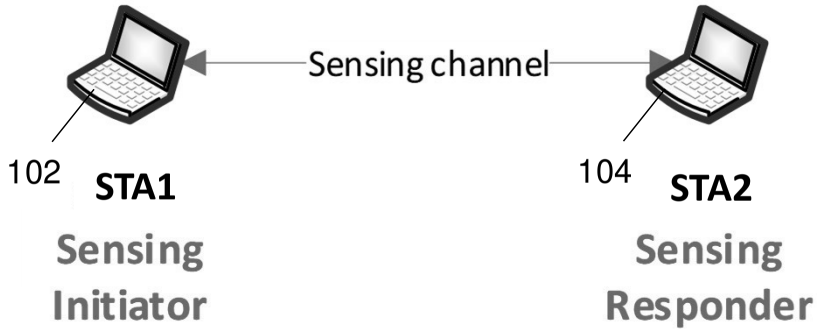

Sensing channel
102
STA1
Sensing
Initiator
104
STA2
Sensing
Responder

100

Figure 1

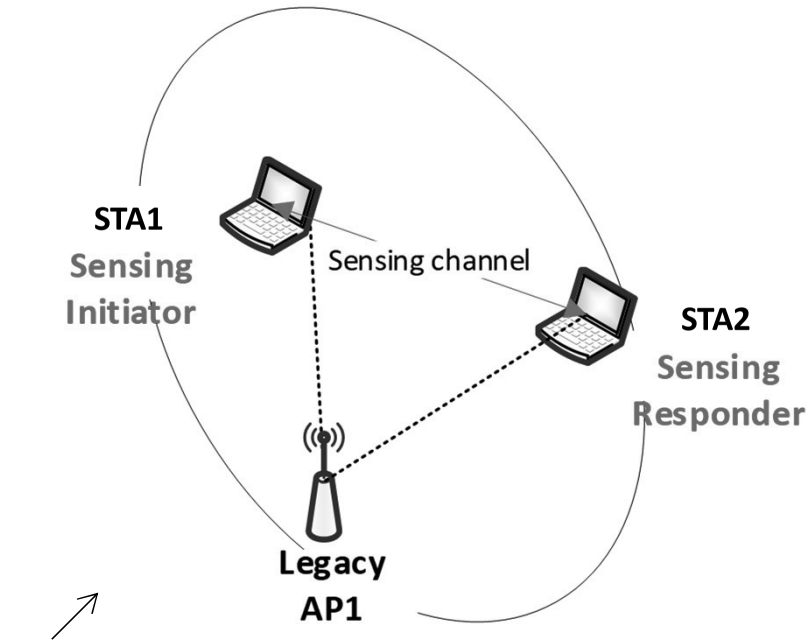


Figure 2A

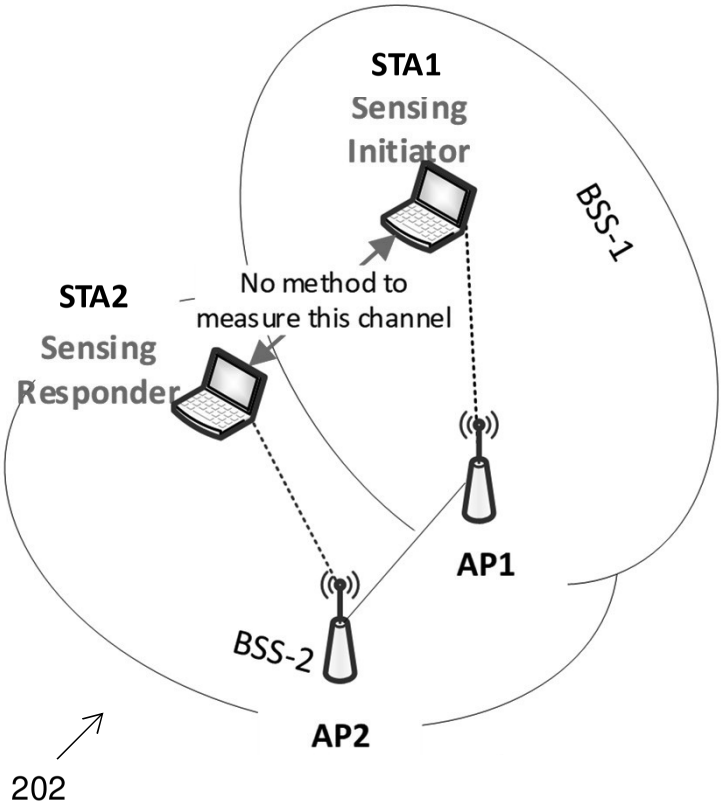


Figure 2B

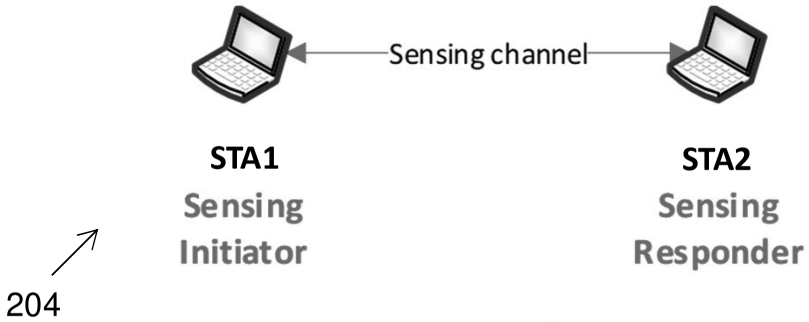


Figure 2C

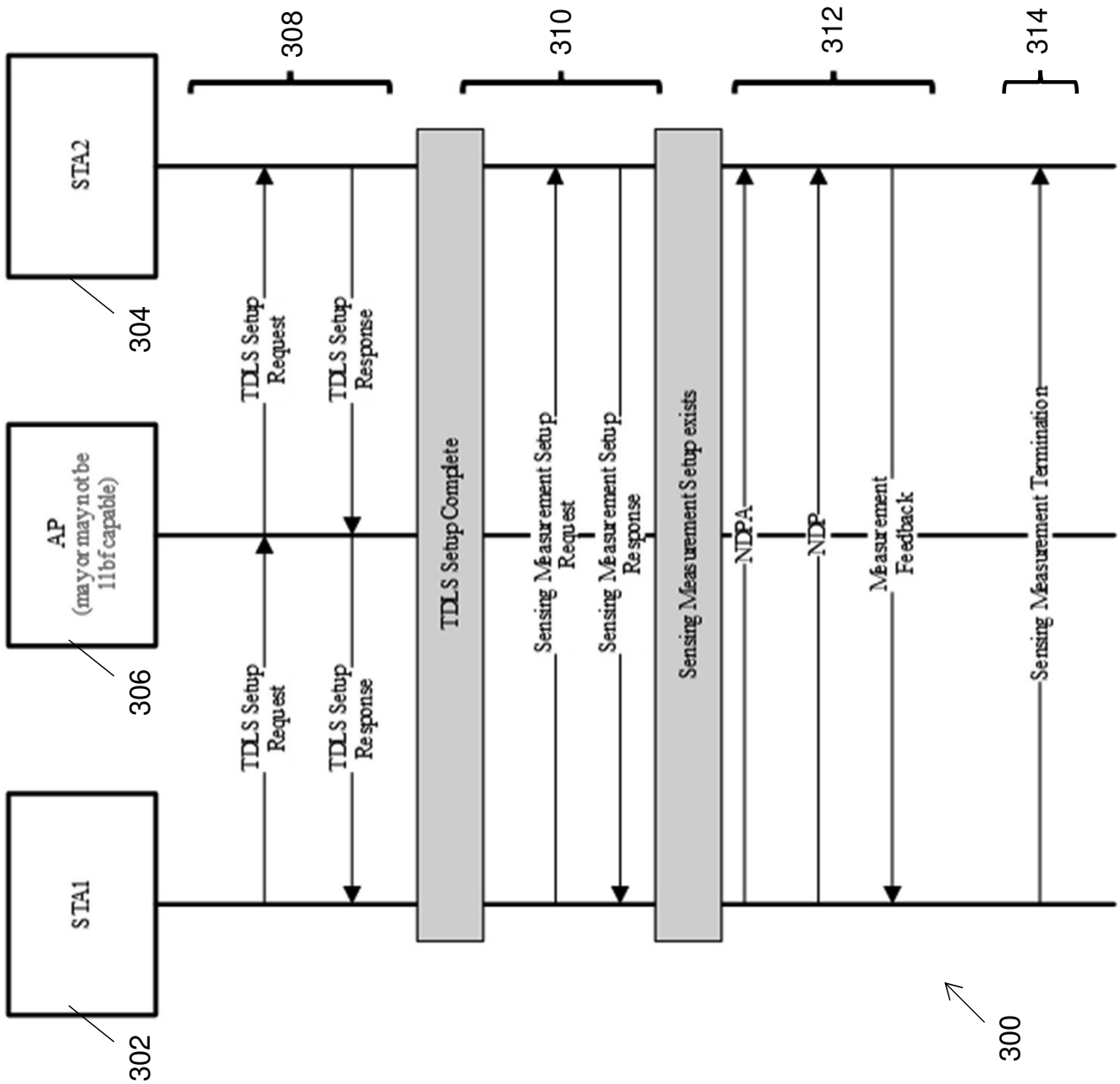

STA2
AP
(may or may not be
11bf capable)
STA1
304
306
302
308
310
312
314
TDLS Setup
Request
TDLS Setup
Response
TDLS Setup
Request
TDLS Setup
Response
TDLS Setup Complete
Sensing Measurement Setup
Request
Sensing Measurement Setup
Response
Sensing Measurement Setup exists
NDPA
NDP
Measurement
Feedback
Sensing Measurement Termination
300

Figure 3

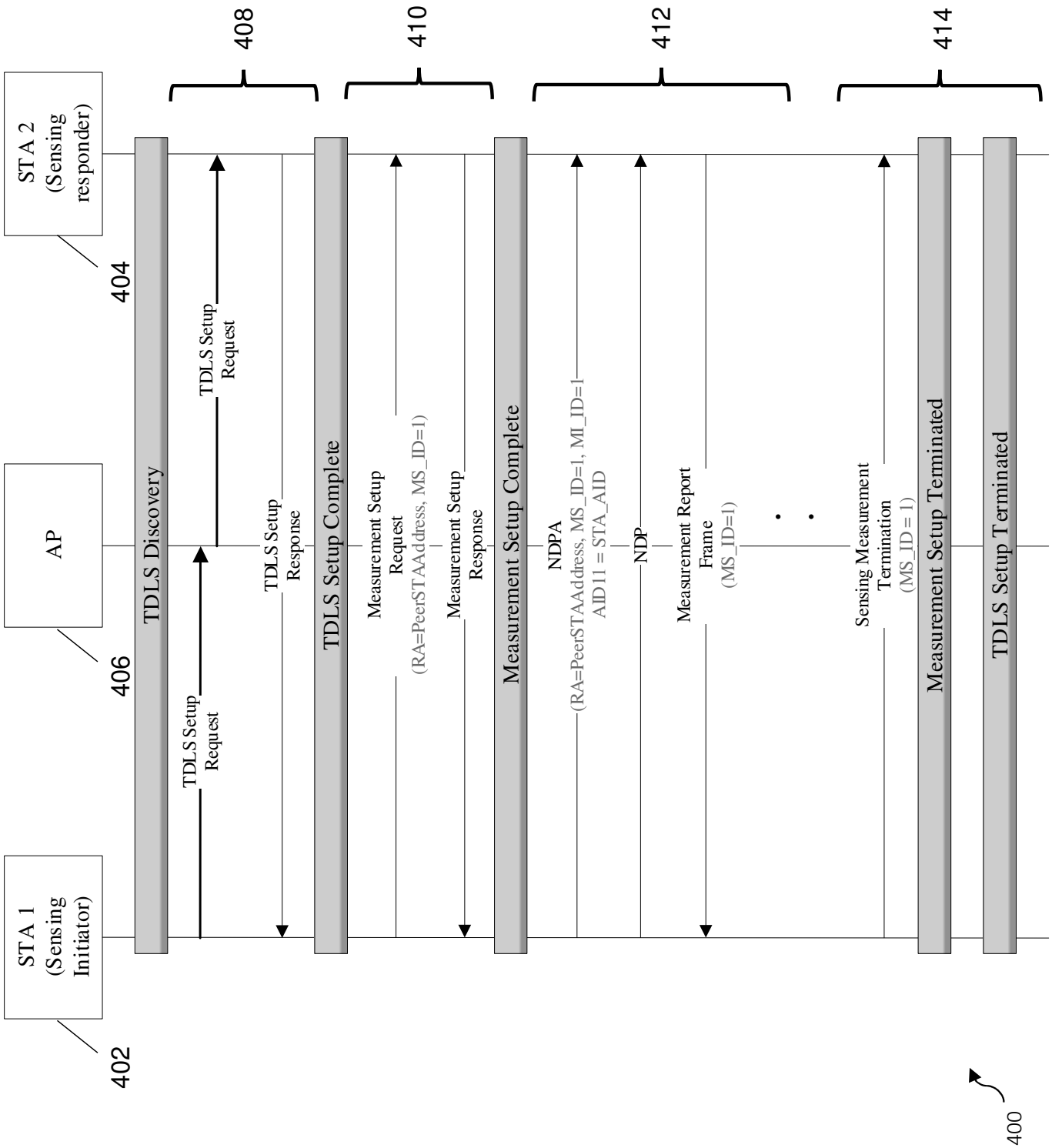
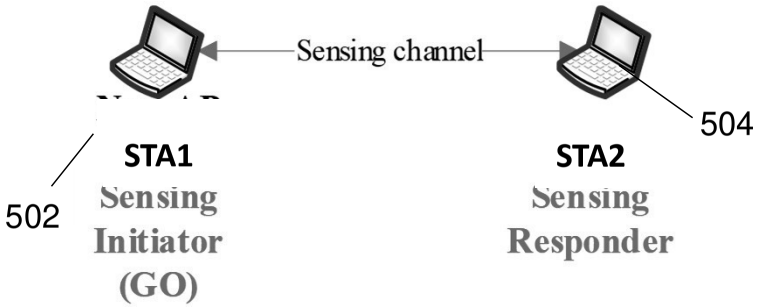

STA 1
(Sensing
Initiator)
AP
STA 2
(Sensing
responder)
402
406
404
408
410
412
414
TDLS Discovery
TDLS Setup
Request
TDLS Setup
Request
TDLS Setup
Response
TDLS Setup Complete
Measurement Setup
Request
(RA=PeerSTAAddress, MS_ID=1)
Measurement Setup
Response
Measurement Setup Complete
NDPA
(RA=PeerSTAAddress, MS_ID=1, MI_ID=1
AID11 = STA_AID
NDP
Measurement Report
Frame
(MS_ID=1)
Sensing Measurement
Termination
(MS_ID = 1)
Measurement Setup Terminated
TDLS Setup Terminated
400

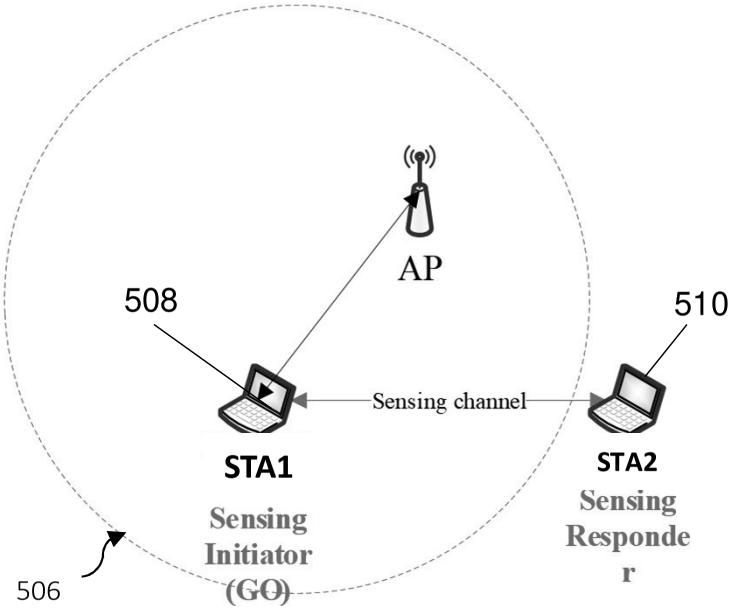
Figure 4



(A) Sensing with no AP involved

500

Figure 5A



(B) Sensing with OBSS or unassociated STA

Figure 5B

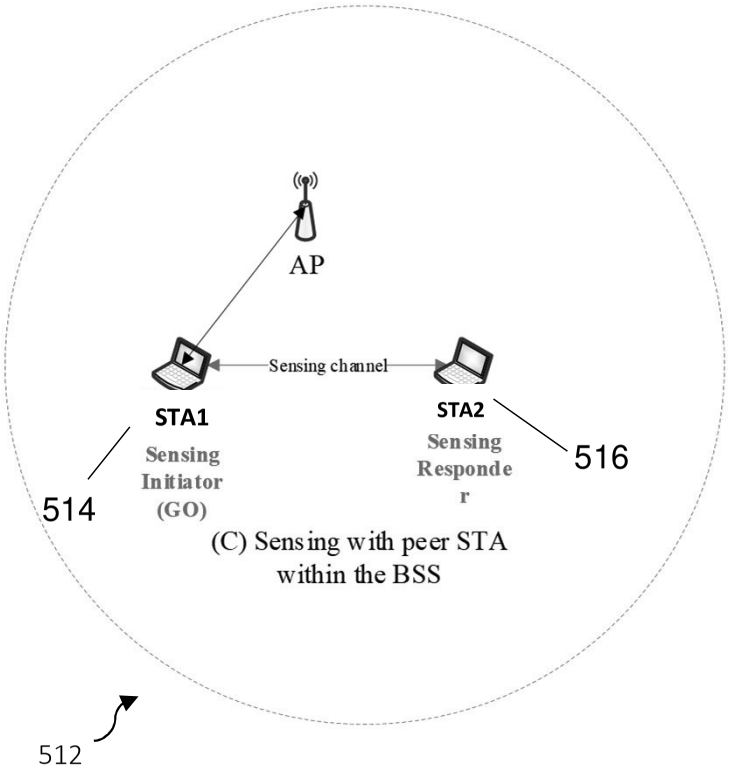


Figure 5C

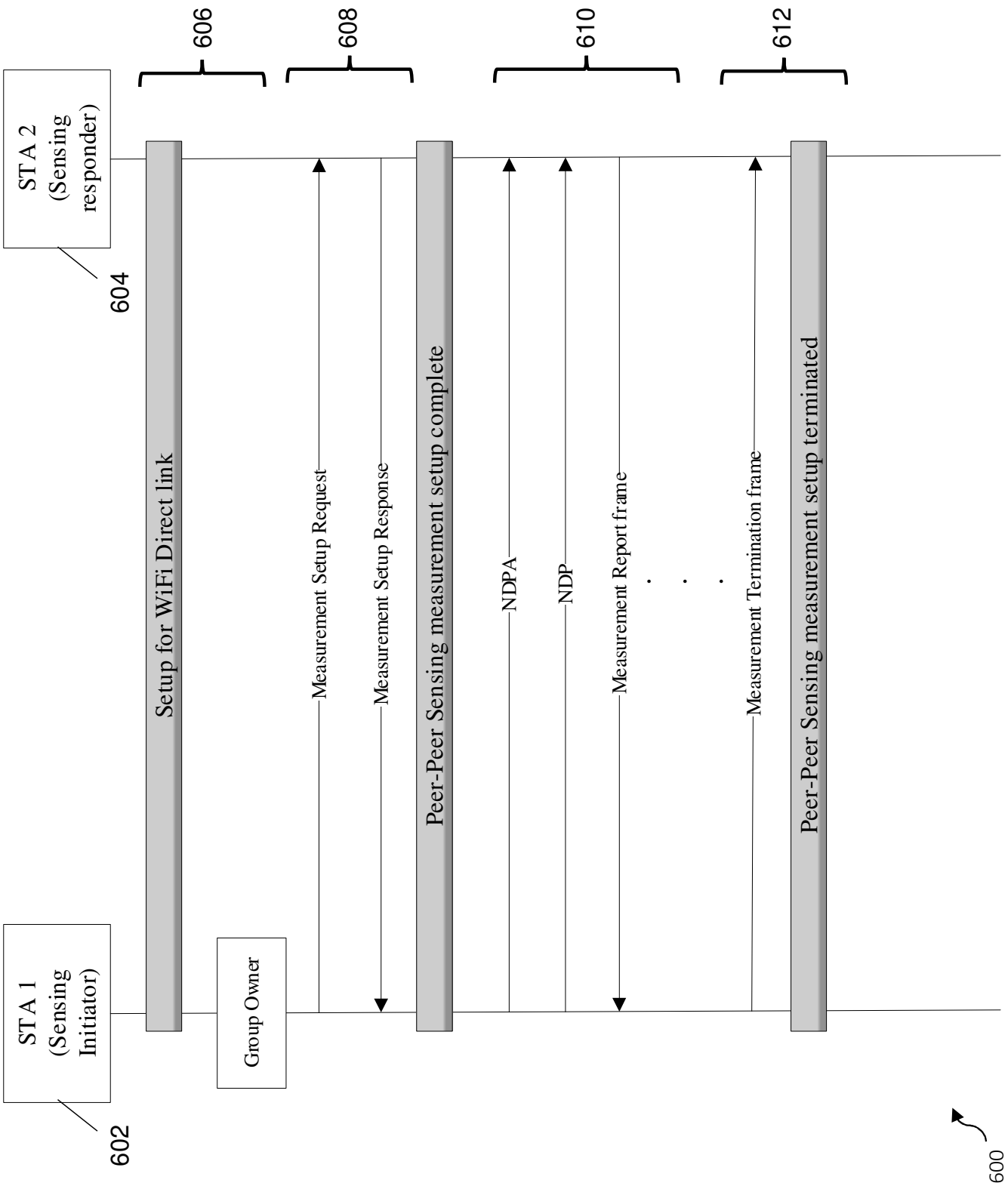

606
608
610
612
STA 2
(Sensing
responder)
604
Setup for WiFi Direct link
Measurement Setup Request
Measurement Setup Response
Peer-Peer Sensing measurement setup complete
NDPA
NDP
Measurement Report frame
Measurement Termination frame
Peer-Peer Sensing measurement setup terminated
STA 1
(Sensing
Initiator)
602
Group Owner
600

Figure 6

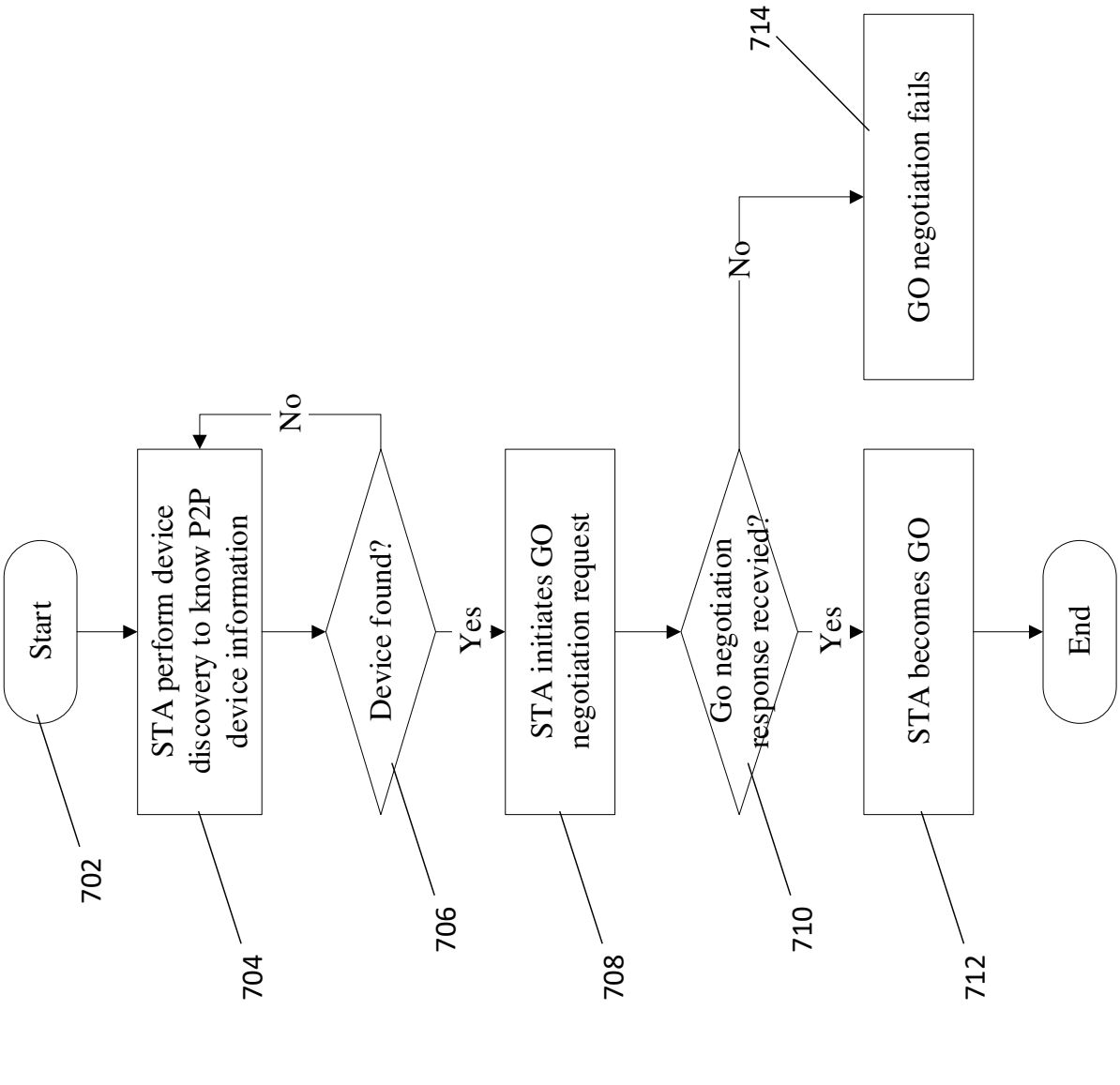

Start
STA perform device discovery to know P2P device information
Device found?
No
Yes
STA initiates GO negotiation request
Go negotiation response recevied?
No
Yes
GO negotiation fails
STA becomes GO
End
702
704
706
708
710
712
714
700

Figure 7

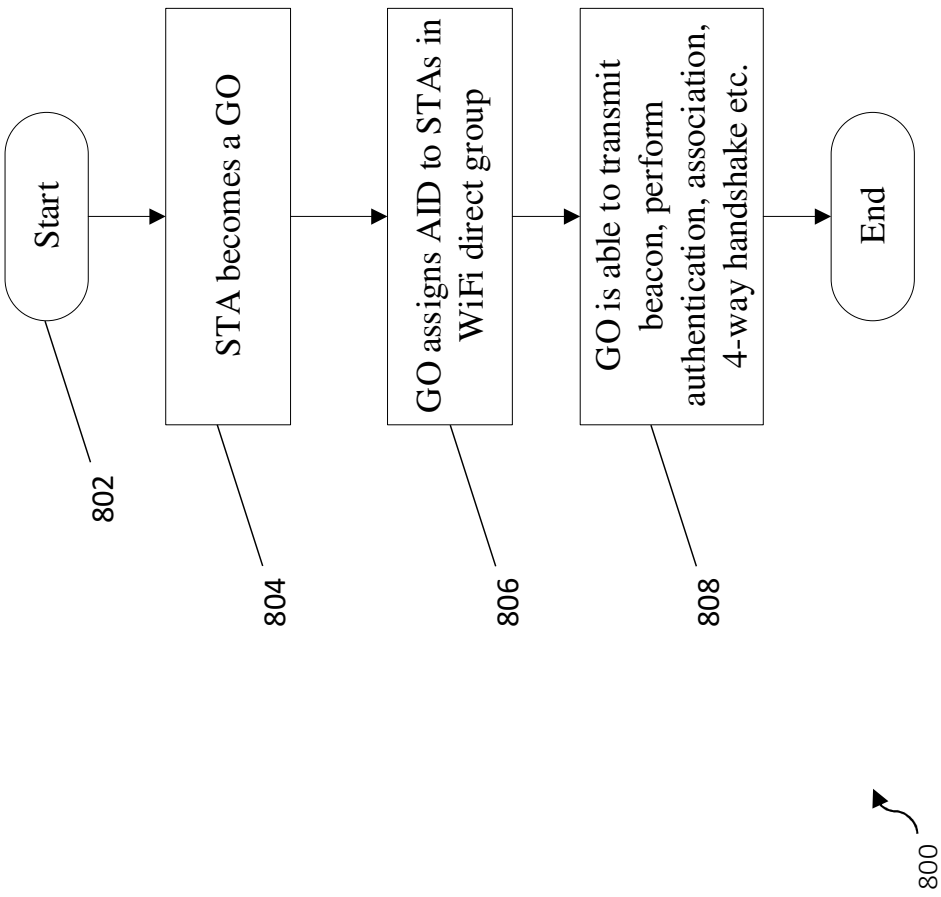

Start
STA becomes a GO
GO assigns AID to STAs in WiFi direct group
GO is able to transmit beacon, perform authentication, association, 4-way handshake etc.
End
802
804
806
808
800

Figure 8

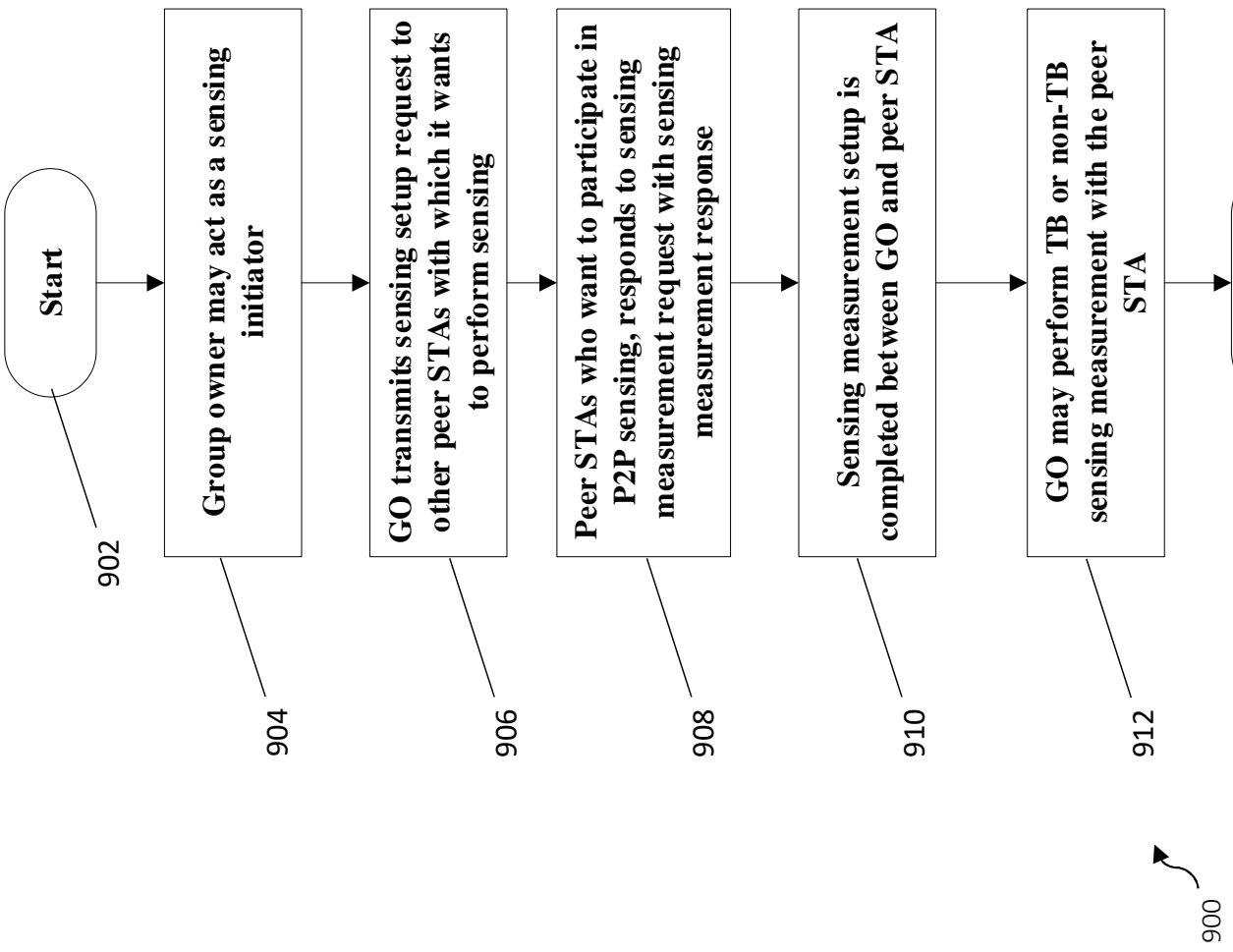

Start
902
Group owner may act as a sensing initiator
904
GO transmits sensing setup request to other peer STAs with which it wants to perform sensing
906
Peer STAs who want to participate in P2P sensing, responds to sensing measurement request with sensing measurement response
908
Sensing measurement setup is completed between GO and peer STA
910
GO may perform TB or non-TB sensing measurement with the peer STA
912
End
900

Figure 9

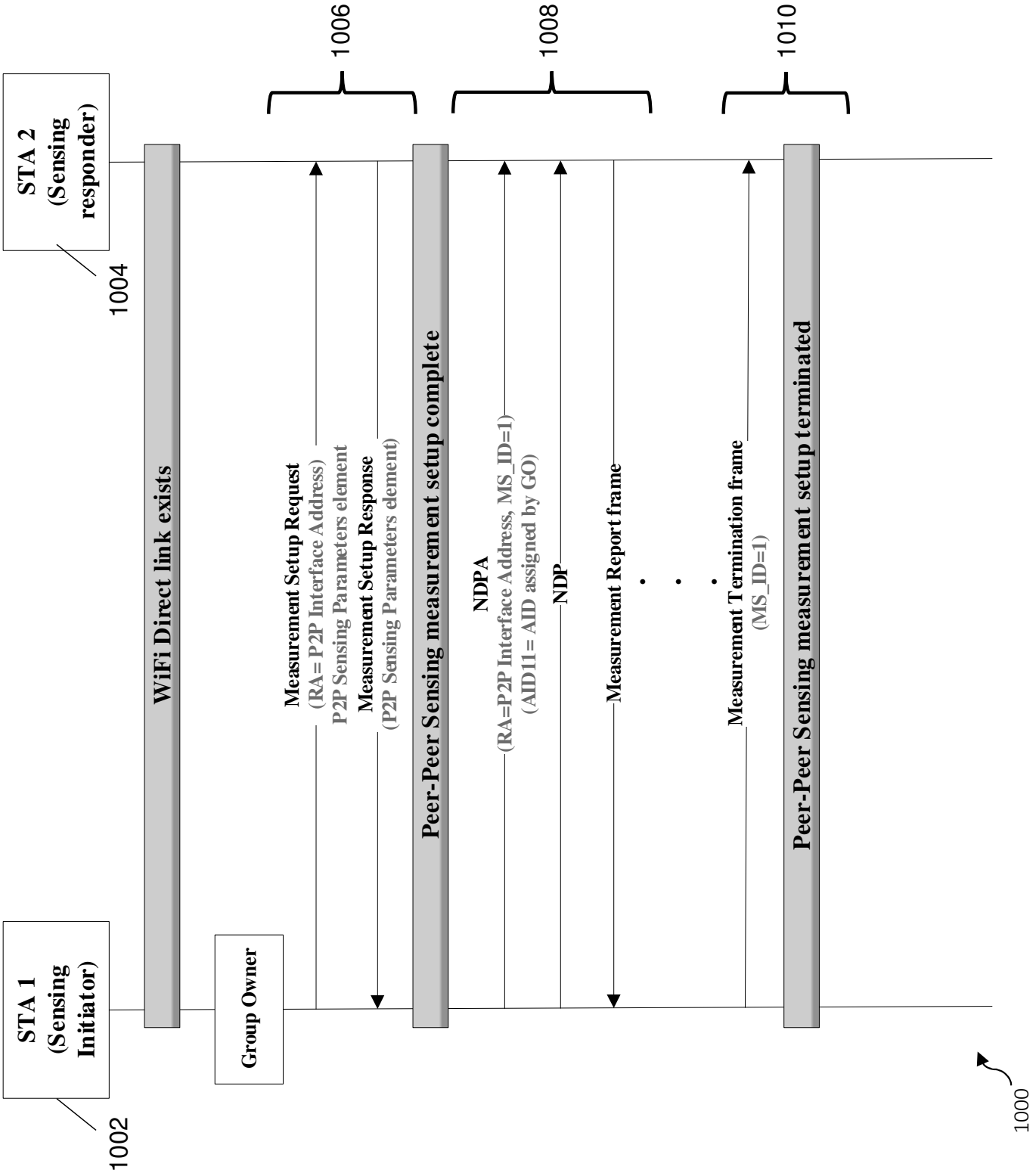

STA 1
(Sensing
Initiator)
1002
Group Owner
WiFi Direct link exists
STA 2
(Sensing
responder)
1004
1006
Measurement Setup Request
(RA= P2P Interface Address)
P2P Sensing Parameters element
Measurement Setup Response
(P2P Sensing Parameters element)
Peer-Peer Sensing measurement setup complete
1008
NDPA
(RA=P2P Interface Address, MS_ID=1)
(AID11= AID assigned by GO)
NDP
Measurement Report frame
1010
Measurement Termination frame
(MS_ID=1)
Peer-Peer Sensing measurement setup terminated
1000

Figure 10

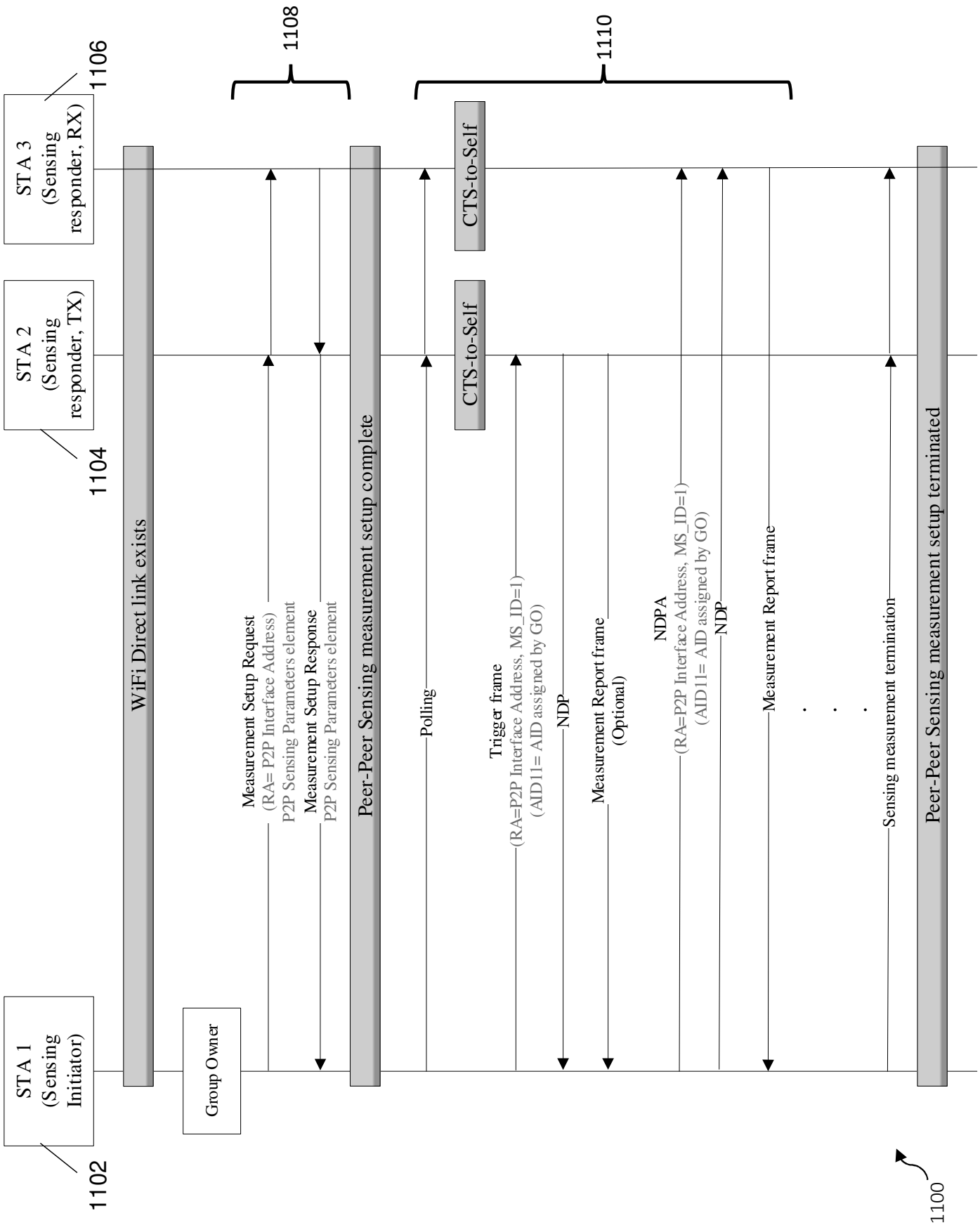

STA 1 (Sensing Initiator)
1102
STA 2 (Sensing responder, TX)
1104
STA 3 (Sensing responder, RX)
1106
Group Owner
WiFi Direct link exists
1108
1110
Measurement Setup Request
(RA= P2P Interface Address)
P2P Sensing Parameters element
Measurement Setup Response
P2P Sensing Parameters element
Peer-Peer Sensing measurement setup complete
Polling
CTS-to-Self
CTS-to-Self
Trigger frame
(RA=P2P Interface Address, MS_ID=1)
(AID11= AID assigned by GO)
NDP
Measurement Report frame
(Optional)
NDPA
(RA=P2P Interface Address, MS_ID=1)
(AID11= AID assigned by GO)
NDP
Measurement Report frame
Sensing measurement termination
Peer-Peer Sensing measurement setup terminated
1100

Figure 11

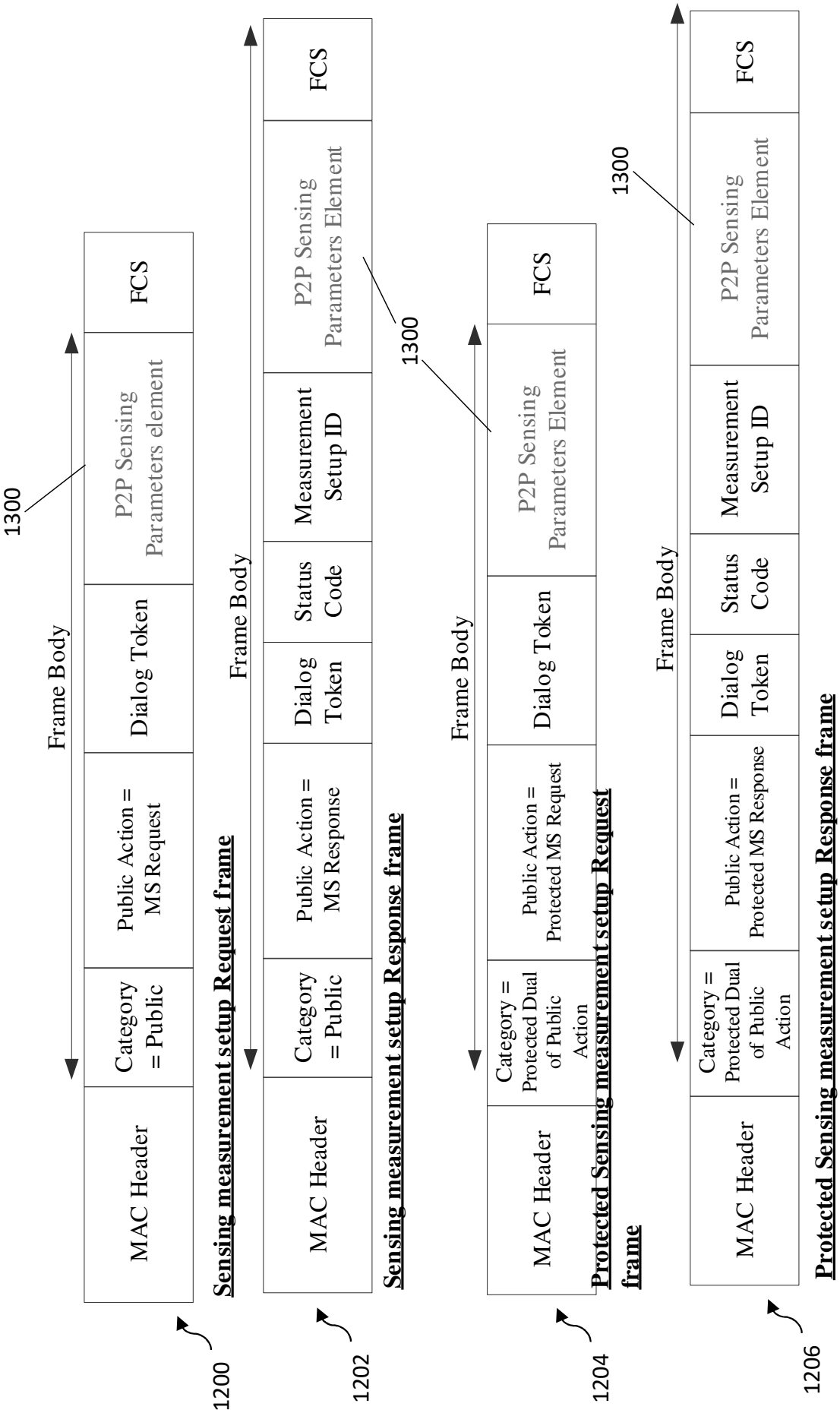

1300
Frame Body
MAC Header
Category = Public
Public Action = MS Request
Dialog Token
P2P Sensing Parameters element
FCS
1200
Sensing measurement setup Request frame
Frame Body
MAC Header
Category = Public
Public Action = MS Response
Dialog Token
Status Code
Measurement Setup ID
P2P Sensing Parameters Element
FCS
1202
Sensing measurement setup Response frame
1300
Frame Body
MAC Header
Category = Protected Dual of Public Action
Public Action = Protected MS Request
Dialog Token
P2P Sensing Parameters Element
FCS
1204
Protected Sensing measurement setup Request frame
1300
Frame Body
MAC Header
Category = Protected Dual of Public Action
Public Action = Protected MS Response
Dialog Token
Status Code
Measurement Setup ID
P2P Sensing Parameters Element
FCS
1206
Protected Sensing measurement setup Response frame

Figure 12

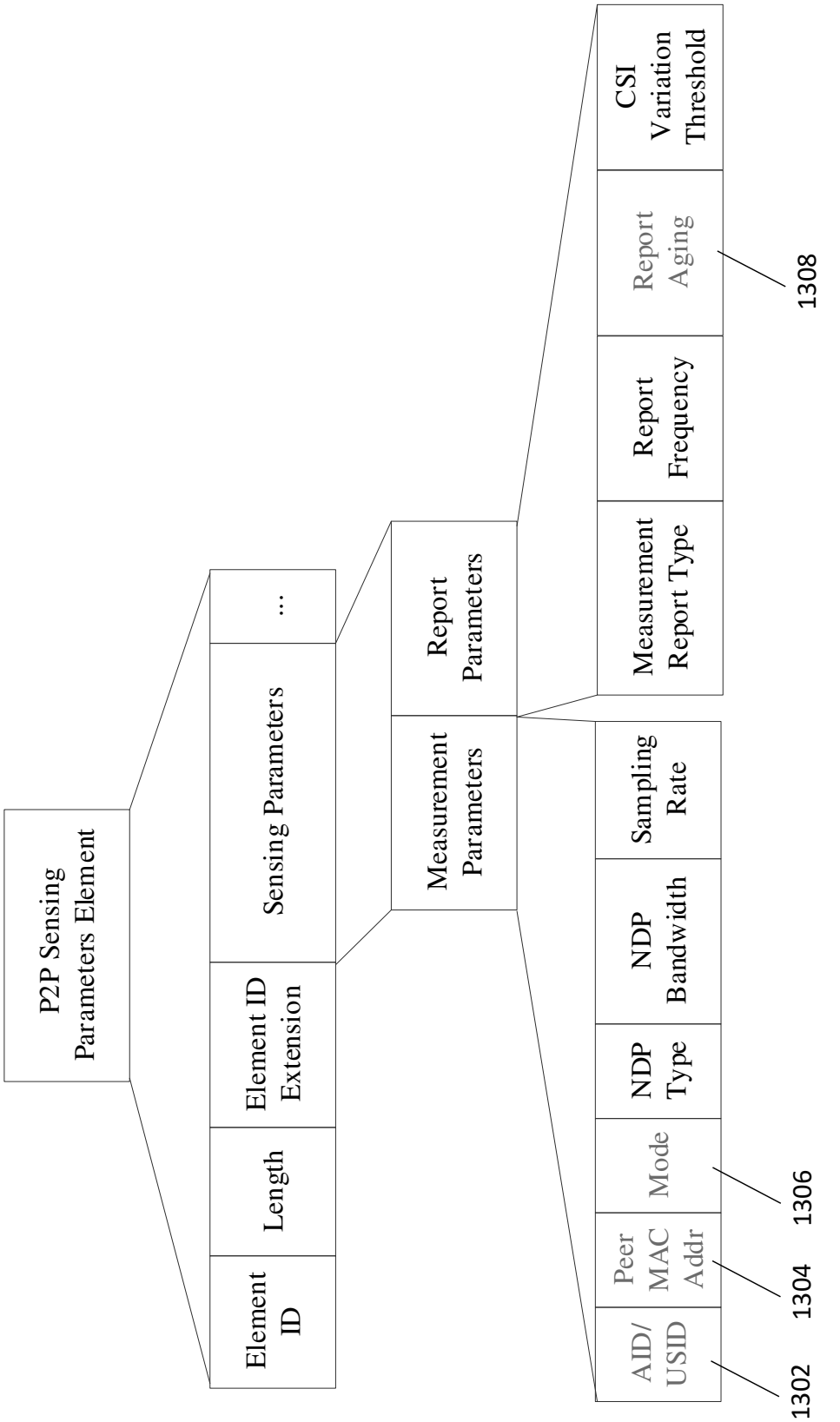
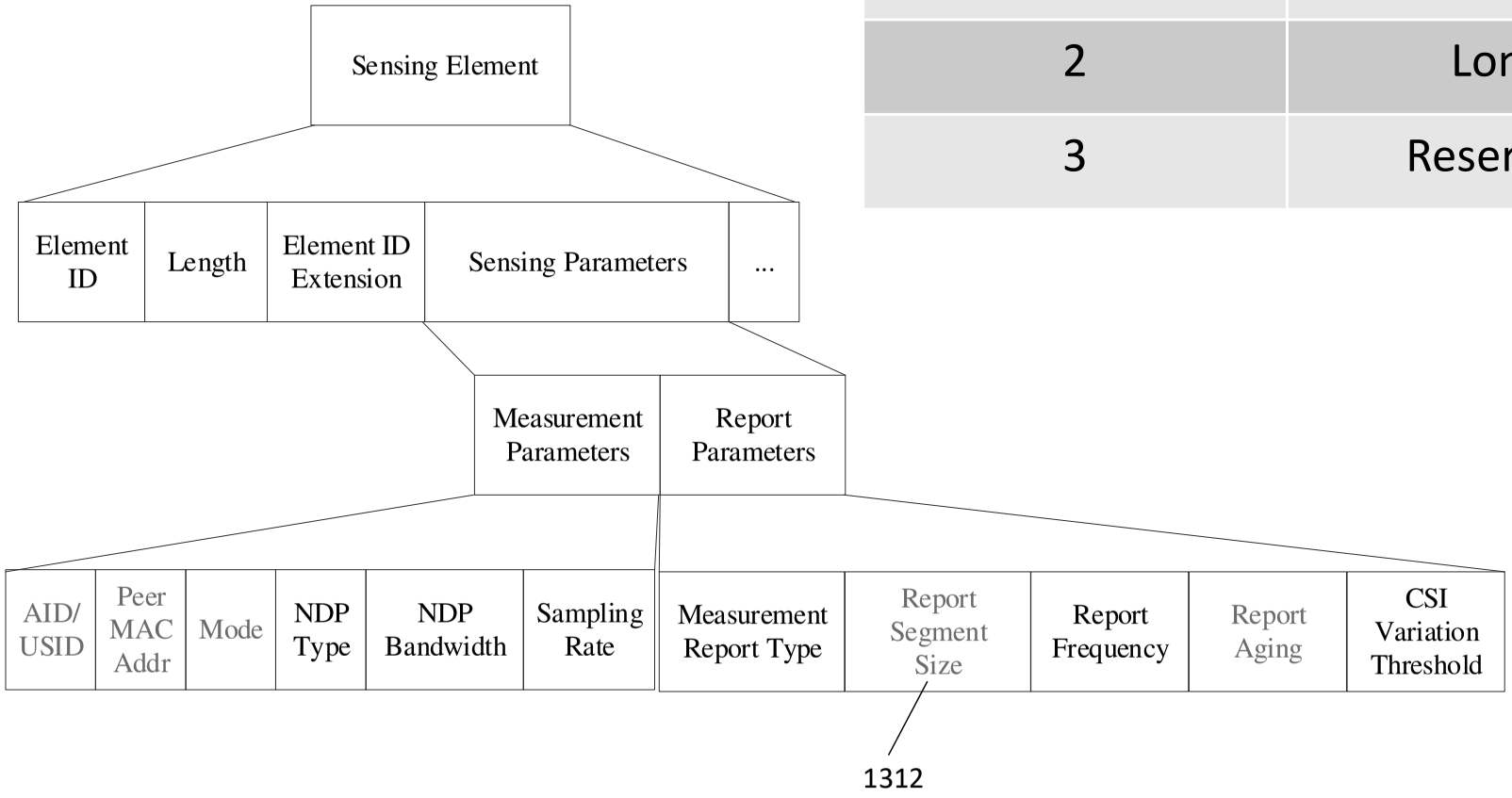

P2P Sensing Parameters Element
Element ID
Length
Element ID Extension
Sensing Parameters
...
Measurement Parameters
Report Parameters
AID/ USID
Peer MAC Addr
Mode
NDP Type
NDP Bandwidth
Sampling Rate
Measurement Report Type
Report Frequency
Report Aging
CSI Variation Threshold
1302
1304
1306
1308
1300

Figure 13A

Report Segment size	Report length
0	Short
1	Medium
2	Long
3	Reserved

1314



1310

Figure 13B

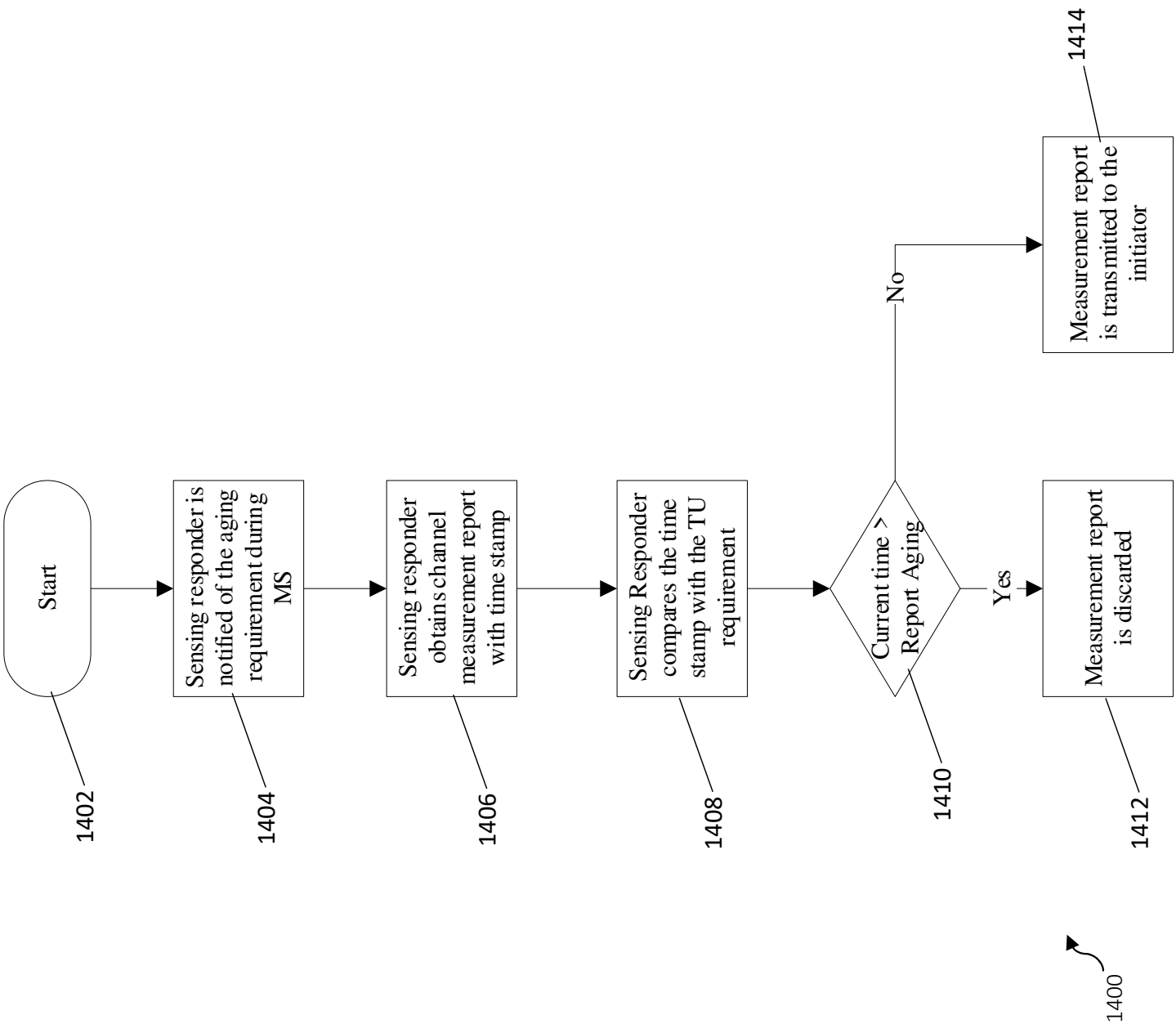

Start
Sensing responder is notified of the aging requirement during MS
Sensing responder obtains channel measurement report with time stamp
Sensing Responder compares the time stamp with the TU requirement
Current time > Report Aging
Yes
No
Measurement report is discarded
Measurement report is transmitted to the initiator
1400
1402
1404
1406
1408
1410
1412
1414

Figure 14

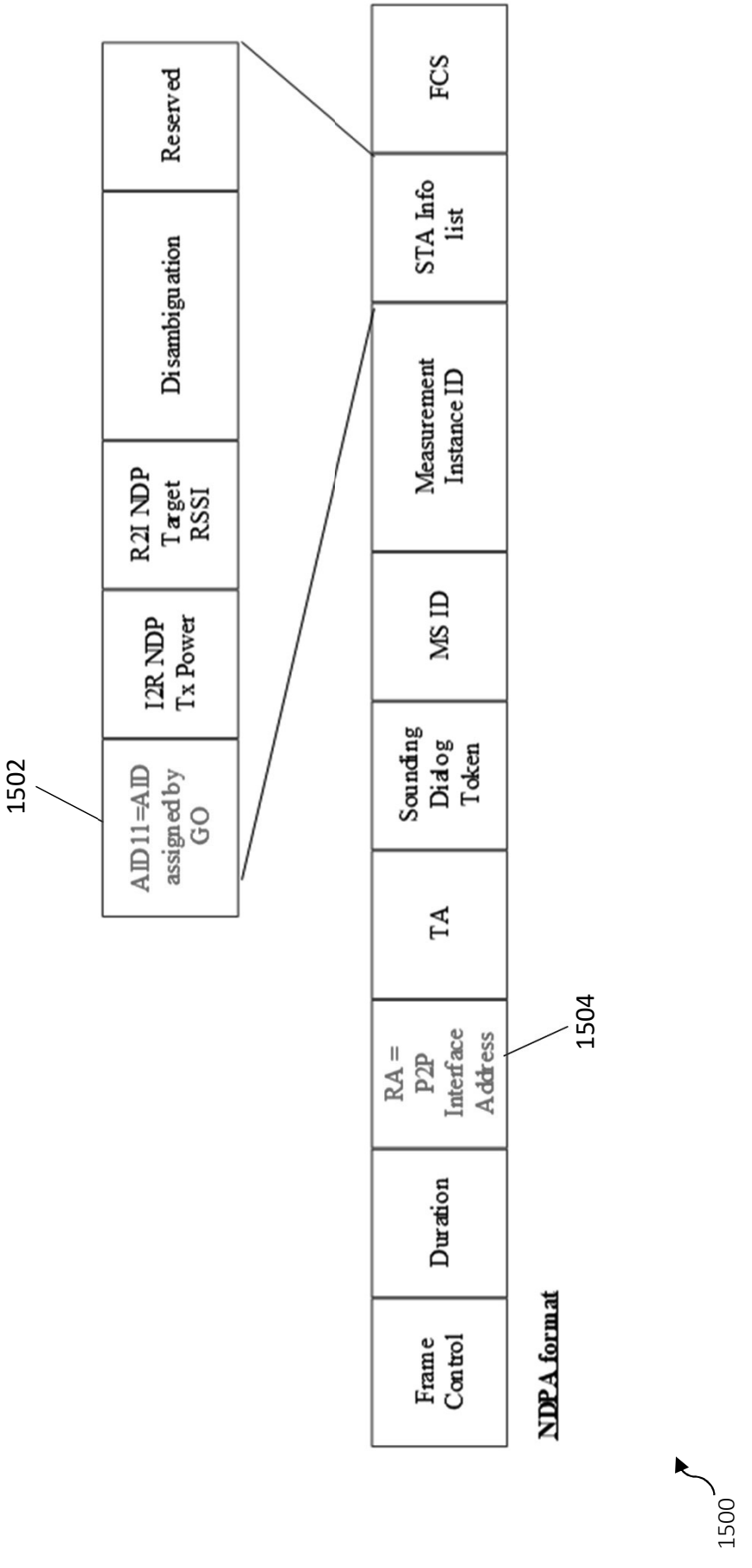

1500
NDPA format
Frame Control
Duration
RA = P2P Interface Address
TA
Sounding Dialog Token
MS ID
Measurement Instance ID
STA Info list
FCS
1504
AID 11=AID assigned by GO
I2R NDP Tx Power
R2I NDP Target RSSI
Disambiguation
Reserved
1502

Figure 15

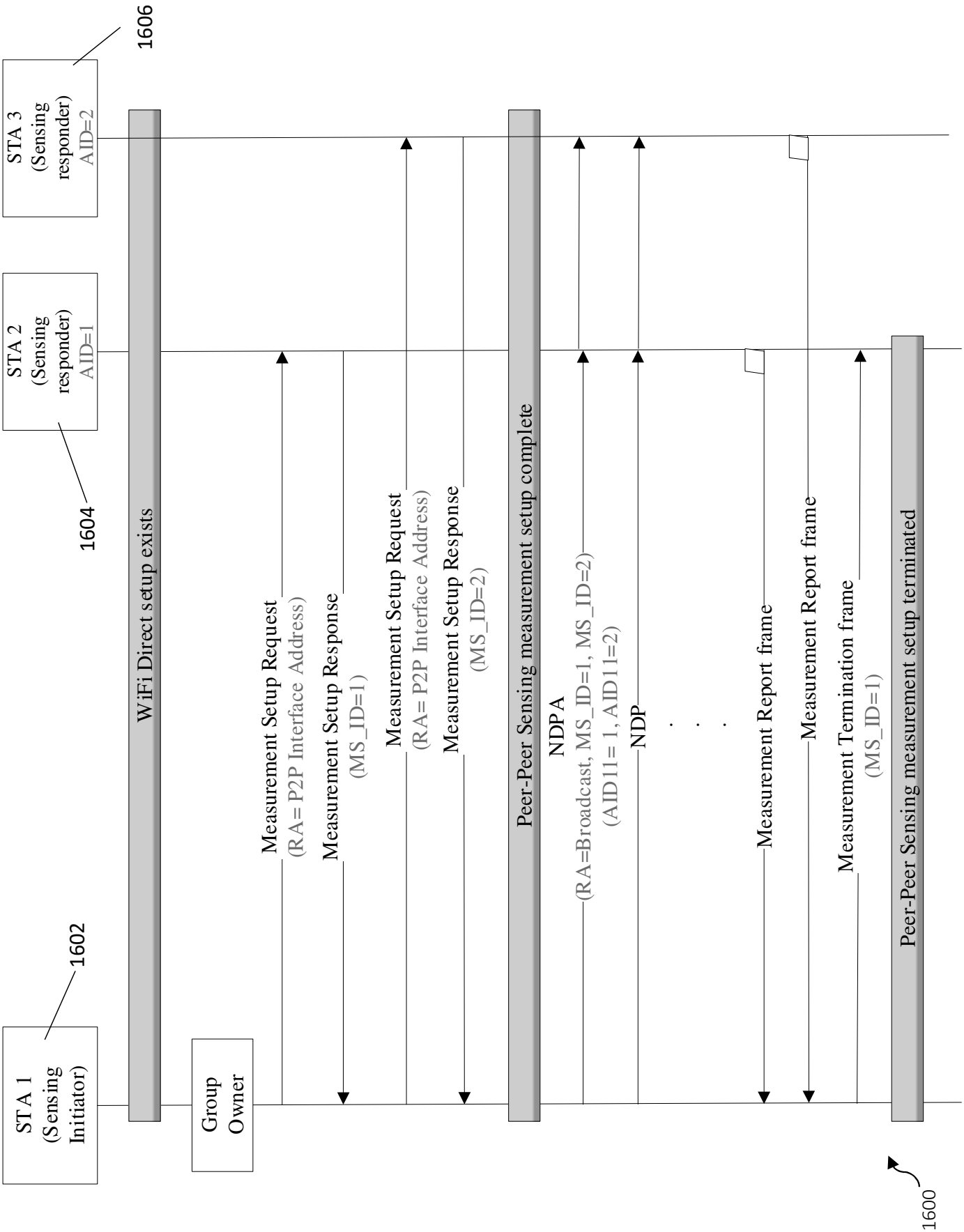

STA 1
(Sensing
Initiator)
1602
Group
Owner
WiFi Direct setup exists
1604
STA 2
(Sensing
responder)
AID=1
STA 3
(Sensing
responder)
AID=2
1606
Measurement Setup Request
(RA= P2P Interface Address)
Measurement Setup Response
(MS_ID=1)
Measurement Setup Request
(RA= P2P Interface Address)
Measurement Setup Response
(MS_ID=2)
Peer-Peer Sensing measurement setup complete
NDP A
(RA=Broadcast, MS_ID=1, MS_ID=2)
(AID11= 1, AID11=2)
NDP
Measurement Report frame
Measurement Report frame
Measurement Termination frame
(MS_ID=1)
Peer-Peer Sensing measurement setup terminated
1600

Figure 16

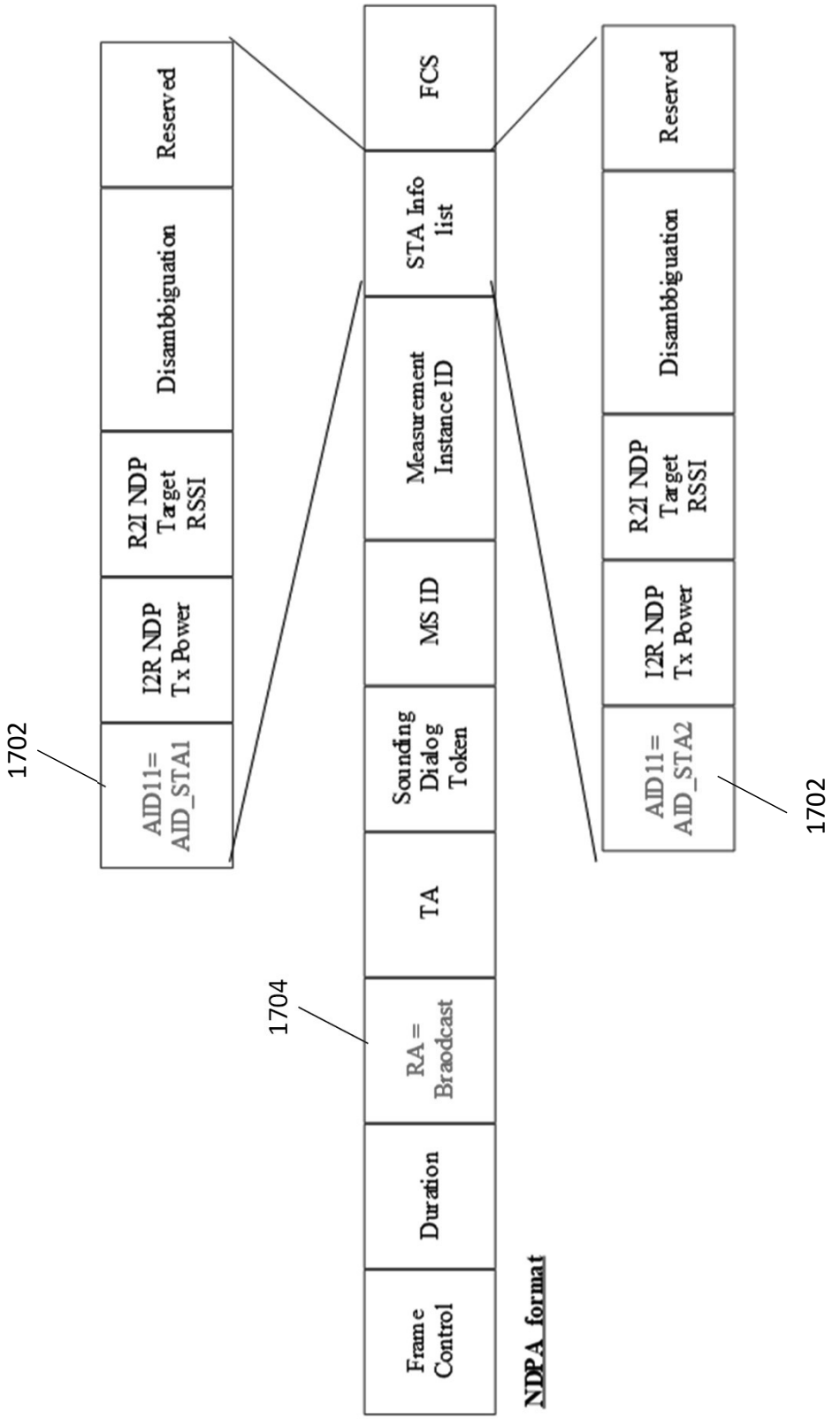

Frame Control
Duration
RA = Braodcast
TA
Sounding Dialog Token
MS ID
Measurement Instance ID
STA Info list
FCS
AID11= AID_STA1
I2R NDP Tx Power
R2I NDP Target RSSI
Disambbiguation
Reserved
AID11= AID_STA2
I2R NDP Tx Power
R2I NDP Target RSSI
Disambbiguation
Reserved
NDPA format
1702
1704
1702
1700

Figure 17

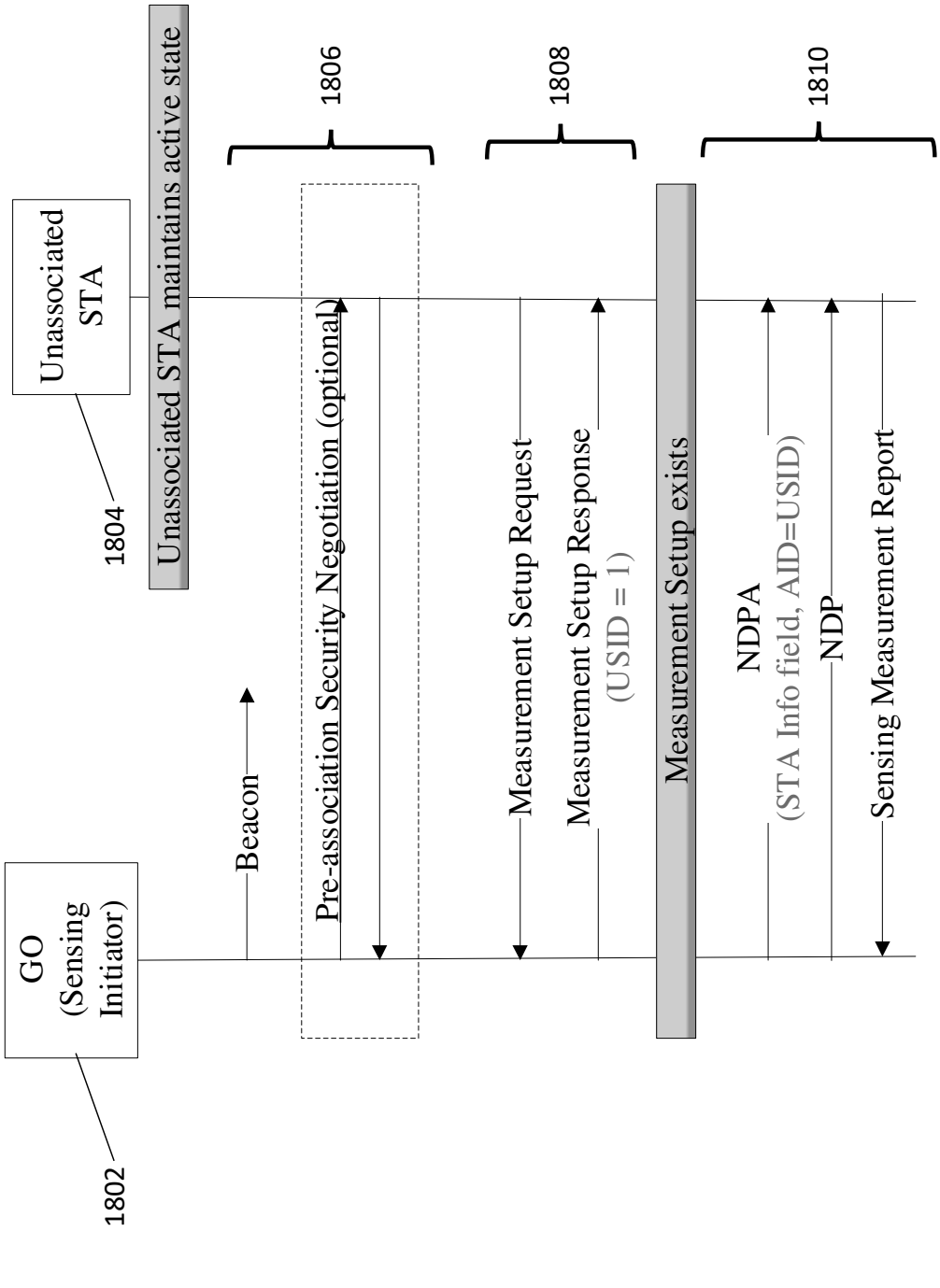
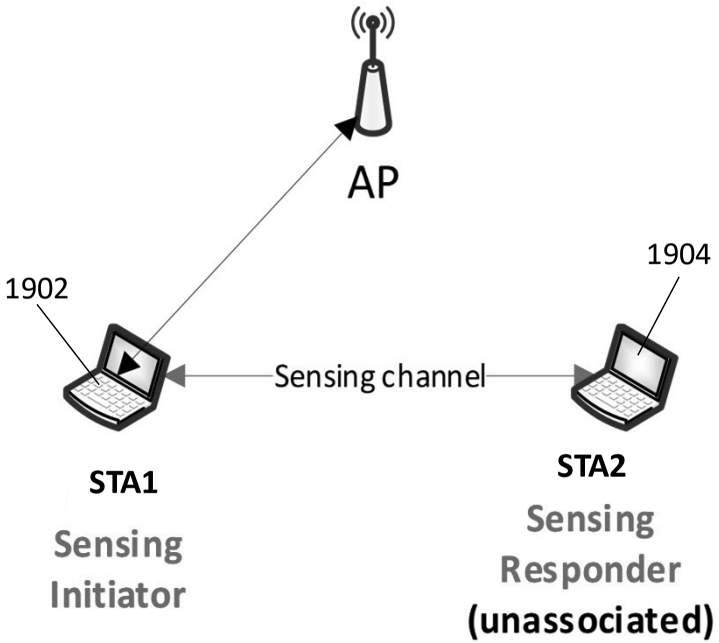

GO
(Sensing
Initiator)
1802
Unassociated
STA
1804
Unassociated STA maintains active state
1806
1808
1810
Beacon
Pre-association Security Negotiation (optional)
Measurement Setup Request
Measurement Setup Response
(USID = 1)
Measurement Setup exists
NDPA
(STA Info field, AID=USID)
NDP
Sensing Measurement Report
1800

Figure 18



1900

Figure 19

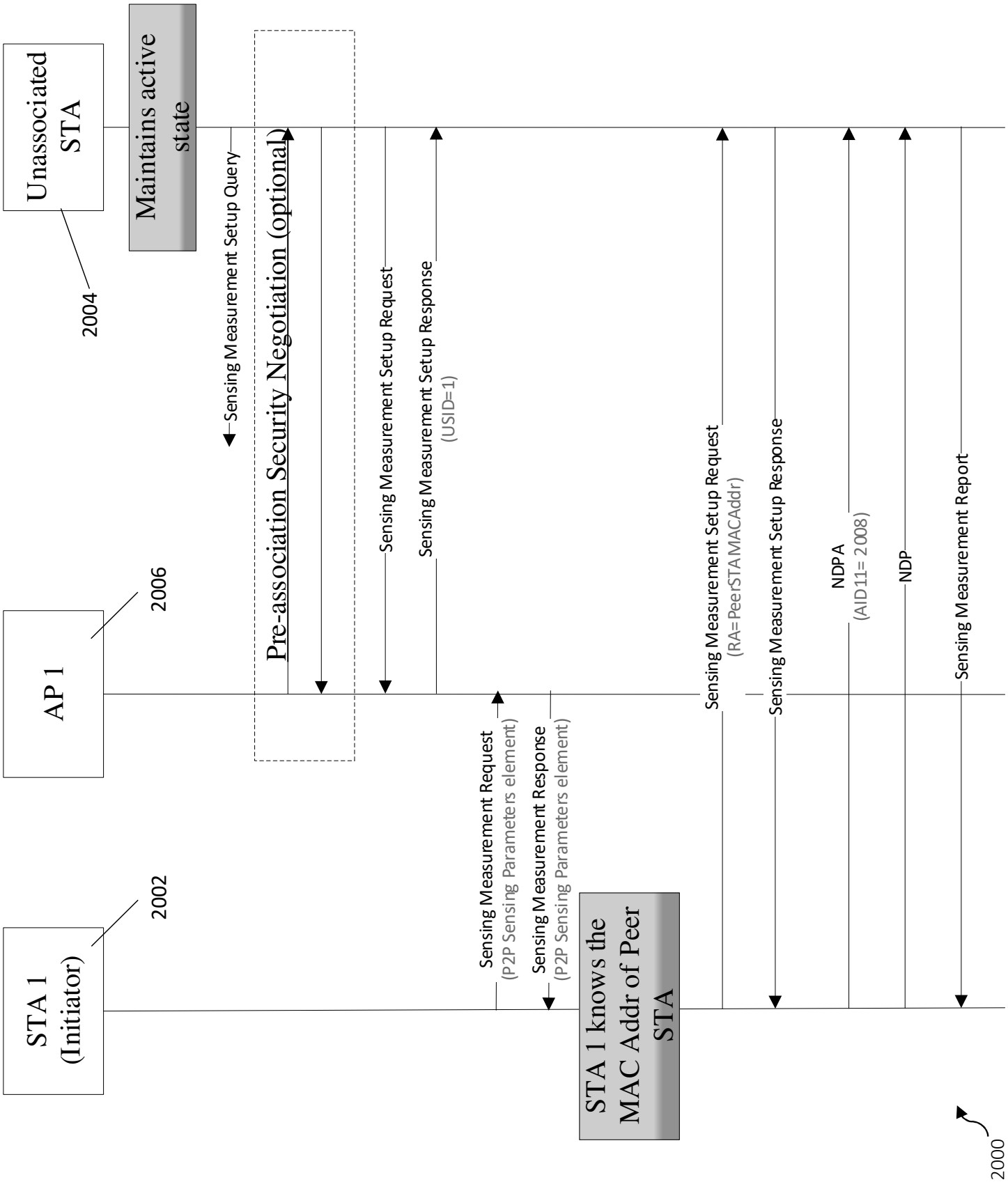
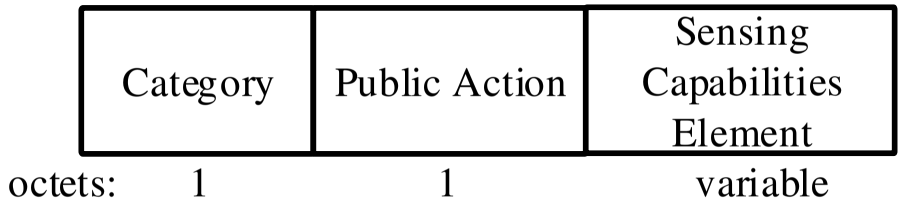

Unassociated STA
Maintains active state
2004
Sensing Measurement Setup Query
Pre-association Security Negotiation (optional)
Sensing Measurement Setup Request
Sensing Measurement Setup Response
(USID=1)
AP 1
2006
Sensing Measurement Request
(P2P Sensing Parameters element)
Sensing Measurement Response
(P2P Sensing Parameters element)
Sensing Measurement Setup Request
(RA= PeerSTAMACAddr)
Sensing Measurement Setup Response
NDPA
(AID11= 2008)
NDP
Sensing Measurement Report
STA 1 knows the MAC Addr of Peer STA
STA 1 (Initiator)
2002
2000

Figure 20



2100

Figure 21

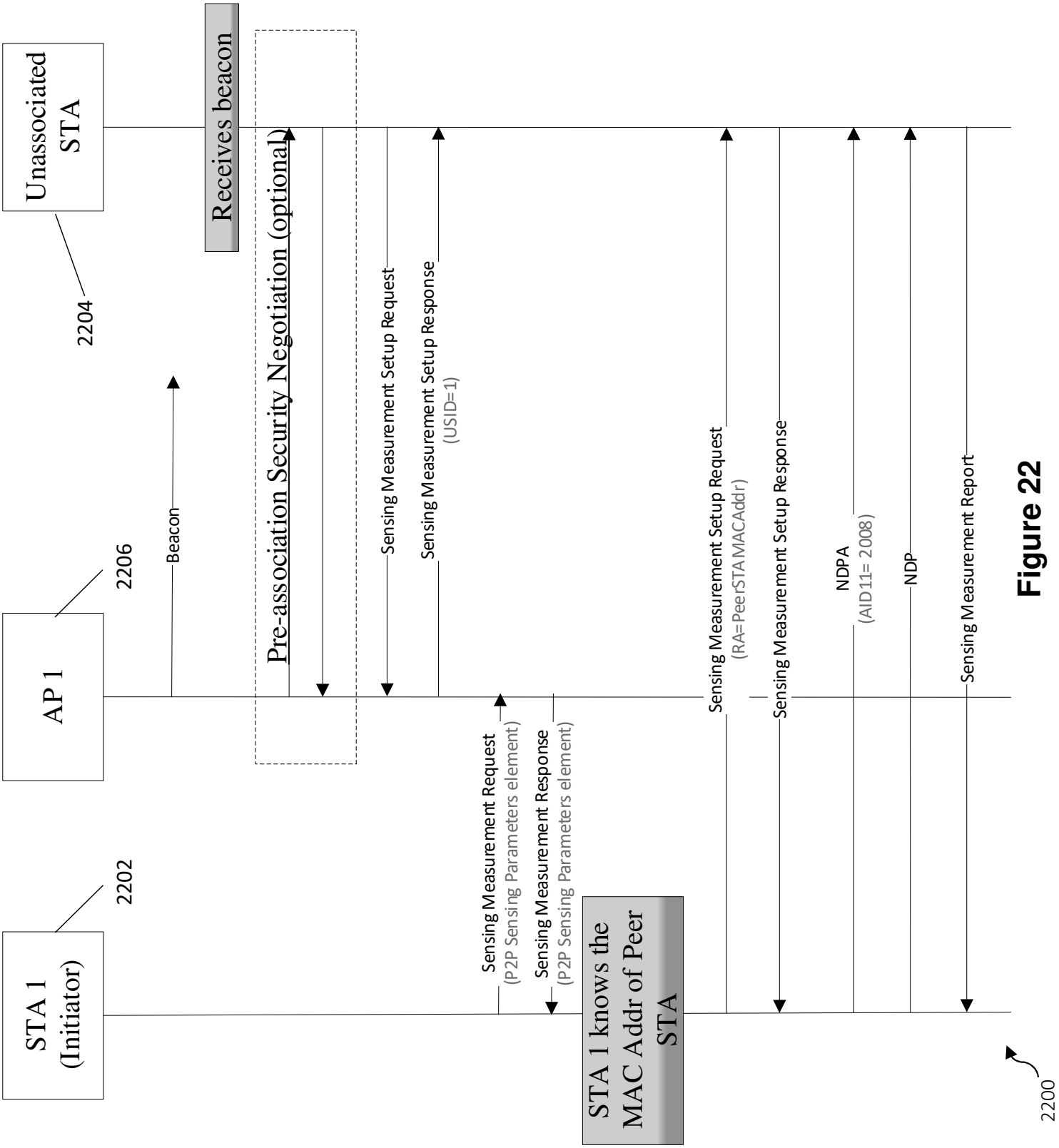

Unassociated STA
2204
Receives beacon
Pre-association Security Negotiation (optional)
AP 1
2206
Beacon
Sensing Measurement Setup Request
Sensing Measurement Setup Response
(USID=1)
Sensing Measurement Setup Request
(RA=PeerSTA MACAddr)
Sensing Measurement Setup Response
NDPA
(AID11= 2008)
NDP
Sensing Measurement Report
STA 1
(Initiator)
2202
Sensing Measurement Request
(P2P Sensing Parameters element)
Sensing Measurement Response
(P2P Sensing Parameters element)
STA 1 knows the MAC Addr of Peer STA
2200

Figure 22

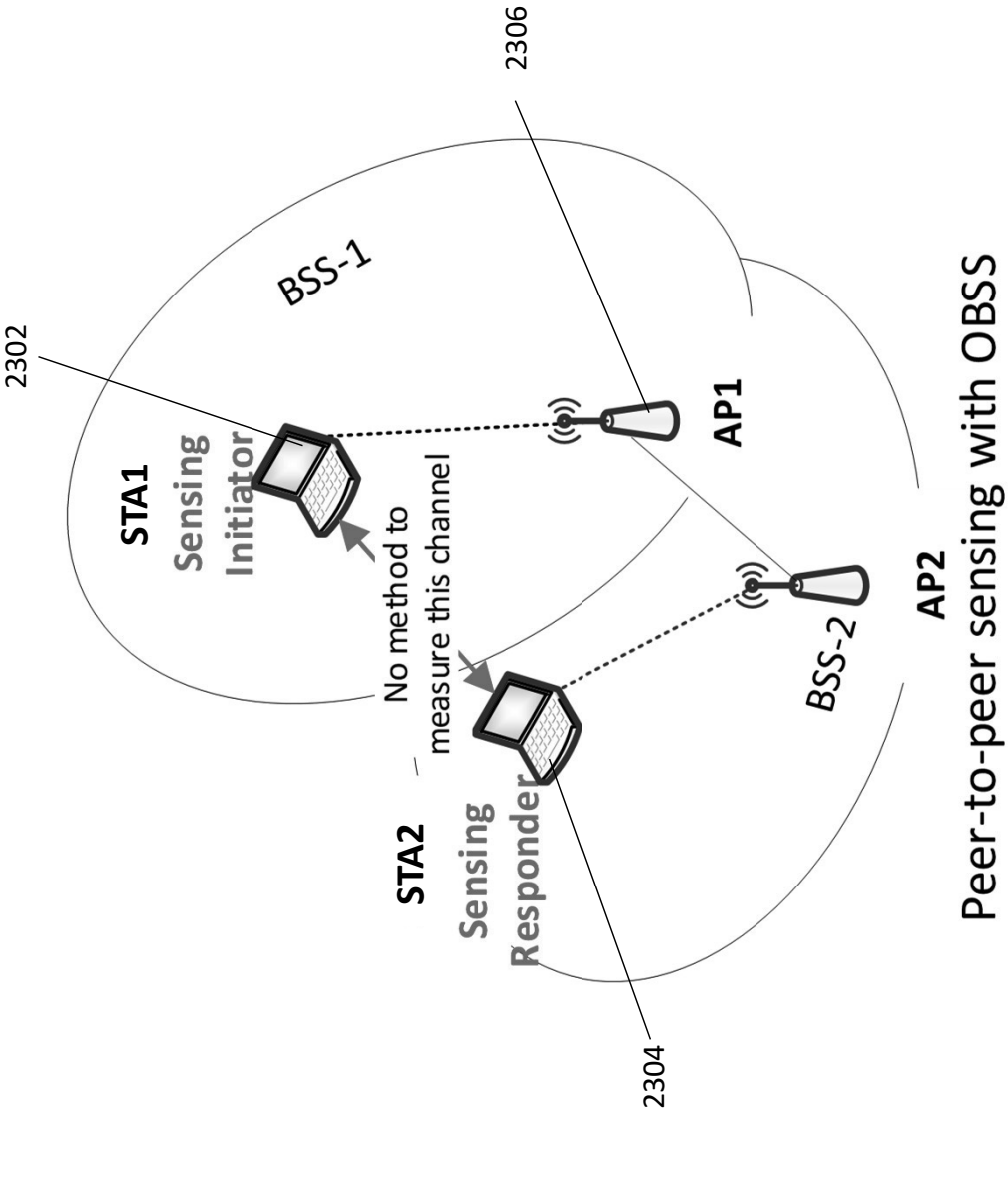

2302
2306
BSS-1
STA1
Sensing
Initiator
AP1
No method to
measure this channel
STA2
Sensing
Responder
BSS-2
AP2
2304
Peer-to-peer sensing with OBSS
STA
2300

Figure 23

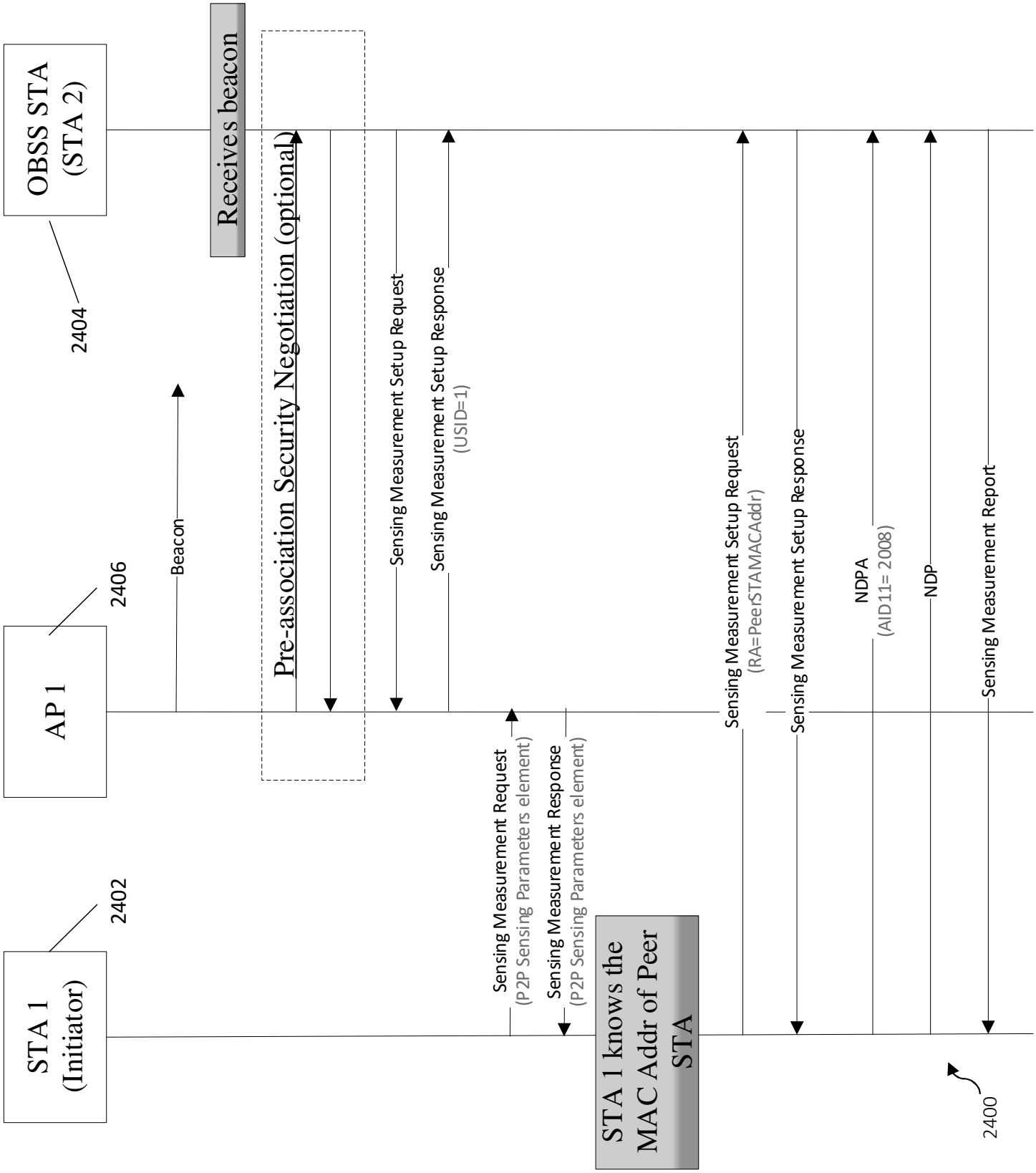

OBSS STA
(STA 2)
2404
Receives beacon
AP 1
2406
Beacon
Pre-association Security Negotiation (optional)
Sensing Measurement Setup Request
Sensing Measurement Setup Response
(USID=1)
STA 1
(Initiator)
2402
Sensing Measurement Request
(P2P Sensing Parameters element)
Sensing Measurement Response
(P2P Sensing Parameters element)
STA 1 knows the MAC Addr of Peer STA
Sensing Measurement Setup Request
(RA=PeerSTAMACAddr)
Sensing Measurement Setup Response
NDPA
(AID11= 2008)
NDP
Sensing Measurement Report
2400

Figure 24

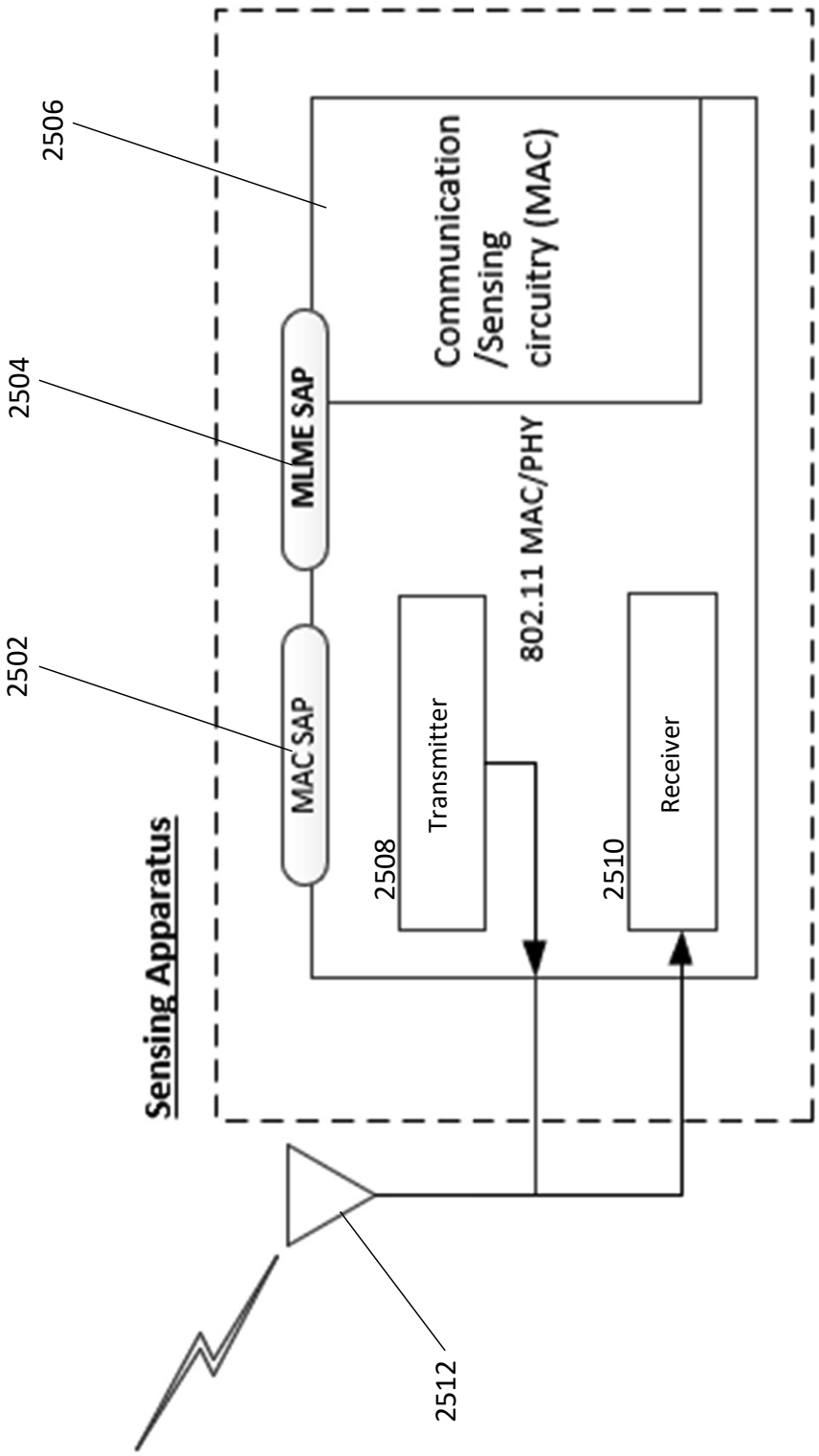

2506
2504
2502
Sensing Apparatus
MAC SAP
MLME SAP
Communication /Sensing circuitry (MAC)
802.11 MAC/PHY
2508
Transmitter
2510
Receiver
2512
2500

Figure 25

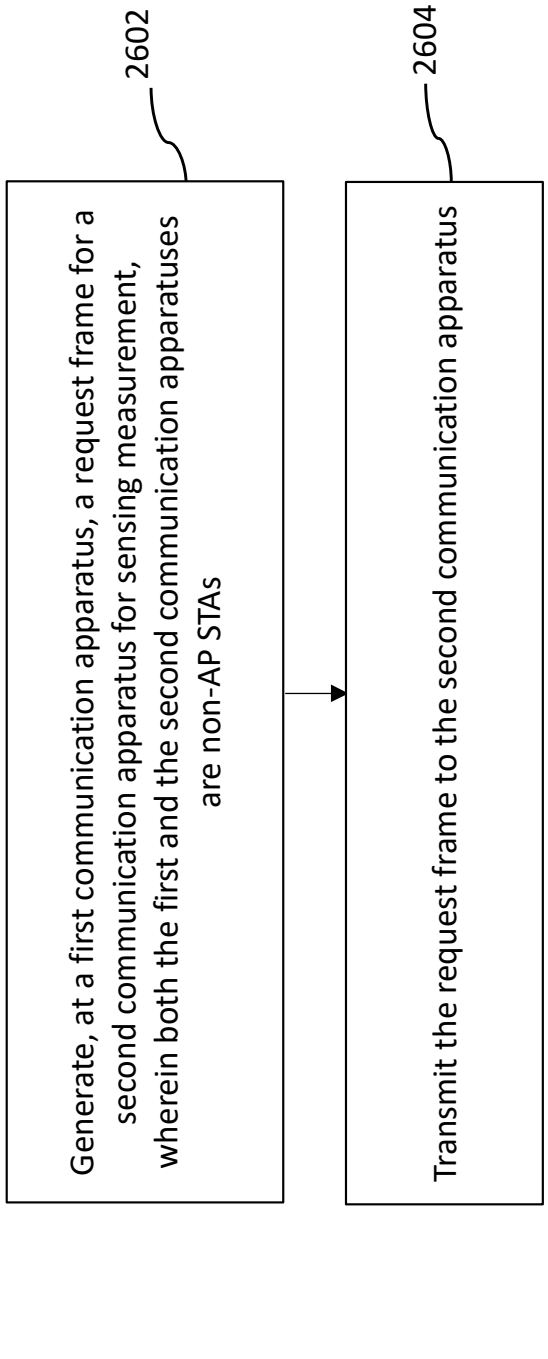

2602
Generate, at a first communication apparatus, a request frame for a second communication apparatus for sensing measurement, wherein both the first and the second communication apparatuses are non-AP STAs
2604
Transmit the request frame to the second communication apparatus
2600

Figure 26

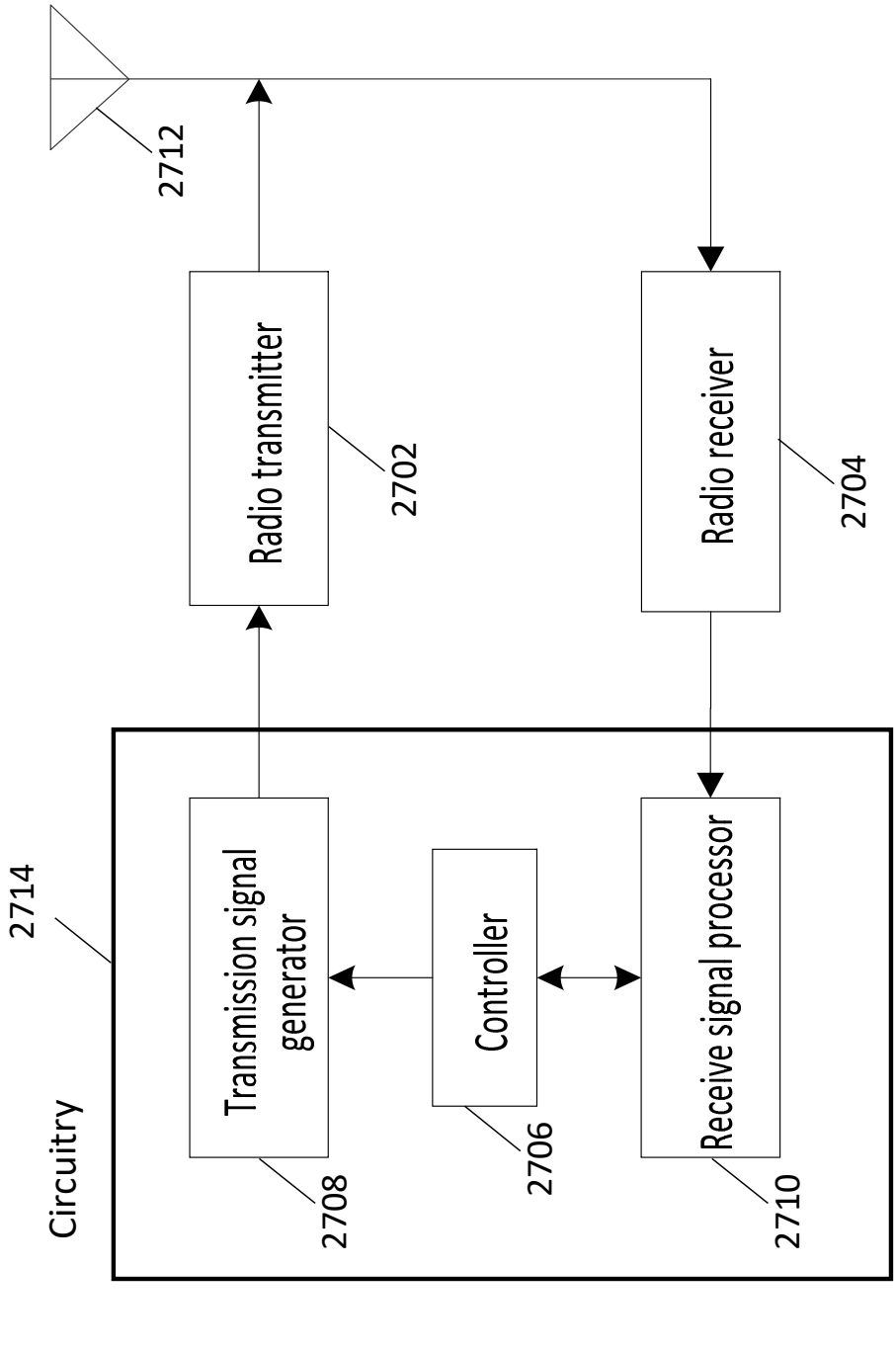

2712
Radio transmitter
2702
Radio receiver
2704
2714
Circuitry
Transmission signal generator
Controller
Receive signal processor
2708
2706
2710
2700

Figure 27