MSC-last known position-MAP phase 2+.

FIG. **25** shows an exemplary routine for method 3 of the scheme selection for cached MSC-current location-MAP phase 2+.

FIG. **26** shows an exemplary routine for method 4 of the scheme selection for no cached MSC-current location-MAP phase 2+.

FIG. **27** shows an exemplary routine for method 5 of the scheme selection for no cached MSC-MAP 99.

FIG. **28** shows an exemplary routine for method 6 of the scheme selection for no cached MSC-release 99.

FIG. **29** shows an exemplary routine for method 7 of the scheme selection for assisted GPS location.

FIG. **30** shows an exemplary routine for method 8 of the scheme selection for MSC location.

FIG. **31** shows an exemplary routine for method 9 of the scheme selection for no cached MSC-current location-MAP phase 2+ roaming out.

FIG. **32** shows an exemplary routine for method 10 of the scheme selection for cached MSC-current location-roaming.

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

The present invention provides an intelligent system that determines the location of a wireless mobile user by choosing selection schemes according to input parameters. The input parameters may include, e.g., a required response time, and/or a requested location method. The selection schemes may also be chosen according to the capabilities of the particular user's mobile device and the wireless network, to the availability of a navigational satellite and/or of a cached position record, to the version number of the utilized software, and/or to whether or not the mobile client is roaming. In the event that repeated tries are necessary, successive selection schemes to be tried are determined, as well as the order in which the selection schemes are to be tried.

A process according to another aspect of the present invention includes retrieving a last known position record from a cache, checking the capabilities of a serving network, and choosing an initial selection scheme according to parameters. The parameters preferably include at a minimum a required response time and a requested location method. The requested location method may include a method employing a navigational satellite.

Yet another process in accordance with another aspect of the present invention includes attempting to retrieve a current position record by an initial selection scheme. If no current position record is retrieved, successive untried selection schemes are tried in turn according to a predetermined algorithm until a current position record is returned. The last known position record is updated, or an error is returned if a current position record has not been retrieved. The last known position record is returned if an error has been returned, if the last known position record exists in the cache, and the last known position record has not expired.

In a wireless network, there are potentially several messages (e.g., Signaling System No. 7 (SS7)) messages which can be used to request and thereby obtain a subscriber's location. The particular process used to obtain the location is referred to herein as "scheme selection".

Scheme selection in accordance with the principles of the present invention determines which of a plurality of possible messages to send, as well as a preferred order in which to send them, particularly when a message fails to result in obtaining a subscriber's location.

A location services platform scheme selection service in accordance with the principles of the present invention makes an intelligent choice between multiple possible SS7 messages used to obtain a subscriber's location. In the disclosed embodiments, the choice is preferably based upon a combination of location request parameters, e.g., the subscriber's equipment capabilities, the network type, and/or the capabilities of the network.

The present invention may be implemented in any suitable location service platform.

FIG. **1** shows exemplary network architecture for scheme selection in a location platform, in accordance with the principles of the present invention.

In FIG. **1**, a location platform (XLP) location server **100** includes a Telecommunication InterFace (TIF) **102**, an Assisted Global Positioning Satellite (Assisted GPS, or AGPS) unit **104**, a location manager **106** and an Operations Support System (OSS) **108**. The OSS **108** further includes system configuration means **110** with a Command Line Interface/Telnet interface **112**, Transaction Detail Records (TDRs) **114**, a performance and fault module **116**, Cell Data **118**, Public Land Mobile Network (PLMN) database **120** and service configuration means **122**. TIF **102** is connected to Home Location Register (HLR) **124** and Mobile Switch Center (MSC) **126**, and Assisted GPS **104** is connected to Serving GPRS Support Node (SGSN) **128** and Push Proxy Gateway (PPG) **130** and GPS reference network **132**. Carrier network elements **134** are connected to XLP **100**, and both carrier network elements **134** and PPG **130** are connected to User Equipment **136**. Billing means **138** are connected to Transaction Detail Records (TDRs) **114**. Message Oriented Middleware (MOM) **140** is connected to performance and fault module **116**. Service configuration means **122** are configured to be accessed by a web browser **142** or by batch means **144**. XLP **100** is also connected via OSA (Open Services Architecture) gateway **146** and adapter **148** to bus **150**, which in turn is connected to Location Enterprise Application (LEA) **152**.

A plurality of methods may be implemented. In one disclosed embodiment, a Xypoint™ Location Platform (XLP) Telecommunication InterFace (TIF) scheme selection function is responsible for deciding which method should be used when the XLP receives a location service request from a location application, based on the parameters of the request, and the capabilities of core network components. In addition, if a method fails, the Telecommunication InterFace (TIF) scheme selection function may also decide whether another method should be triggered, or if an error should instead be reported.

Once a method is selected, a sequence of MAP messages may be initiated by the Telecommunication InterFace (TIF) to the core network, and responses from the core network may be processed by the TIF as well, or Assisted GPS related messages will be exchanged between the XLP and the core network.

Preferably, the Home Location Register (HLR)s will support 3rd Generation Partnership Project (3GPP) Release 99 version of the Mobile Application Part (MAP). In the disclosed embodiments, the XLP uses only the Release 99 MAP version to communicate with the Home Location Register (HLR). It is assumed for the purposes of the enclosed embodiments that other network components (e.g., of roaming partners) may be compliant with MAP version 1, MAP version 2 or MAP version 3 for Phase 2+.

Location Request

Table 1 shows exemplary parameters that may be provided by an Immediate Request. The parameters are preferably passed through an Open Services Architecture (OSA) interface.

TABLE 1

Parameters of location request

Parameter name	Notes
Priority	NORMAL or HIGH
Accuracy	Unsigned Long (radius in meters)
Type	CURRENT, CURRENT_OR_LAST_KNOWN, or INITIAL.
ResponseTime	NO_DELAY, return initial or last known; LOW_DELAY, attempt update but return best available within time constraint;

TABLE 1-continued

Parameters of location request	
Parameter name	Notes
	DELAY_TOLERANT, get updated value; USE_TIMER_VALUE, get current position within response time requirement.
AltitudeRequested	Altitude request flag.
RequestedLocation	Network = default or AGPS
Method	
Timer	Time in seconds to respond used for USE_TIMER_VALUE responseTime.

Main Process of Scheme Selection

FIG. **2** shows an exemplary scheme selection main process, in accordance with the principles of the present invention.

In particular, when receiving a location request, the Telecommunication InterFace (TIF) **102** starts a timer in step **402**. The timer value is either indicated by the received request, or is set to a default value when a timer value is not provided. Based on the target subscriber identifier, Mobile Station ISDN (MSISDN), the Telecommunication InterFace (TIF) **102** checks the Position Cache database **403** in step **404** and determines whether a position record exists in step **406**. If a position record exists, the Telecommunication InterFace (TIF) **102** then retrieves the record in step **408** and checks the serving network (meaning Mobile Switch Center (MSC) or Serving GPRS Support Node (SGSN)) capability in step **410** from a pre-provisioned Public Land Mobile Network (PLMN) database **120**.

With all this information, including the request parameters and potential network capability, the Telecommunication InterFace (TIF) **102** uses the logic defined in FIG. **3** to select a method to retrieve the position information from the core network in step **412**. FIG. **4** also shows the mechanism for possible retry once a method fails. FIGS. **3** and **4** will be discussed a bit further down.

In step **418** it is determined whether a position has been obtained, and if so, then the method proceeds to step **416** or if not, then in step **420** the timer is checked. In step **422**, it is determined whether the timer has expired, and if not, then the next selection scheme is selected in step **424**. In step **426** it is determined whether the selected scheme has been tried before, and if the scheme is untried, then in step **428** the selected scheme is tried, and then the method returns to step **418**.

In a successful scenario, including the case with several retries, the Telecommunication InterFace (TIF) **102** will return the retrieved position information to the OSA (Open Services Architecture) interface in step **414**, which passes to the location application. At the same time, the Telecommunication InterFace (TIF) **102** also updates the Position Cache database **403** in step **416**.

In an unsuccessful scenario, in step **411** the Telecommunication InterFace (TIF) **102** will return the last known position information retrieved from the Position Cache database **403** with an error, or just an error if no cached location information is available (or the information expires).

Exemplary Scenarios

The following methods have been defined as exemplary schemes for an XLP to use to retrieve location information, either from a core network or locally from a cache database of the XLP.

Method 0: Requested position not obtainable, existing information from the cache database, if it is not expired, will be returned if available.

Method 1: Use MAP_Provide_Subscriber_Info and cached MSC-number to retrieve the requested position information.

Method 2: Use MAP_Any_Time_Interrogation to retrieve the requested position information.

Method 3: Use Mobile Terminated (MT) Short Message (refresh location information), MAP_Provide_Subscribe_Info and cached MSC-number (Mobile Switch Center-number) to retrieve the requested position information. (Phase 2+)

Method 4: When a cached MSC is not available, use MAP_Send_Rou8ting_For_S_M to the HLR to obtain the MSC number. Then, use the mobile terminated (MT) short message to refresh location information filled by the MAP_Provide_Subscriber_Info.

Method 5: Use MAP_Provide_Subscriber_Location and cached MSC-number to retrieve the requested position information. (Release 99)

Method 6: When a cached MSC is not available, use MAP_Send_Routing for LCS to obtain the MSC number, then use MAP_Provide_Subscriber_Location to retrieve the requested position information. (Release 99)

Method 7: Use Assisted GPS (AGPS) to retrieve the requested position information. (Release 99).

Method 8: Use MAP_Send_Routing_Info_For_SM to retrieve the current MSC-number when no cached MSC-number is available.

Detailed Scheme Selection

FIG. **3** shows an exemplary scheme selection decision tree, in accordance with one aspect of the present invention.

If No Delay is required, then AGPS and core network requests are not possible, and the Method 0 is selected in step **200**.

Alternatively, if Low Delay is required, then in step **201** only core network methods are selected. In step **211** the internal database **403** is queried to determine whether location information of the target subscriber is cached in the database **403**. If the location information is not cached in the database **403**, then in step **212** Method 6 is selected. If the location information is cached in the database **403**, then in step **214** the MAP version is determined. If the MAP version is Release 99, then in step **220** Method 5 is selected. If the MAP version is 2+, then in step **218** it is determined whether the position request type is Updated. If the position request type is Updated, then in step **226** Method 3 is selected. If not, then in step **228** it is determined whether or not Roaming applies. If the mobile is roaming, then Method 9 is selected in step **230**, and if not, then in step **232** Method 1 is selected. If the MAP version is other than 2+ or Release 99, then in step **216** it is determined whether the position request type is Updated. If so, then in step **222** Method 8 is selected, and if not, then in step **224** Method 0 is selected.

Similarly, if the Response Time is Delay Tolerant, then in step **233** either AGPS or Network is selected according to the requested Location Method. If AGPS was requested, then in step **234** the terminal capability is determined, and if the terminal is capable of AGPS or unknown, then in step **238** Method 7 is selected. If either Network was selected in step **233**, or it was determined that the terminal capability did not include AGPS in step **234**, then in step **240** the internal database **403** is queried to determine whether location information of the target subscriber is cached in the database **403**. If the location information is not cached in the database **403**, then in step **241** Method 6 is selected. If the location information is cached in the database **403**, then in step **242** the MAP version is determined. If the MAP version is Release 99, then in step **256** Method 5 is selected. If the MAP version

is 2+, then in step **244** it is determined whether the position request type is Updated. If the position request type is Updated, then in step **248** Method 3 is selected. If not, then in step **250** it is determined whether or not Roaming applies. If the mobile is not roaming, then Method 4 is selected in step **252**, and if not, then in step **254** Method 1 is selected. If the MAP version is other than 2+ or Release 99, then in step **243** it is determined whether the position request type is Updated. If so, then in step **246** Method 8 is selected, and if not, then in step **247** Method 0 is selected.

As discussed above, FIG. **3** presents a key concept of scheme selection. When receiving a location request the location application, firstly the Telecommunication InterFace (TIF) **102** examines the requesting parameters. Based on Accuracy and RequestedLocationMethod, the TIF **102** decides if Assisted GPS (AGPS) method (Method 7) should be used. Note that the ResponseTime and the request Type are taken into account for the decision as well, e.g. if NO-DELAY is required then the Assisted GPS (AGPS) method is not possible. If the AGPS method is not possible, or the request asks for a non-AGPS method, e.g. if RequestLocationMethod=Network, then the Telecommunication InterFace (TIF) **102** queries the internal database **403** to see if location information of the target subscriber is cached in the database **403**. Note that the location information of a certain subscriber includes the serving Mobile Switch Center (MSC)/Serving GPRS Support Node (SGSN) number, and supported Mobile Application Part (MAP) version etc. Based on the MAP version and other request parameters, the Telecommunication InterFace (TIF) **102** will decide which method should be used for the request.

If there is no location information record of target User Equipment, Telecommunication InterFace (TIF) **102** will trigger Method 6 to retrieve the serving Mobile Switch Center (MSC)/Serving GPRS Support Node (SGSN) information, and assume the serving Mobile Switch Center (MSC)/Serving GPRS Support Node (SGSN) supports Release 99 Mobile Application Part (MAP) version.

Upon a failure of a certain selected method, the Telecommunication InterFace (TIF) **102** will try a different method as long as the timer for this location request transaction has not yet expired, or until a user_specified number of retries have been executed, or until no more reasonable retries remain.

FIG. **4** shows a strategy for selecting an alternate scheme for a retry, in accordance with the principles of the present invention.

In particular, as shown in FIG. **4**, if the original method employed in step **300** is method 5, then successive attempts may employ, e.g., method 6 in step **310**, method 1 in step **320**, and method 7 in step **330**. If the original method is method 1 in step **340**, successive attempts may employ method 2 in step **350** and method 8 in step **360**. If the original method is method 3 in step **370**, successive attempts may employ method 4 in step **380** and method 7 in step **390**.

Method 0

FIG. **5** shows exemplary scheme selection method 0 wherein a requested position is not obtainable, in accordance with the principles of the present invention.

In particular, FIG. **5** shows the detailed procedure of method 0. Method 0 is used in the case that the requested position is not obtainable.

In step **502** the position cache database **403** is checked and in step **504** it is determined whether a position is available. If a position is available, then in step **506** a reply is formatted including an error plus a position and in step **510** a response is returned. If no position is available, then in step **508** a reply is formatted including only an error signal, and in step **510** the response is returned.

Method 1

FIG. **6** shows exemplary scheme selection method 1 wherein the Telecommunication InterFace (TIF) **102** determines that the position information was previously cached, in accordance with the principles of the present invention.

In particular, FIG. **6** shows the detailed procedure of method 1, which is used in the case that the Telecommunication InterFace (TIF) **102** determinates that the position information was cached before, and the serving Mobile Switch Center (MSC)/Serving GPRS Support Node (SGSN) supports the Mobile Application Part (MAP) version defined for Phase 2+.

In step **602** a signal MAP_Provide_Subscriber_Info is sent to a Traffic Manager **603**, and in step **604** the TIF **102** waits for a reply. In step **606** it is determined whether a reply has been received by TIF **102**, and if a reply has been received a result is returned in step **608**. If no reply has been received, it is determined in step **610** whether the timer has expired, and if the timer has expired, then an error is returned in step **612**. If the timer has not expired, then the method returns to step **604**.

Method 2

FIG. **7** shows exemplary scheme selection method 2 wherein the position information of the target User Equipment is not available, in accordance with the principles of the present invention.

In particular, FIG. **7** shows the details of method 2, which is used in the case that the position information of the target User Equipment is not available, hence no information regarding the serving Mobile Switch Center (MSC)/Serving GPRS Support Node (SGSN) is available, and the request Type is LAST KNOWN.

In step **702** a MAP_Any_Time_Interrogation signal is sent by the TIF **102** to the Traffic Manager **603**, and in step **704** the TIF **102** waits for a reply. In step **706** it is determined whether a reply has been received, and if a reply has been received, then a result is returned in step **708**. If a reply has not been received, then in step **710** it is determined whether the timer has expired, and if the timer has expired, then an error is returned in step **712**. If the timer has not expired, then the method returns to step **704**.

Method 3

FIG. **8** shows exemplary scheme selection method 3 wherein the position information of the target User Equipment is available from a cache database **403**, in accordance with the principles of the present invention.

In particular, FIG. **8** shows the embodiment of method 3, which is used in the case that the position information of the target User Equipment is available from the cache database **403**, which indicates the serving Mobile Switch Center (MSC)/Serving GPRS Support Node (SGSN) supports Mobile Application Part (MAP) version for Phase 2+, and the request type is CURRENT.

In step **802**, a MAP_MT_Forward Short Message is sent by the TIF **102** to the Traffic Manager **603**, and in step **804** the TIF **102** waits for a Short Message. In step **806** it is determined whether an error has been received, and if an error has been received the method jumps to step **818** to return an error. If no error has been received, then in step **808** a MAP_Provide_Subscriber_Info signal is sent, and in step **810** the TIF **102** waits for a reply. In step **812** it is determined whether a reply has been received, and if a reply has been received, then a result is returned in step **814**. If no reply has been received, then in step **816** it is determined whether the timer has

expired, and if the timer has expired, then in step **818** an error is returned. If the timer has not expired, then the method returns to step **810**.

Method 4

FIG. **9** shows exemplary scheme selection method 4 wherein no cached position information regarding the target User Equipment is available, in accordance with the principles of the present invention.

In particular, FIG. **9** shows method 4, which is used in the case that no cached position information of the target User Equipment is available and the request Type is CURRENT. In this case, Telecommunication Interface (TIF) **102** queries the Home Location Register (HLR) for the serving Mobile Switch Center (MSC) using MAP_Send_Routing_Info_For_SM, and then sends a null short message to the target User Equipment to refresh it location information in the serving Mobile Switch Center (MSC)/Visitor Location Register (VLR).

If the Mobile Terminated (MT) short message delivery is successful, the Telecommunication InterFace (TIF) **102** then initiates MAP_Provide_Subscriber_Info to retrieve the location information of the target User Equipment.

In step **902**, a MAP_Send_Routing_For_SM signal is sent by the TIF **102** to the Traffic Manager **603**, and in step **904** the TIF **102** waits for a reply. In step **906** it is determined whether a reply has been received, and if a reply has been received, then the MSC position is compared to the Quality of Position (QoP) in step **908** from the PLMN database **120**. If a reply has not been received, then it is determined whether the timer has expired in step **910**, and if the timer has expired then an error is returned in step **930**. If the timer has not expired, then the method returns to step **904**. On completion of step **908**, it is determined whether the position meets a desired Quality of Position (QoP) in step **912**, and if the position meets the desired QoP, then a result is returned in step **926**. If the position does not meet the desired QoP, then a MAP_MT_Forward Short Message is sent by the TIF **102** to the Traffic Manager **603** in step **914**, and the TIF **102** waits for a reply in step **916**. In step **918** it is determined whether an error has been received, and if an error has been received, then an error is returned in step **930**. If an error has not been received, then a MAP_Provide_Subscriber_Info signal is sent by the TIF **102** in step **920**, and the TIF **102** waits for a reply in step **922**. In step **924** it is determined whether a reply has been received, and if a reply has been received, then in step **926** a result is returned. If no reply has been received, then in step **928** it is determined whether the timer has expired, If the timer has expired, then in step **930** an error is returned, and if the timer has not expired, then the method returns to step **922**.

Method 5

FIG. **10** shows exemplary scheme selection method 5 wherein position information is available in the cache database **403**, in accordance with the principles of the present invention.

In particular, FIG. **10** shows the procedure details of method 5, which is used in the case that the position information is available in the cache database **403**, indicating that the serving Mobile Switch Center (MSC)/Serving GPRS Support Node (SGSN) supports Release 99 Mobile Application Part (MAP) version.

In step **1002** a MAP_Provide_Subscriber_Location signal is sent by the TIF **102** to the Traffic Manager **603**, and in step **1004** the TIF **102** waits for a reply. In step **1006** it is determined whether a reply has been received, and if a reply has been received, then in step **1008** a result is returned. If no reply has been received, then in step **1010** it is determined whether the timer has expired, and if the timer has expired, then in step **1012** an error is returned. If the timer has not expired, then the method returns to step **1004**.

Method 6

FIG. **11** shows exemplary scheme selection method 6 wherein no cached position information regarding the target subscriber is available, in accordance with the principles of the present invention.

In particular, FIG. **11** shows method 6, which is used in the case that no cached position information of the target subscriber is available, the Telecommunication InterFace (TIF) **102** uses Release 99 Mobile Application Part (MAP) version to communicate with the various network components. Firstly the Telecommunication InterFace (TIF) **102** initiates MAP_Send_Routing_Info_For_LCS (LCS is short for LoCation Services) to retrieve the serving Mobile Switch Center (MSC)/Serving GPRS Support Node (SGSN)-number of the target User Equipment from the Home Location Register (HLR). If the original request asks for the location information higher than Mobile Switch Center (MSC)/Serving GPRS Support Node (SGSN) level, the Telecommunication InterFace (TIF) **102** uses MAP_Provide_Subscriber_Location to retrieve the location information of the target User Equipment from the Mobile Switch Center (MSC)/Serving GPRS Support Node (SGSN).

In step **1102** a MAP_Send_Routing_For_LCS signal is sent by the TIF **102** to the Traffic Manager **603**, and in step **1104** the TIF **102** waits for a reply. It is determined in step **1106** whether a reply has been received, and if a reply has been received the method proceeds to step **1110**. If no reply has been received, then in step **1108** it is determined whether the timer has expired, and if the timer has expired, then an error is returned in step **1124**. If the timer has not expired, then the method returns to step **1104** In step **1110** the MSC position is compared to the desired Quality of Position (QoP), by means of the PLMN database **120**, and in step **1112** it is determined whether the position meets the desired QoP. If the position meets the desired QoP, then a result is returned in step **1120**, and if the position does not meet the desired QoP, then a Send_MAP_Provide_Subscriber_Location signal is sent in step **1114** and the TIF **102** waits for a reply in step **1116**. In step **1118** it is determined whether a reply has been received, and if a reply has been received, then in step **1120** a result is returned. If a reply has not been received, then in step **1122** it is determined whether the timer has expired, and if the timer has expired, then in step **1124** an error is returned. If the timer has not expired, then the method returns to step **1116**.

Method 7

FIG. **12** shows exemplary scheme selection method 7 wherein an Assisted Global Positioning Satellite system (AGPS) mechanism is used to retrieve accurate position information regarding the target User Equipment, in accordance with the principles of the present invention.

In particular, FIG. **12** shows method 7, which uses Assisted GPS (AGPS) mechanism to retrieve the accurate position of the target User Equipment. In order to let the target User Equipment measure its position, the XLP needs to provide some assistance data to the target User Equipment. The assistance data is built upon the location information of the serving network element. Therefore, if no cached position information of the target User Equipment is available (or it is too old), the Telecommunication InterFace (TIF) **102** will initiate Method 6 to retrieve the necessary information from the core network.

In step **1202**, it is determined whether the position is stored in cache **403**, and if the position is not stored in cache **403**, then the method exits in step **1203** and Scheme Selection Method 6 is tried (see FIG. **11**). If the position is stored in

cache **403**, or if a position has been determined to have been received in step **1201**, then in step **1204** a location request is sent with the last position to AGPS unit **1205**, and in step **1206** the TIF **102** waits for a reply. In step **1208** it is determined whether a reply has been received, and if a reply has been received, then in step **1210** a result is returned. If a reply has not been received, then in step **1212** it is determined whether the timer has expired, and if the timer has expired, or if no position was received in step **1201**, then in step **1214** an error is returned. If the timer has not expired, then the method returns to step **1206**.

Method 8

FIG. **13** shows exemplary scheme selection method 8 wherein cached position information is available, in accordance with the principles of the present invention.

In particular, FIG. **13** shows method 8, which is used for the case that the cached position information is available, indicating that the serving Mobile Switch Center (Mobile Switch Center (MSC))/Serving GPRS Support Node (SGSN) supports either Mobile Application Part (MAP) version 1 or version 2, and the request Type is CURRENT.

In step **1302**, a MAP_Send_Routing_For Short Message is sent by TIF **102** to Traffic Manager **603**, and in step **1304** the TIF **102** waits for a reply. In step **1306** it is determined whether a reply has been received, and if a reply has been received, then the MSC position is compared to the desired Quality of Position (QoP) in step **1308** by using the PLMN database **120**, and in step **1310** it is determined whether the position meets the desired QoP. If a reply has not been received, then in step **1312** it is determined whether the timer has expired, and if the timer has expired, then in step **1314** an error is returned. If the timer has not expired, then the method returns to step **1304**. If the position meets the desired QoP, then a result is returned in step **1316**, and if the position does not meet the desired QoP, then an error is returned in step **1314**.

Other methods are possible and encompassed by the present invention. For instance, FIGS. **14** to **32** show methods of another embodiment of the present invention in accordance with the present invention.

The present invention provides a significant advantage of the reduction of unnecessary SS7 network traffic.

While the invention has been described with reference to the exemplary embodiments thereof, those skilled in the art will be able to make various modifications to the described embodiments of the invention without departing from the true spirit and scope of the invention.

What is claimed is:

1. A process of providing location information regarding a wireless client in a network, comprising:

receiving, at a physical location server, a location information request for location information associated with a wireless device;

selecting between a cached last known position of a relevant subscriber, and a next untried location retrieval scheme when no last known position has been retrieved;

determining, from said physical location server, a roaming status of said wireless device; and

selecting, with said physical location server, one of a plurality of location retrieval schemes to retrieve said location information associated with said wireless device, said selecting being based on said roaming status.

2. The process of providing location information regarding a wireless client in a network according to claim **1**, further comprising:

retrieving a best available location information from a physical memory cache.

3. The process of providing location information regarding a wireless client in a network according to claim **1**, further comprising:

returning an error as said location information if no current location information has been retrieved.

4. The process of providing location information regarding a wireless client in a network according to claim **1**, further comprising:

returning a last known location information as a best available location information if an error has been returned, when said last known position exists in a cache and has not expired.

5. The process of providing location information regarding a wireless client in a network according to claim **1**, further comprising:

setting a timer before an attempt to update said location information for said wireless device; and

returning an error as provided location information when said timer has expired.

6. The process of providing location information regarding a wireless client in a network according to claim **1**, further comprising:

choosing as said next untried location retrieval scheme a navigational satellite system when said wireless device can access said navigational satellite system.

7. The process of providing location information regarding a wireless client in a network according to claim **1**, further comprising:

choosing said next untried location retrieval scheme according to a version number of a software application employed.

8. A method of responding in a wireless network to a location request, comprising:

determining a requested accuracy to a response to a location request;

based on said requested accuracy, selecting between a cached last known position of a relevant subscriber, and a next untried locating scheme when no last known position of said relevant subscriber has been retrieved;

determining a roaming status of a relevant subscriber for which location information was requested; and

selecting between a plurality of possible location determination schemes based on said determined roaming status of said relevant subscriber.

9. The method of responding in a wireless network to a location request according to claim **8**, wherein:

said next untried locating scheme includes use of a GPS system.

10. The method according to claim **8**, wherein:

said next untried locating scheme provides location information determined by the wireless network.

11. The method of responding in a wireless network to a location request according to claim **8**, wherein:

said next untried locating scheme includes using one of a GPS system and a land-based wireless network.

12. The method of responding in a wireless network to a location request according to claim **8**, further comprising:

determining availability of said last known position in a cache.

13. A method of responding in a wireless network to a location request, comprising:

determining a requested accuracy to a response to a location request;

based on said requested accuracy, selecting between retrieval of a cached last known position record of a

relevant subscriber, if available, and a next untried locating scheme when no current position record has been retrieved;

determining a roaming status of a relevant subscriber for which location information was requested; and

selecting between a plurality of possible location determination schemes based on said determined roaming status of said relevant subscriber.

14. The method of responding in a wireless network to a location request according to claim **13**, wherein:

said last known position record is retrieved from a cache.

15. The method of responding in a wireless network to a location request according to claim **13**, further comprising:

returning an error as provided location information when no current position record has been retrieved.

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