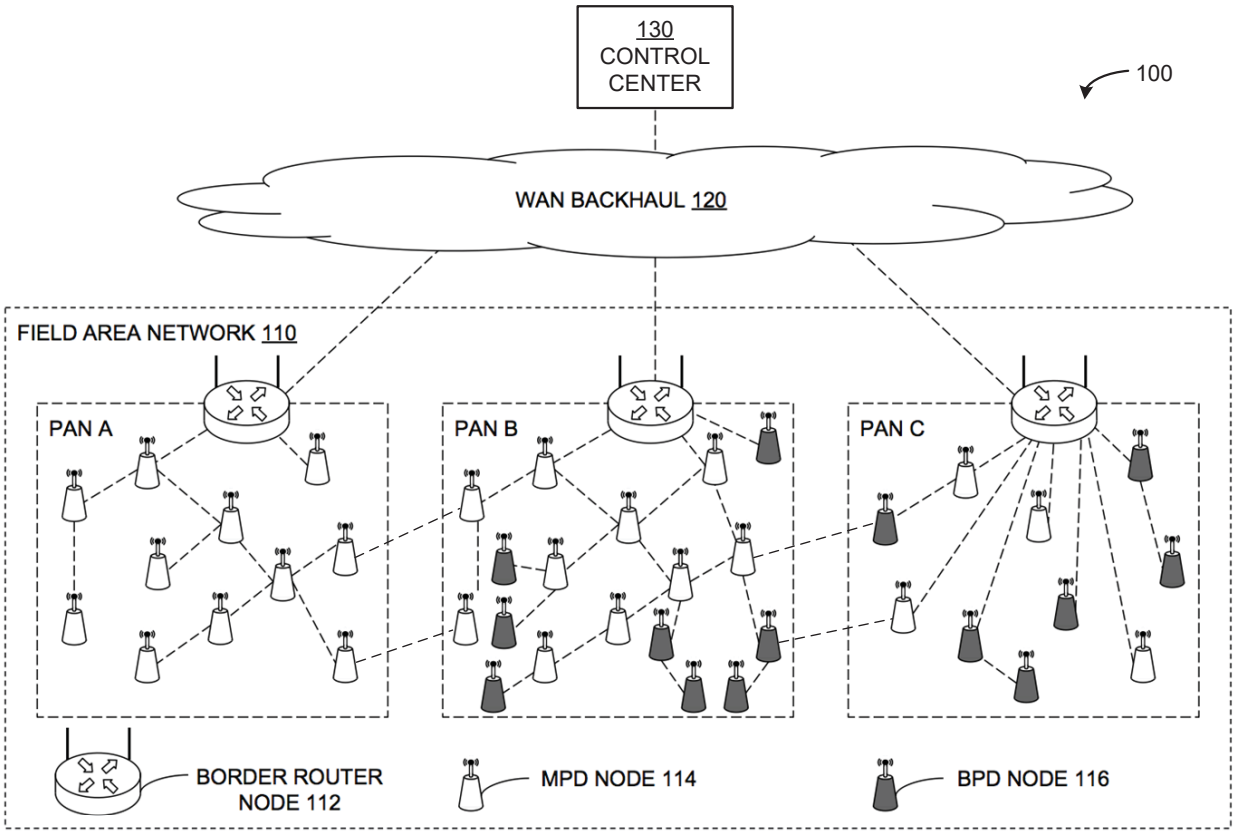

130
CONTROL
CENTER
100
WAN BACKHAUL 120
FIELD AREA NETWORK 110
PAN A
PAN B
PAN C
BORDER ROUTER
NODE 112
MPD NODE 114
BPD NODE 116

FIG. 1

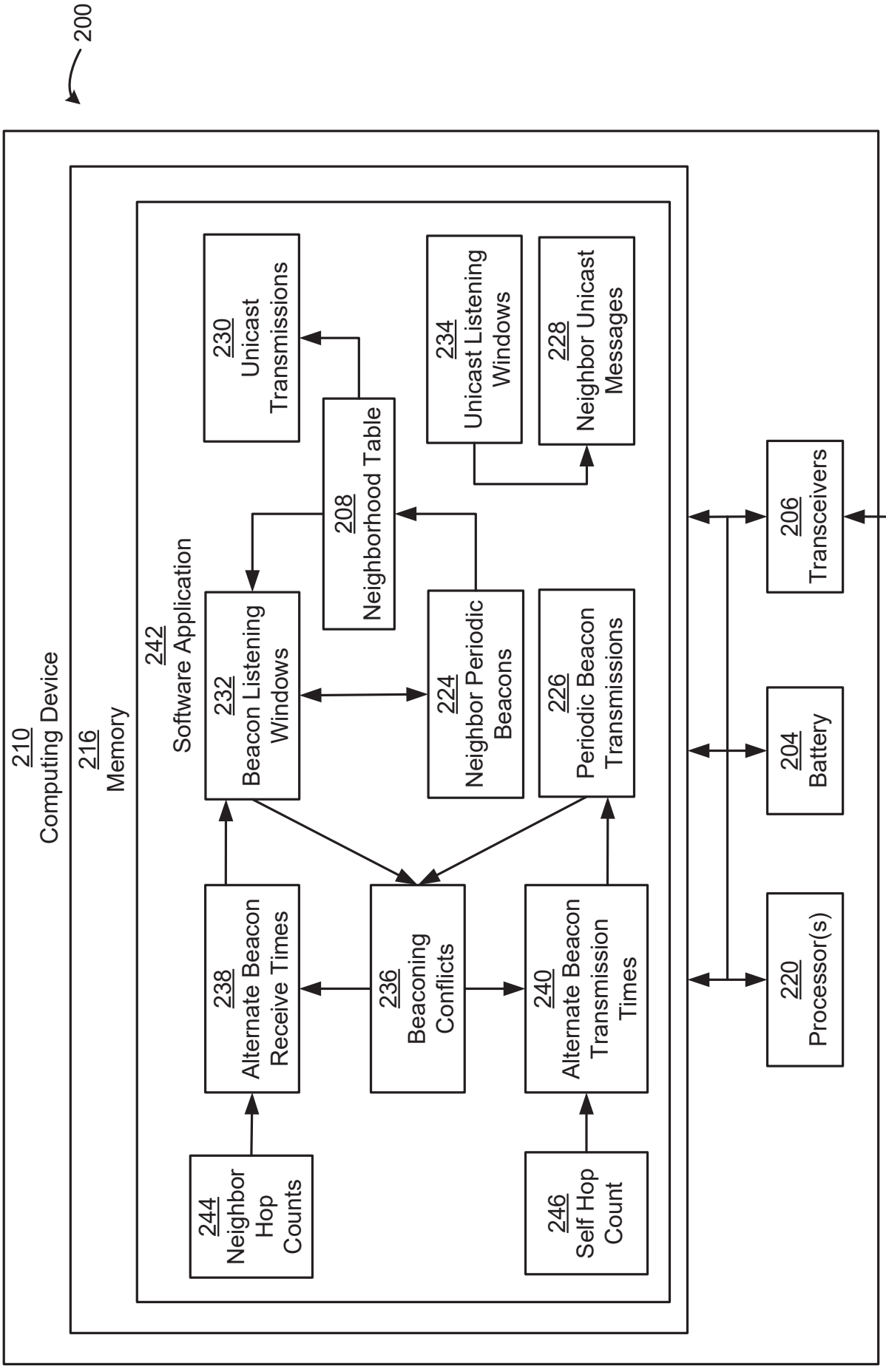

200
210 Computing Device
216 Memory
242 Software Application
230 Unicast Transmissions
234 Unicast Listening Windows
228 Neighbor Unicast Messages
208 Neighborhood Table
232 Beacon Listening Windows
224 Neighbor Periodic Beacons
226 Periodic Beacon Transmissions
238 Alternate Beacon Receive Times
236 Beaconing Conflicts
240 Alternate Beacon Transmission Times
244 Neighbor Hop Counts
246 Self Hop Count
206 Transceivers
204 Battery
220 Processor(s)
To Links 214

FIG. 2

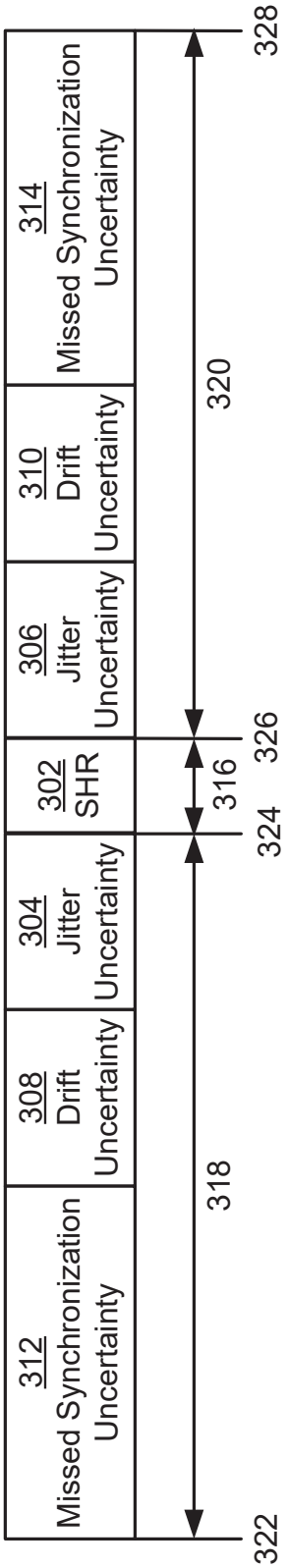

312 Missed Synchronization Uncertainty
308 Drift Uncertainty
304 Jitter Uncertainty
302 SHR
306 Jitter Uncertainty
310 Drift Uncertainty
314 Missed Synchronization Uncertainty
318
316
320
322
324
326
328

FIG. 3

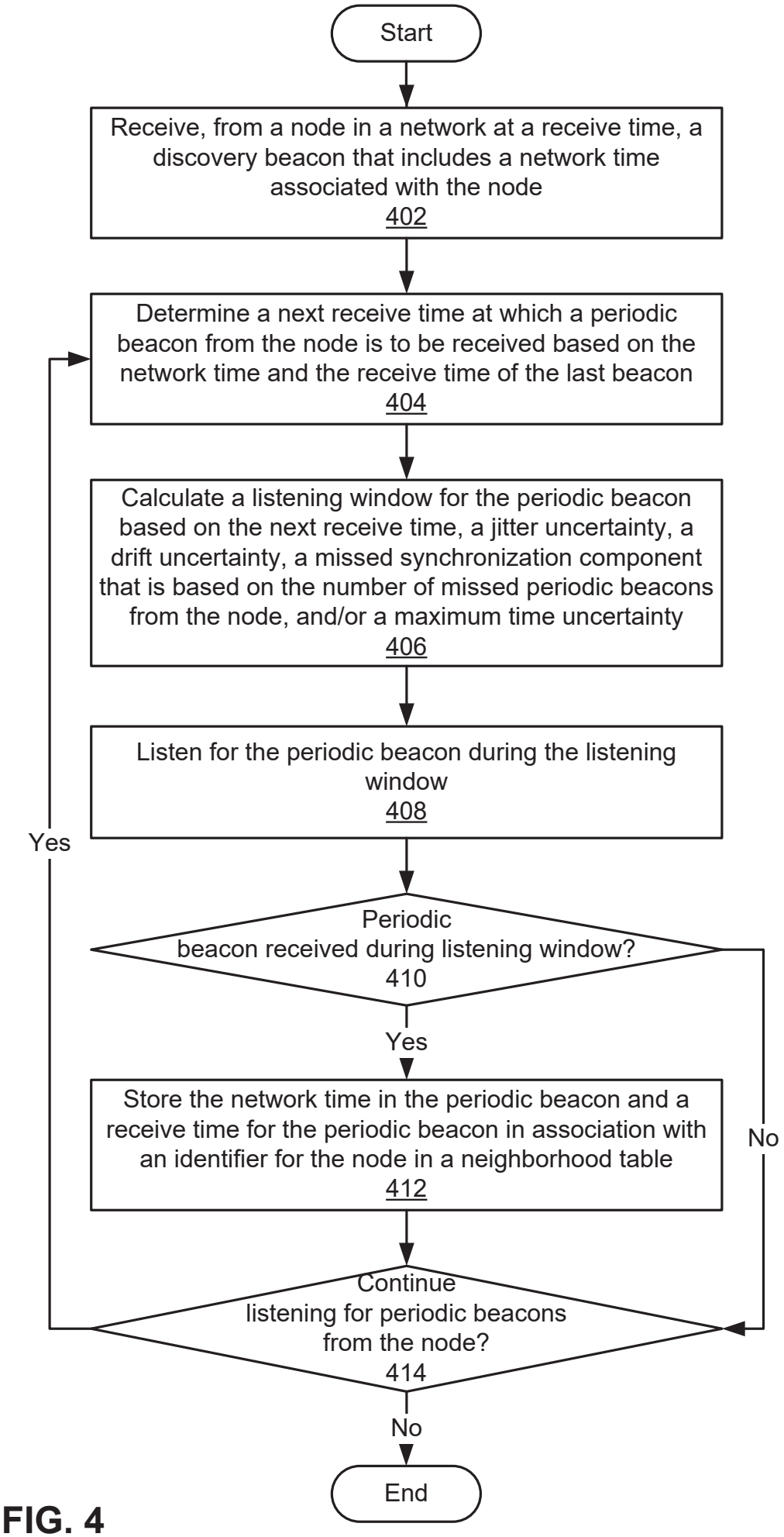

Start
Receive, from a node in a network at a receive time, a discovery beacon that includes a network time associated with the node
402
Determine a next receive time at which a periodic beacon from the node is to be received based on the network time and the receive time of the last beacon
404
Calculate a listening window for the periodic beacon based on the next receive time, a jitter uncertainty, a drift uncertainty, a missed synchronization component that is based on the number of missed periodic beacons from the node, and/or a maximum time uncertainty
406
Listen for the periodic beacon during the listening window
408
Periodic beacon received during listening window?
410
Yes
No
Store the network time in the periodic beacon and a receive time for the periodic beacon in association with an identifier for the node in a neighborhood table
412
Continue listening for periodic beacons from the node?
414
Yes
No
End

FIG. 4

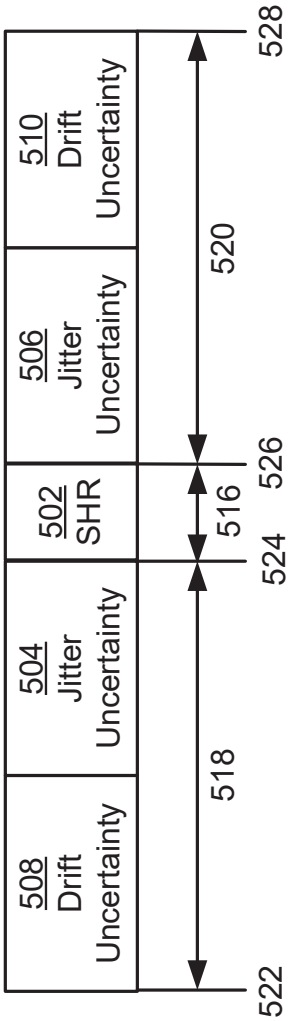

508 Drift Uncertainty
504 Jitter Uncertainty
502 SHR
506 Jitter Uncertainty
510 Drift Uncertainty
518
516
520
522
524
526
528

FIG. 5

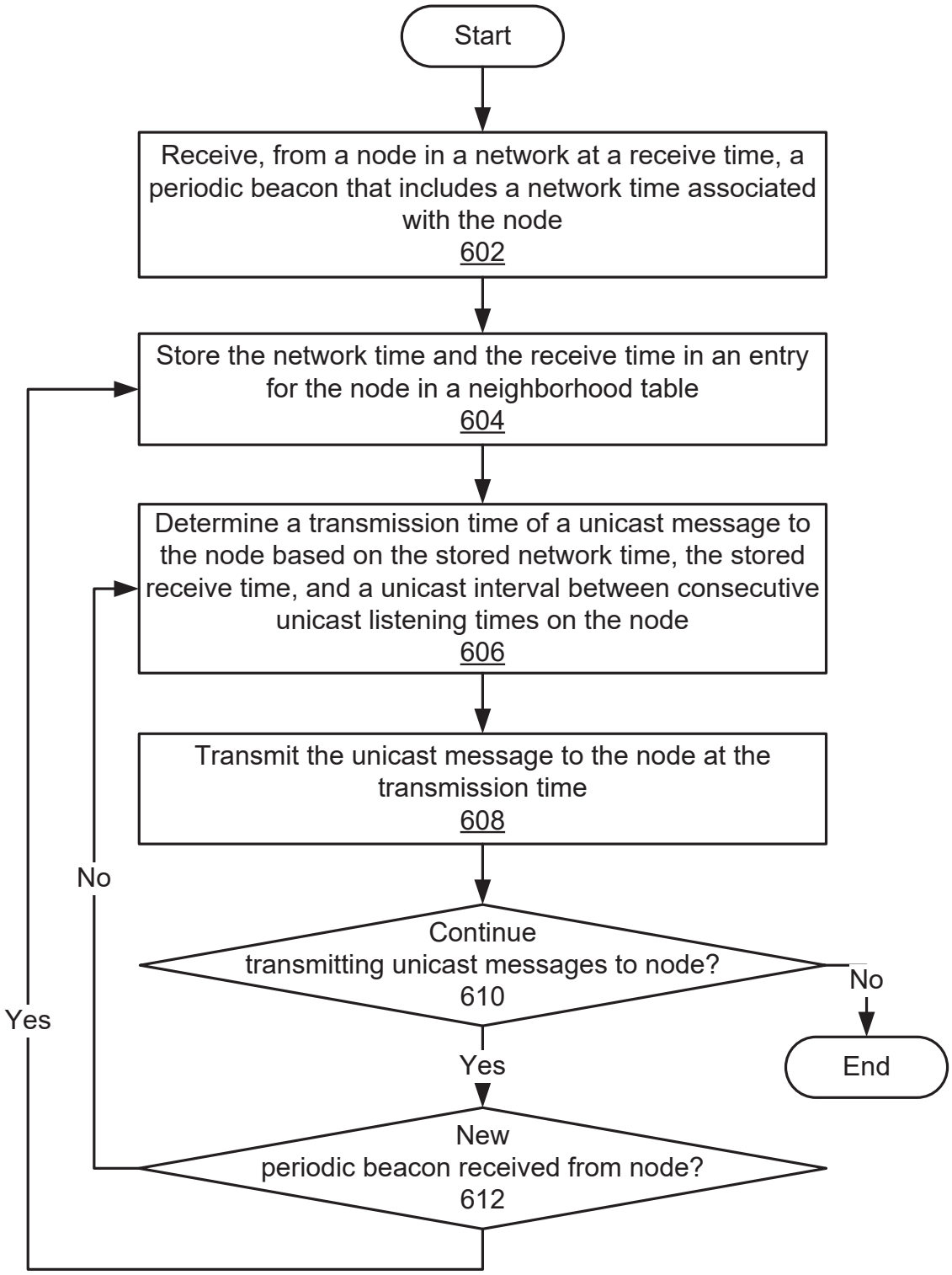

Start
Receive, from a node in a network at a receive time, a periodic beacon that includes a network time associated with the node
602
Store the network time and the receive time in an entry for the node in a neighborhood table
604
Determine a transmission time of a unicast message to the node based on the stored network time, the stored receive time, and a unicast interval between consecutive unicast listening times on the node
606
Transmit the unicast message to the node at the transmission time
608
Continue transmitting unicast messages to node?
610
No
End
Yes
New periodic beacon received from node?
612
No
Yes

FIG. 6A

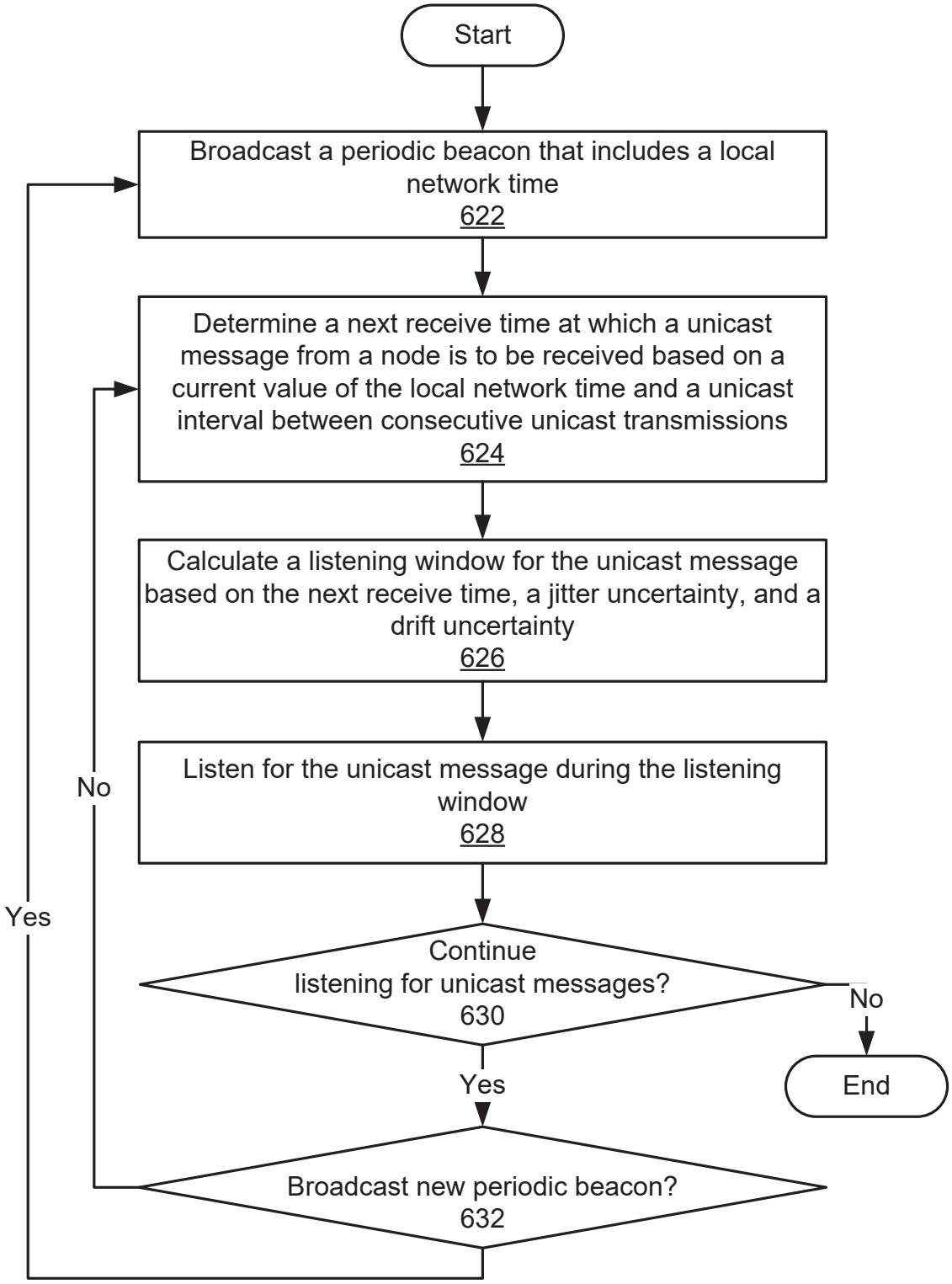

Start
Broadcast a periodic beacon that includes a local network time
622
Determine a next receive time at which a unicast message from a node is to be received based on a current value of the local network time and a unicast interval between consecutive unicast transmissions
624
Calculate a listening window for the unicast message based on the next receive time, a jitter uncertainty, and a drift uncertainty
626
Listen for the unicast message during the listening window
628
Continue listening for unicast messages?
630
No
End
Yes
Broadcast new periodic beacon?
632
No
Yes

FIG. 6B

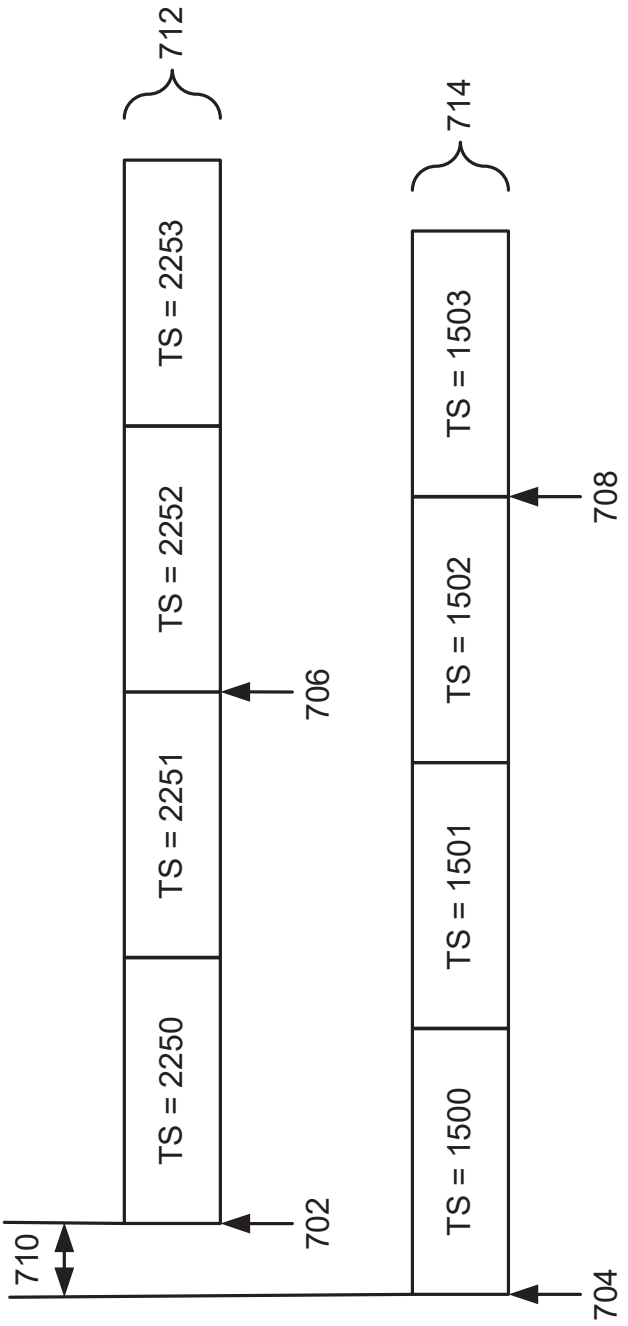

712
714
TS = 2253
TS = 2252
TS = 2251
TS = 2250
TS = 1503
TS = 1502
TS = 1501
TS = 1500
706
708
702
704
710

FIG. 7

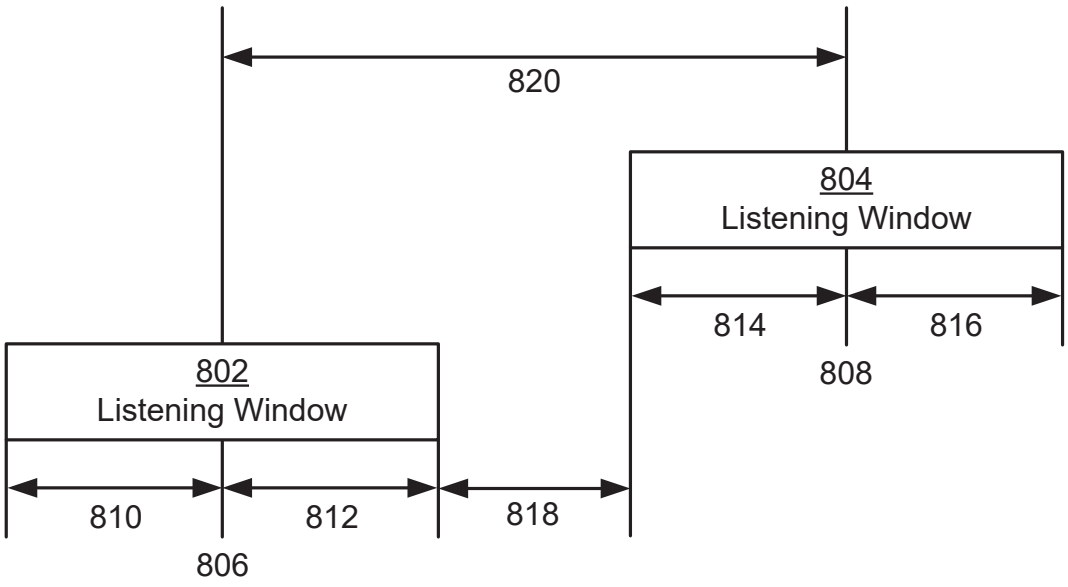

820
804
Listening Window
814
816
808
802
Listening Window
810
812
818
806

FIG. 8

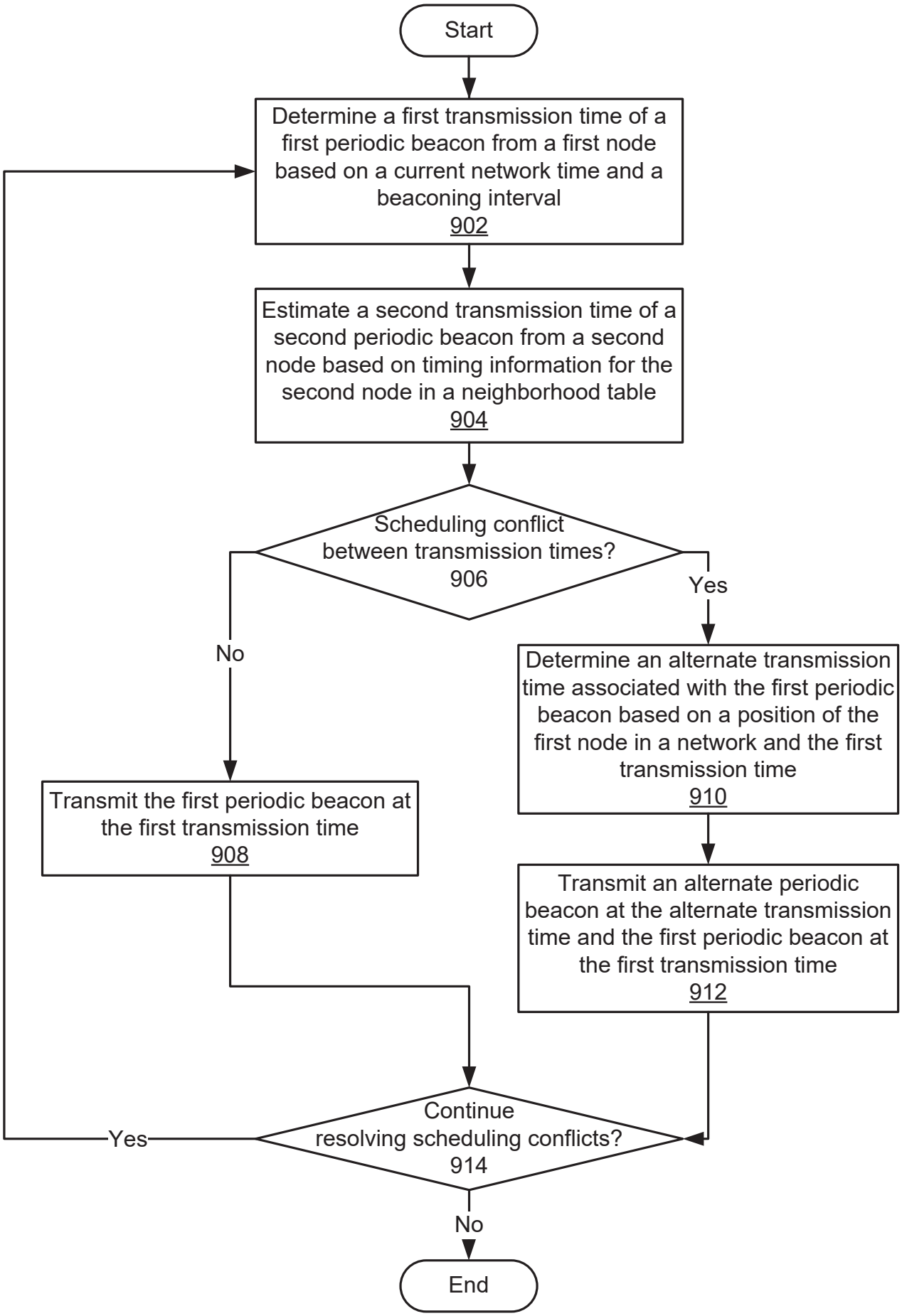

Start
Determine a first transmission time of a first periodic beacon from a first node based on a current network time and a beaconing interval
902
Estimate a second transmission time of a second periodic beacon from a second node based on timing information for the second node in a neighborhood table
904
Scheduling conflict between transmission times?
906
Yes
No
Determine an alternate transmission time associated with the first periodic beacon based on a position of the first node in a network and the first transmission time
910
Transmit the first periodic beacon at the first transmission time
908
Transmit an alternate periodic beacon at the alternate transmission time and the first periodic beacon at the first transmission time
912
Continue resolving scheduling conflicts?
914
Yes
No
End

FIG. 9

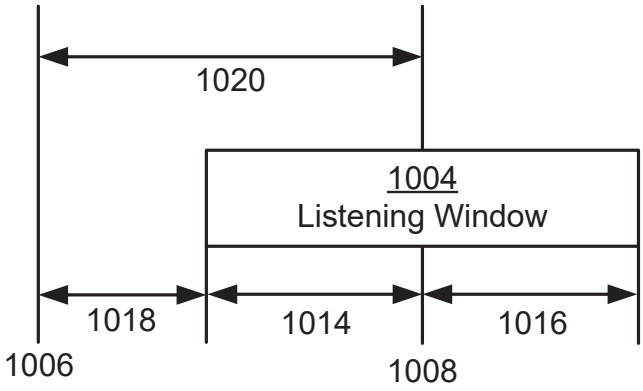


FIG. 10

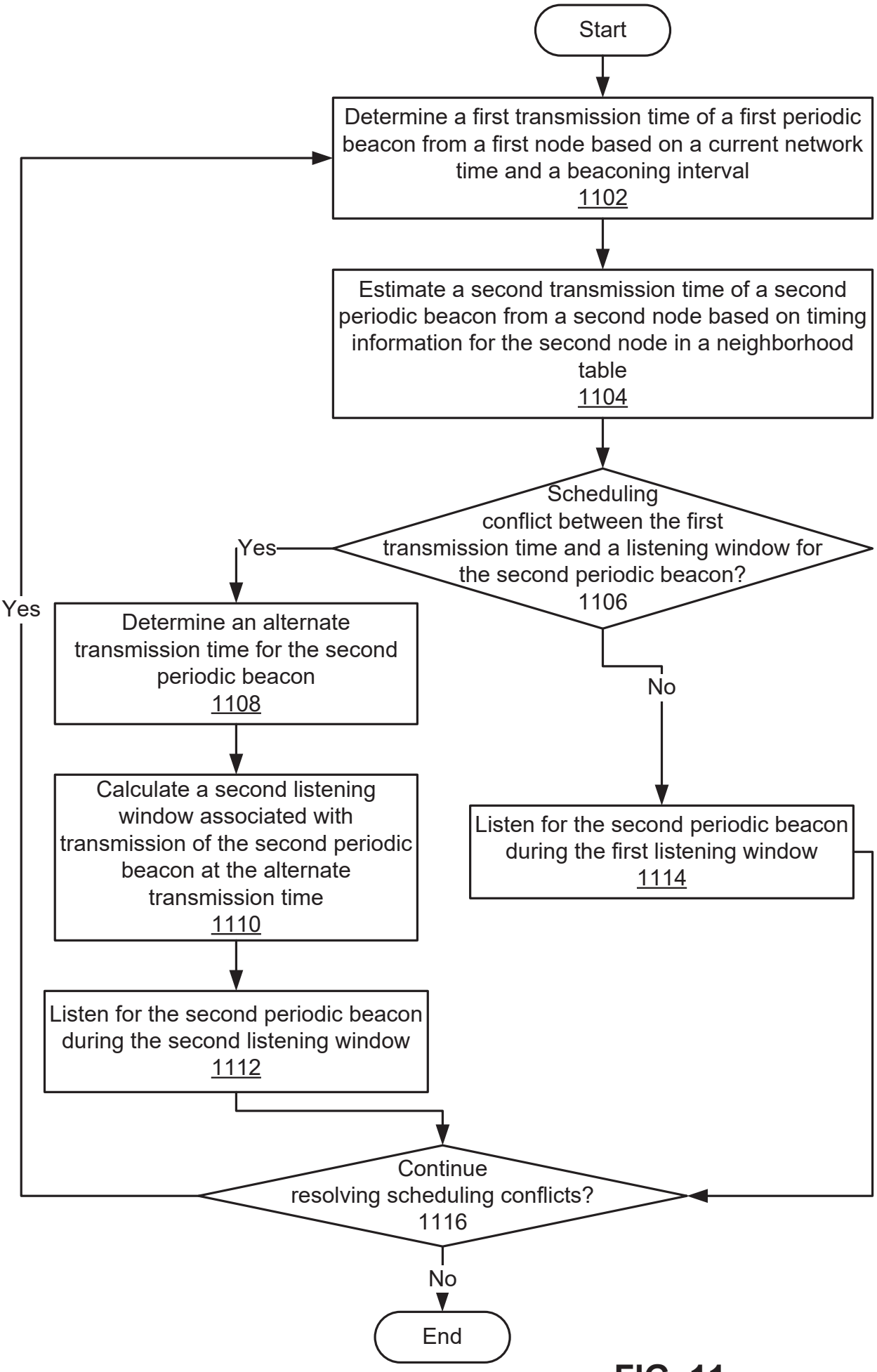

Start
Determine a first transmission time of a first periodic beacon from a first node based on a current network time and a beaconing interval
1102
Estimate a second transmission time of a second periodic beacon from a second node based on timing information for the second node in a neighborhood table
1104
Scheduling conflict between the first transmission time and a listening window for the second periodic beacon?
1106
Yes
No
Determine an alternate transmission time for the second periodic beacon
1108
Calculate a second listening window associated with transmission of the second periodic beacon at the alternate transmission time
1110
Listen for the second periodic beacon during the second listening window
1112
Listen for the second periodic beacon during the first listening window
1114
Continue resolving scheduling conflicts?
1116
Yes
No
End

FIG. 11