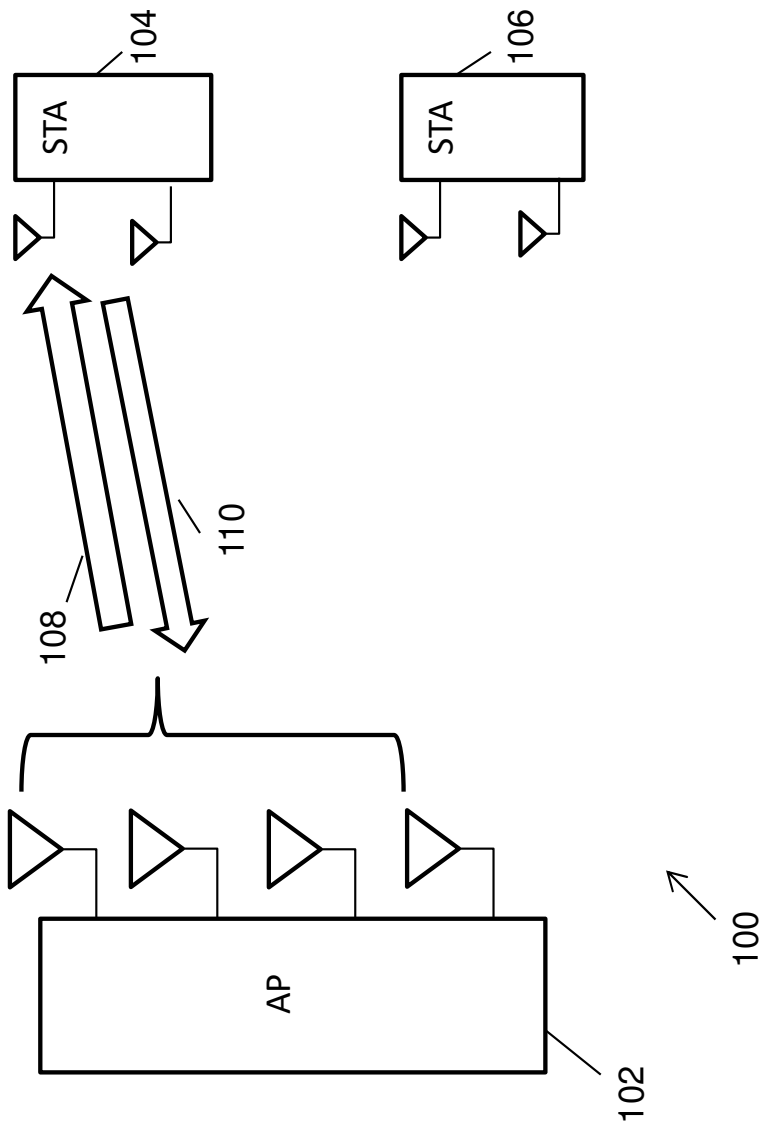


Figure 1

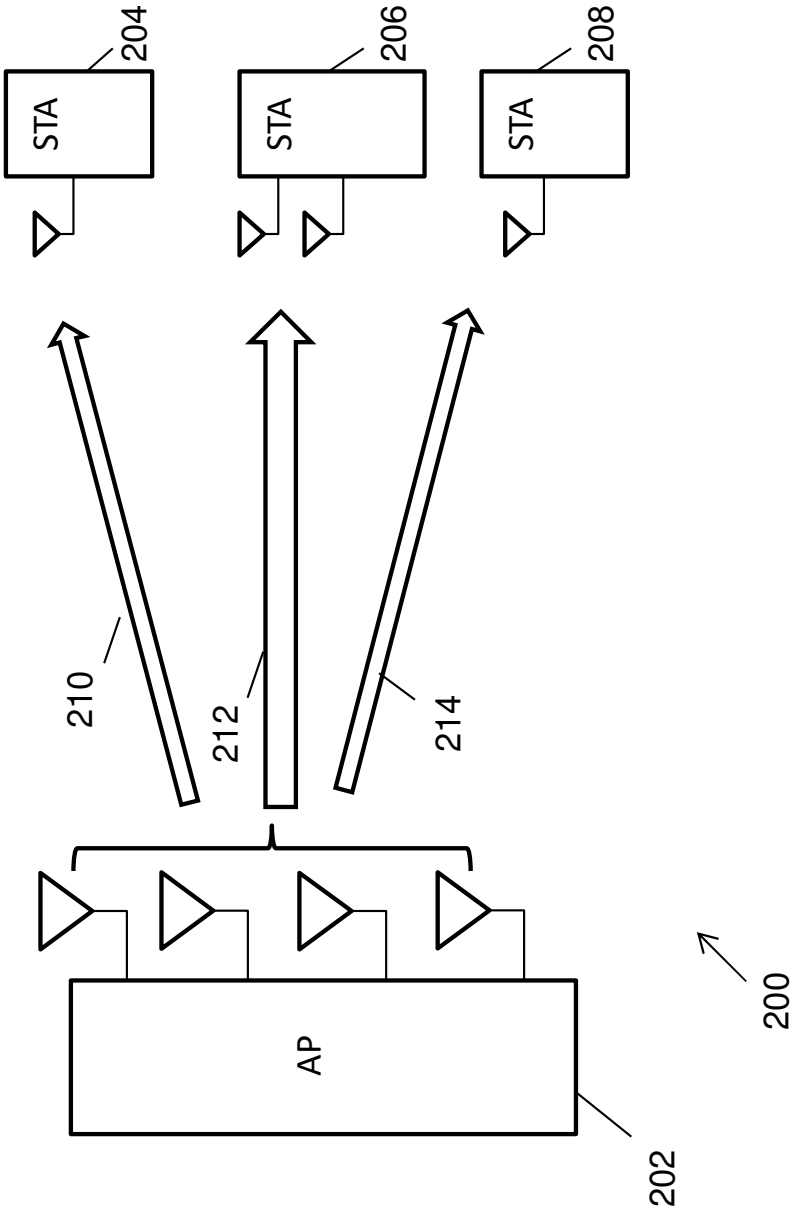


Figure 2

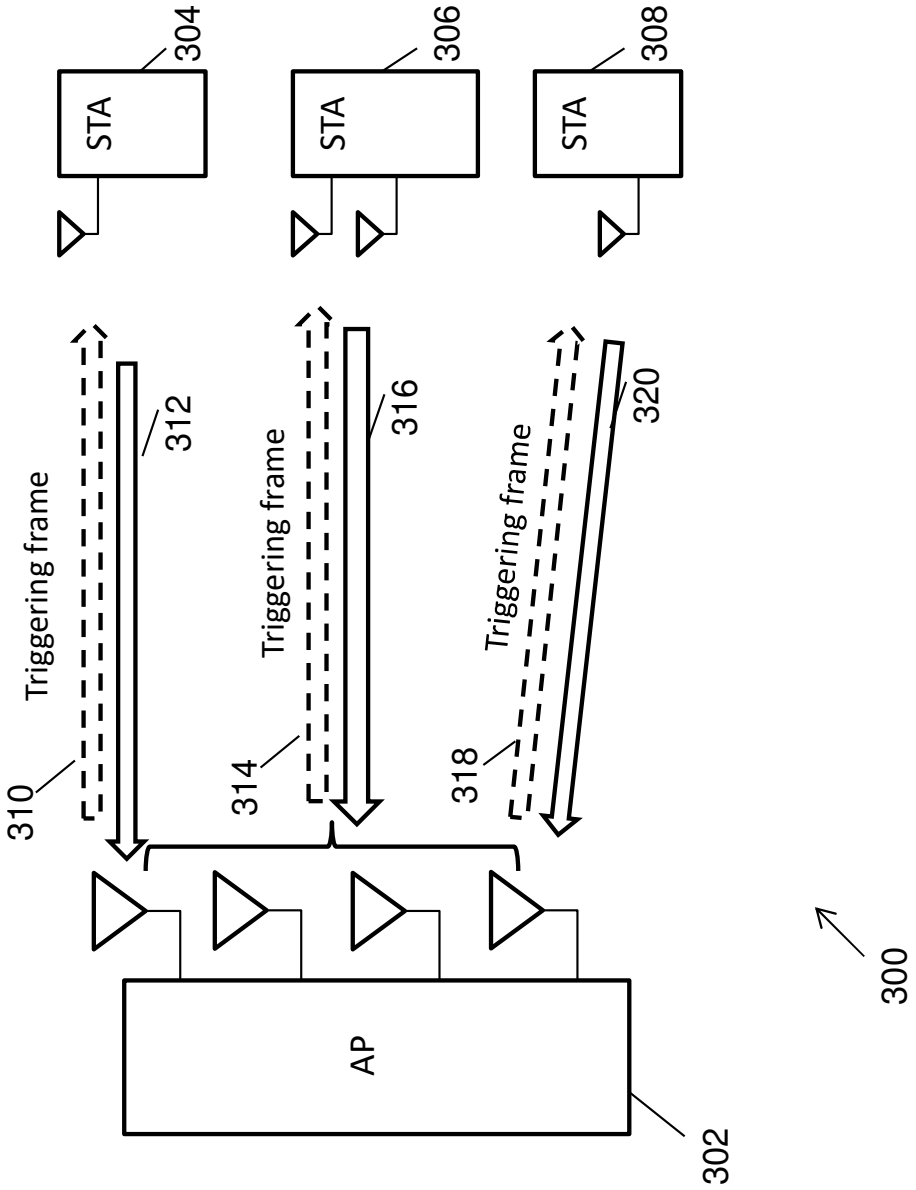

STA
304
STA
306
STA
308
Triggering frame
310
312
Triggering frame
314
316
Triggering frame
318
320
AP
302
300

Figure 3

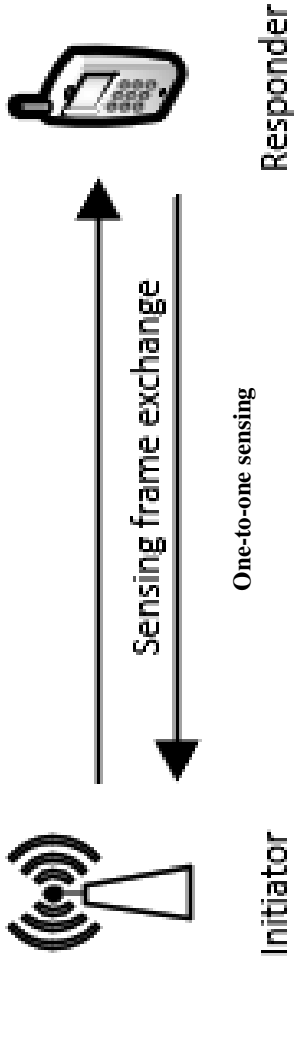

Responder
Sensing frame exchange
One-to-one sensing
Initiator
400

Figure 4

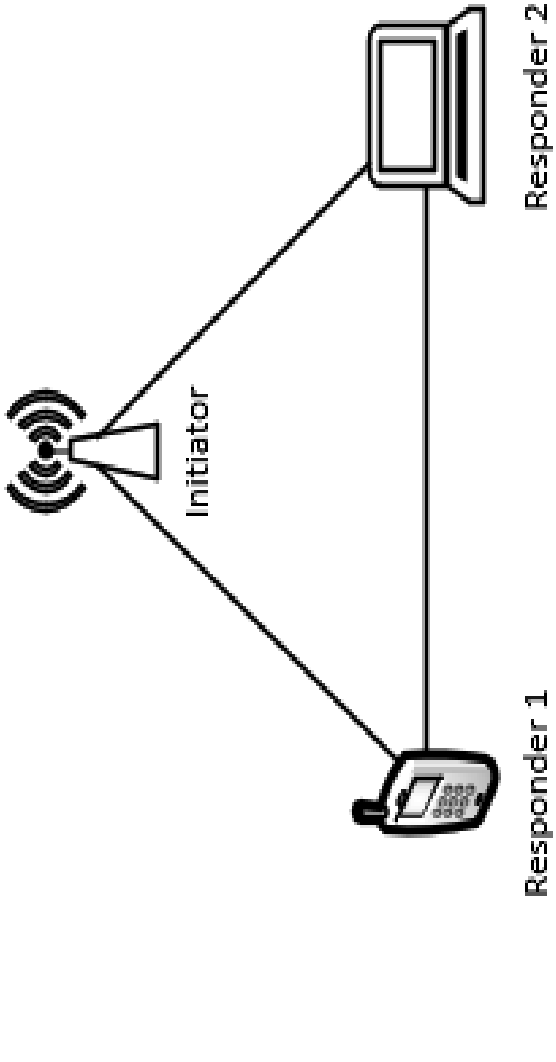


Figure 5

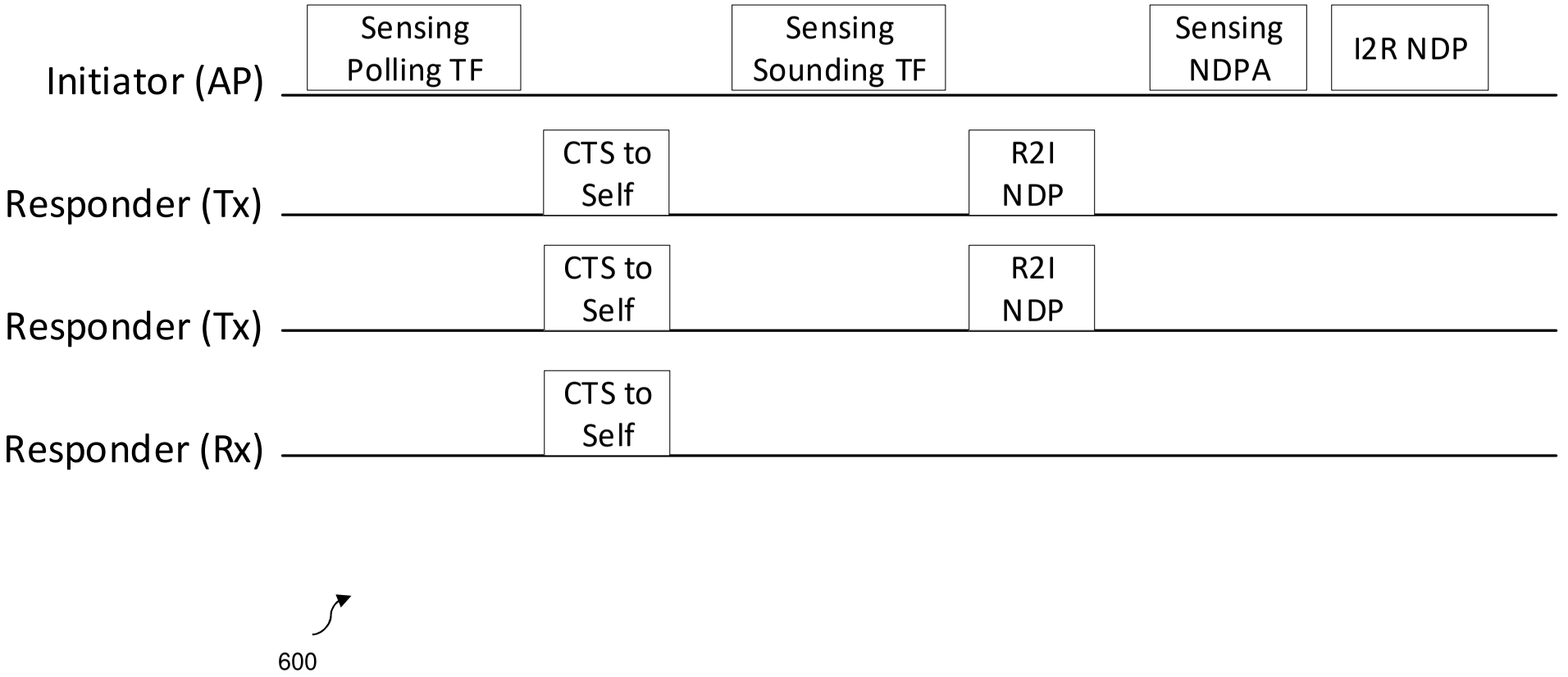

Initiator (AP)
Sensing Polling TF
Sensing Sounding TF
Sensing NDPA
I2R NDP
Responder (Tx)
CTS to Self
R2I NDP
Responder (Tx)
CTS to Self
R2I NDP
Responder (Rx)
CTS to Self
600

Figure 6

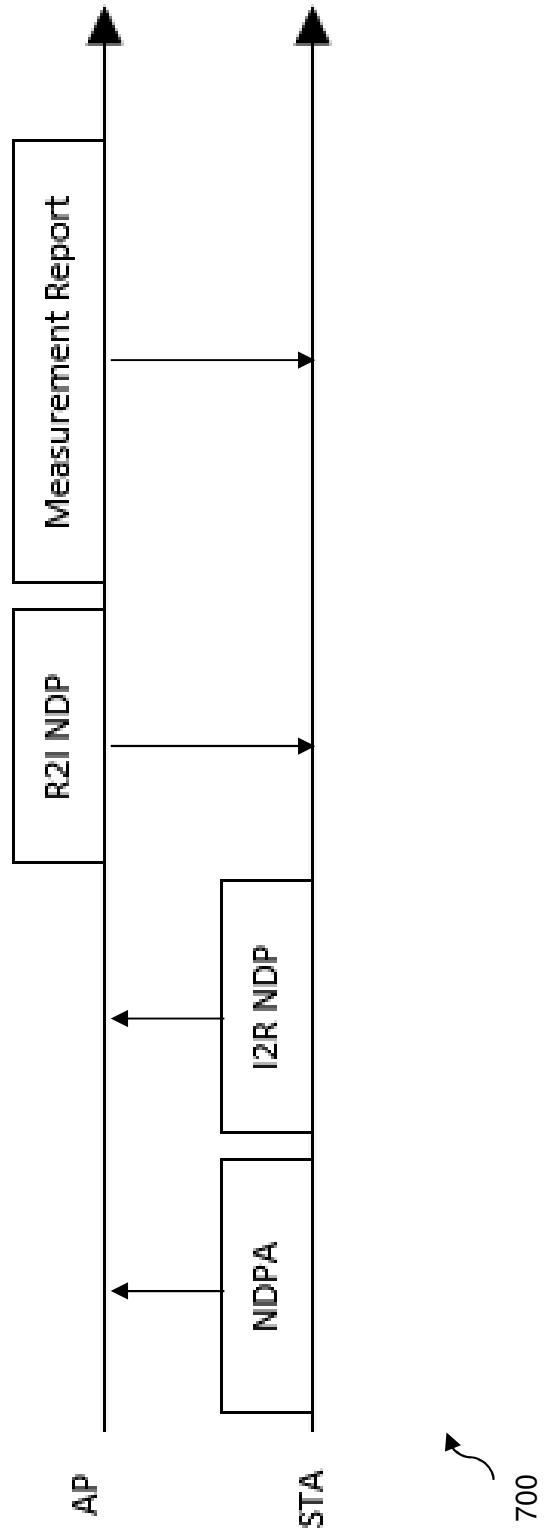


Figure 7

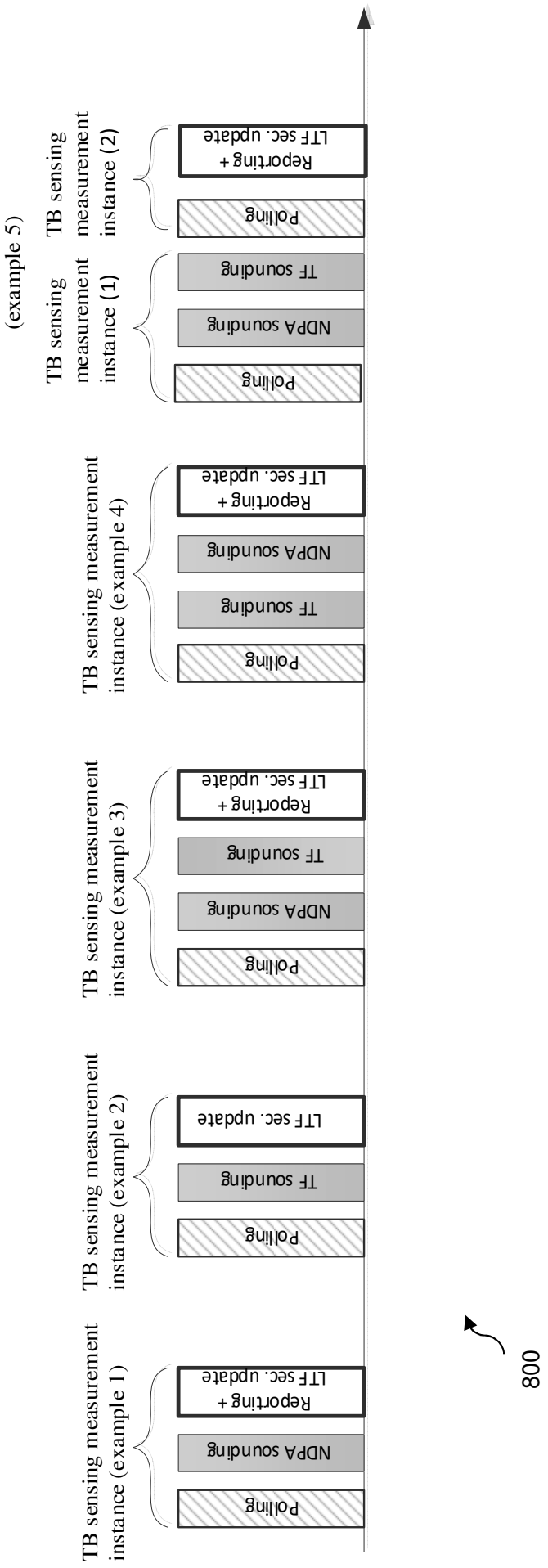

(example 5)
TB sensing measurement instance (1)
Polling
NDPA sounding
TF sounding
Reporting + LTF sec. update
TB sensing measurement instance (2)
Polling
Reporting + LTF sec. update
TB sensing measurement instance (example 1)
Polling
NDPA sounding
Reporting + LTF sec. update
TB sensing measurement instance (example 2)
Polling
TF sounding
LTF sec. update
TB sensing measurement instance (example 3)
Polling
NDPA sounding
TF sounding
Reporting + LTF sec. update
TB sensing measurement instance (example 4)
Polling
TF sounding
NDPA sounding
Reporting + LTF sec. update
800

Figure 8

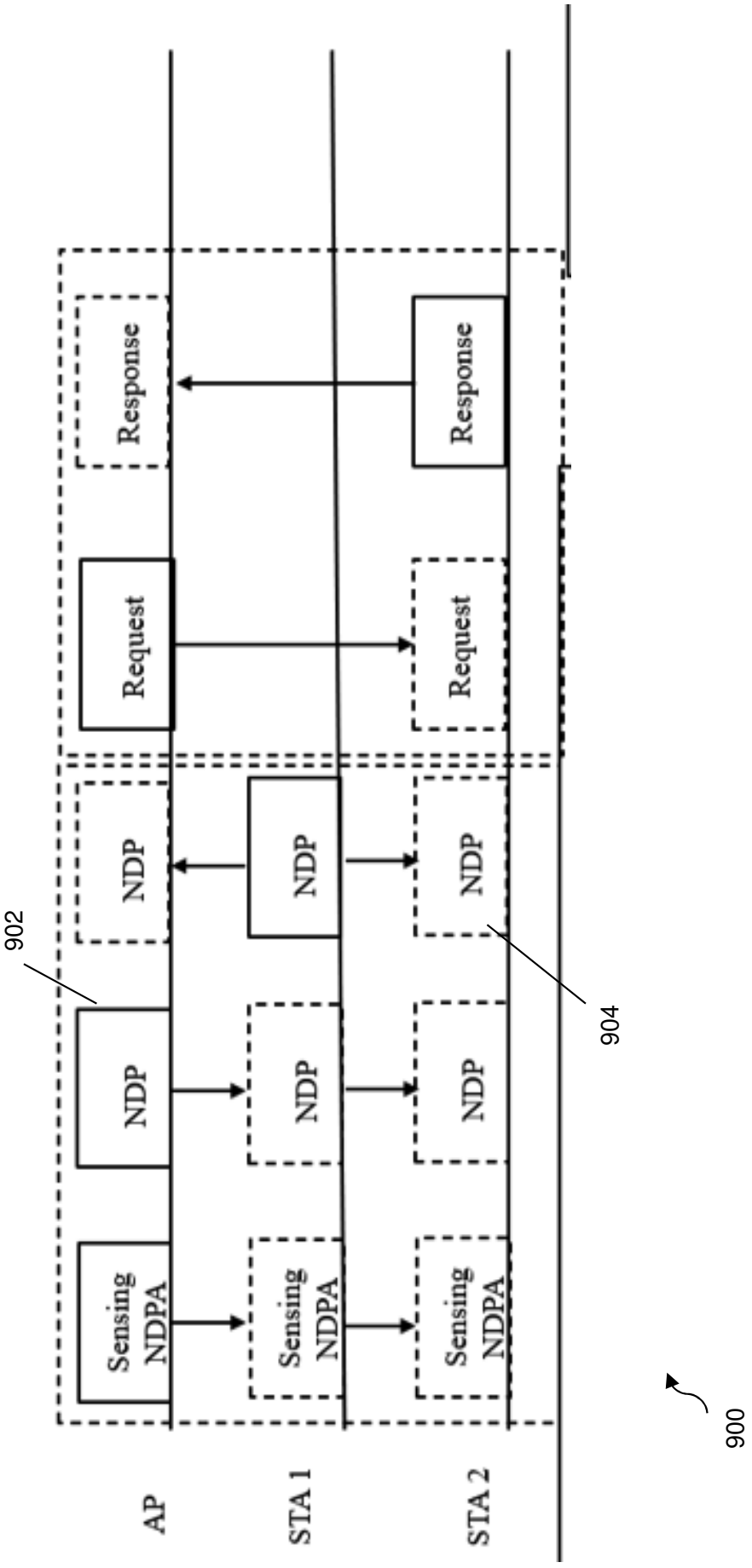


Figure 9

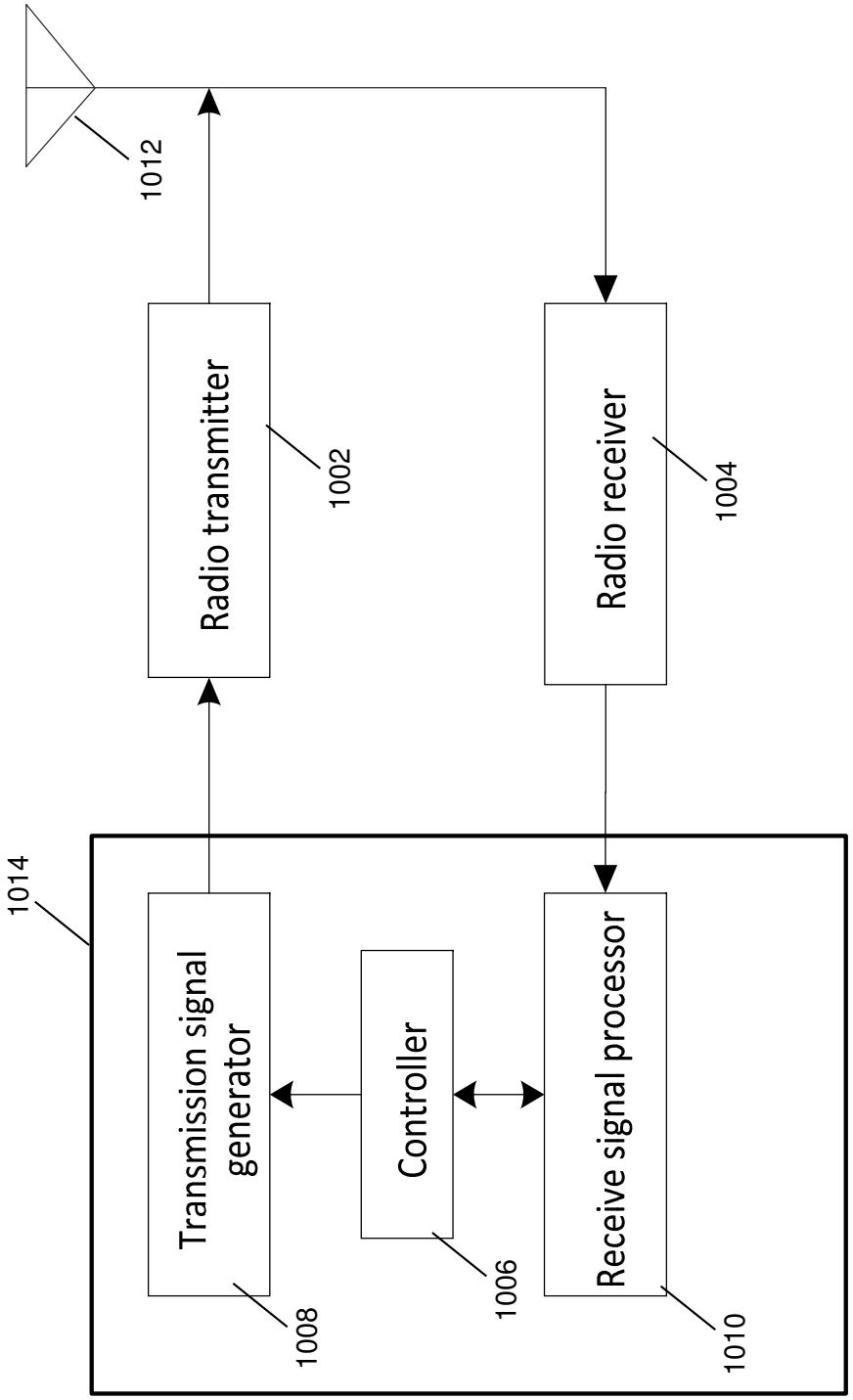

1012
Radio transmitter
1002
Radio receiver
1004
1014
Transmission signal generator
Controller
Receive signal processor
1008
1006
1010
1000

Figure 10

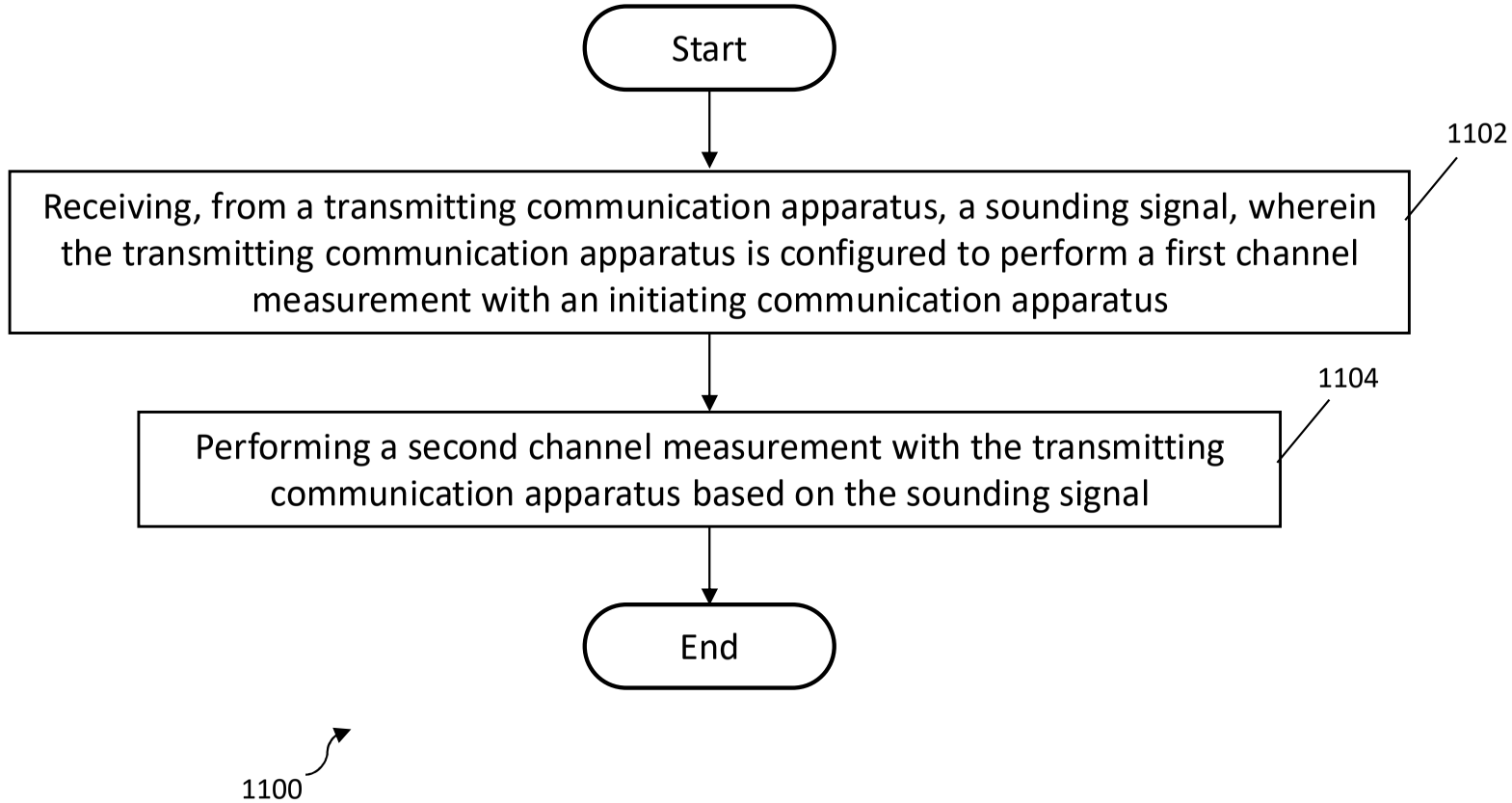

Start
1102
Receiving, from a transmitting communication apparatus, a sounding signal, wherein the transmitting communication apparatus is configured to perform a first channel measurement with an initiating communication apparatus
1104
Performing a second channel measurement with the transmitting communication apparatus based on the sounding signal
End
1100

Figure 11

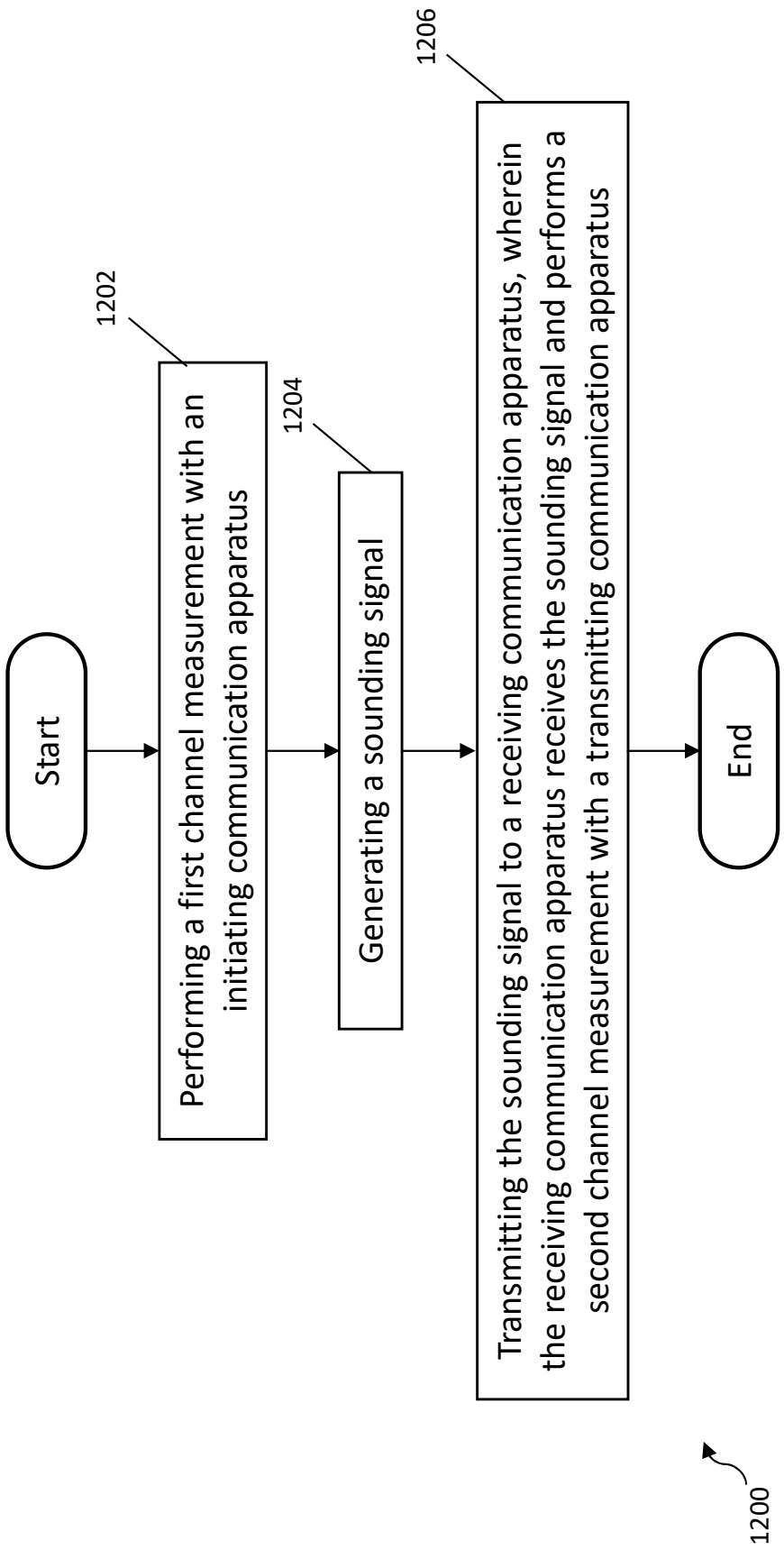

Start
Performing a first channel measurement with an initiating communication apparatus
Generating a sounding signal
Transmitting the sounding signal to a receiving communication apparatus, wherein the receiving communication apparatus receives the sounding signal and performs a second channel measurement with a transmitting communication apparatus
End
1202
1204
1206
1200

Figure 12

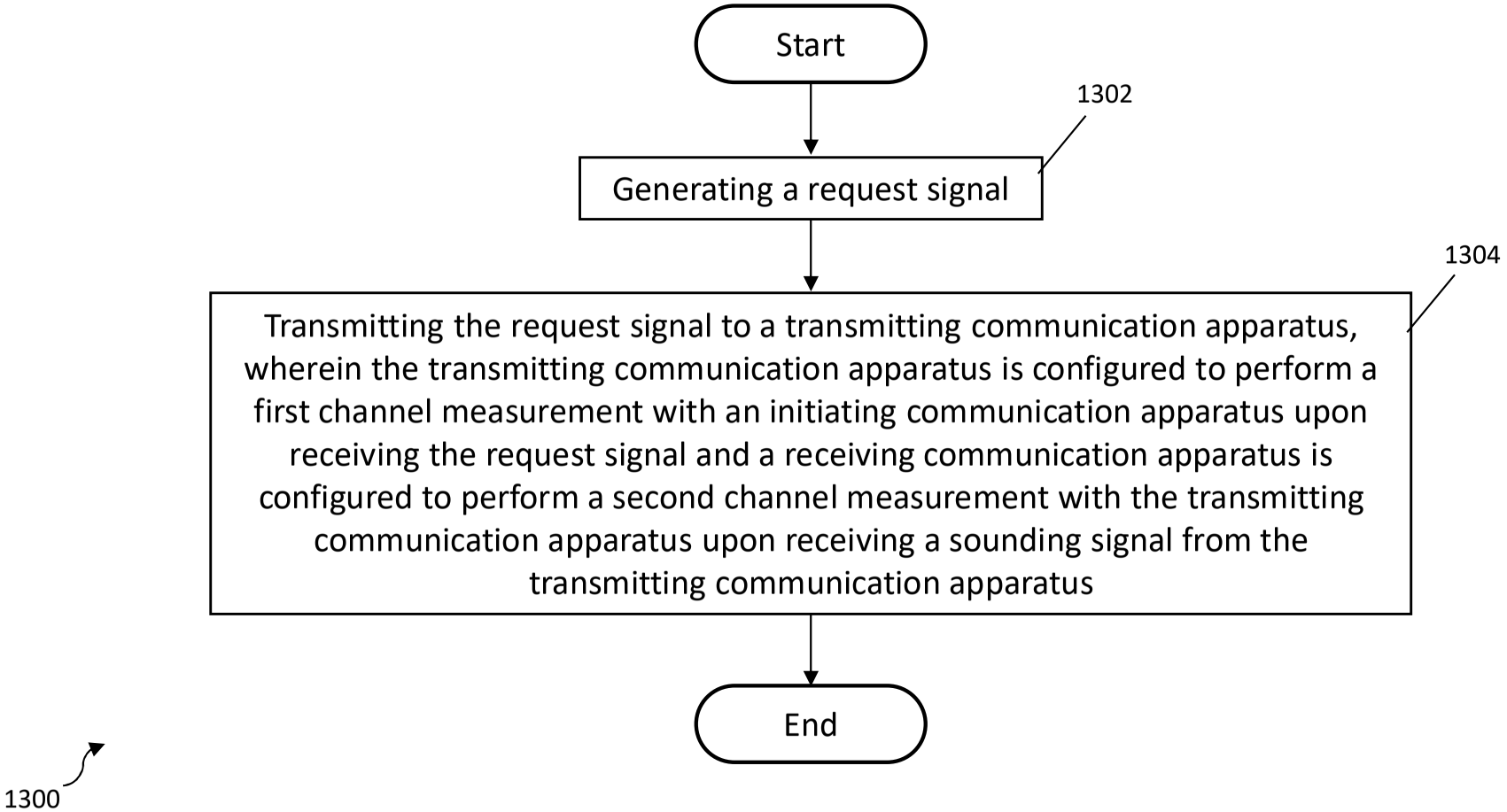

Start
1302
Generating a request signal
1304
Transmitting the request signal to a transmitting communication apparatus, wherein the transmitting communication apparatus is configured to perform a first channel measurement with an initiating communication apparatus upon receiving the request signal and a receiving communication apparatus is configured to perform a second channel measurement with the transmitting communication apparatus upon receiving a sounding signal from the transmitting communication apparatus
End
1300

Figure 13

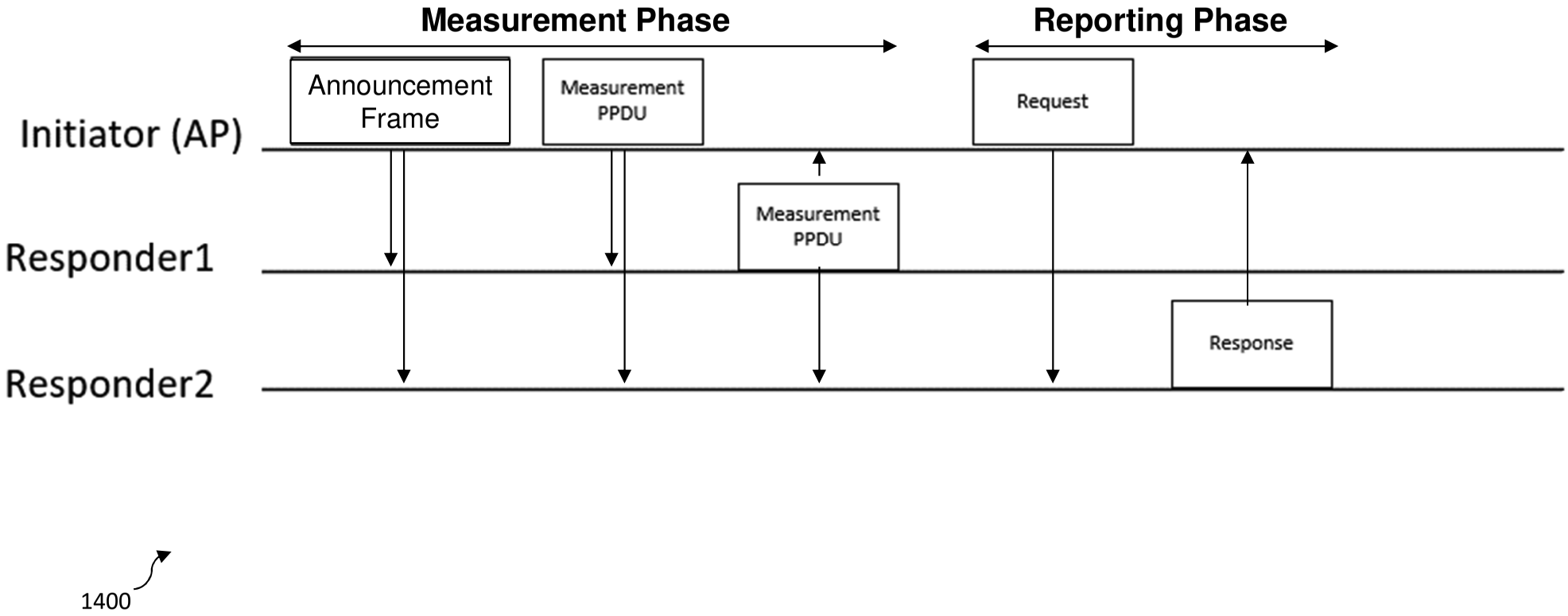

Measurement Phase
Reporting Phase
Announcement Frame
Measurement PPDU
Request
Initiator (AP)
Measurement PPDU
Responder1
Response
Responder2
1400

Figure 14

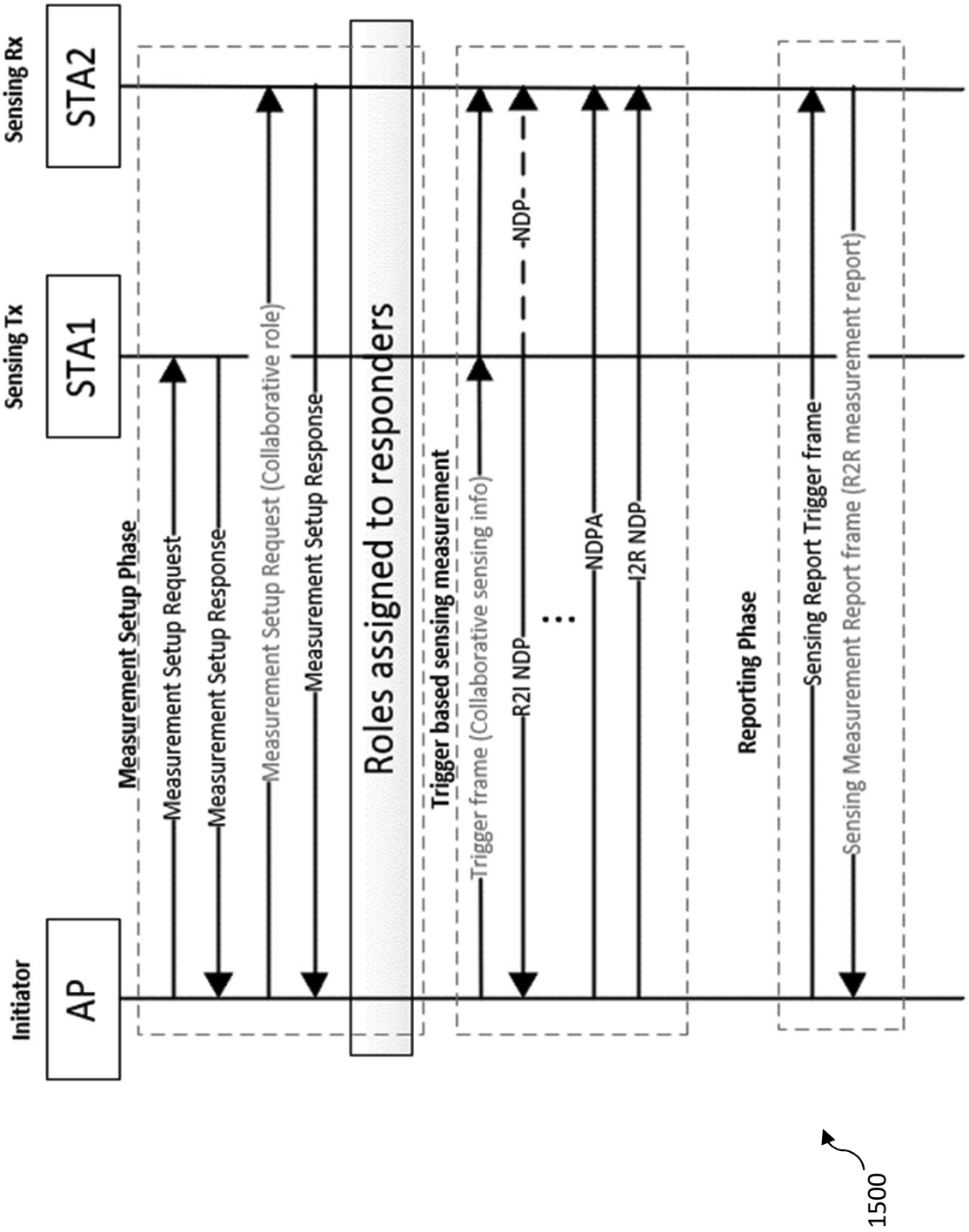

Initiator
AP
Sensing Tx
STA1
Sensing Rx
STA2
Measurement Setup Phase
Measurement Setup Request
Measurement Setup Response
Measurement Setup Request (Collaborative role)
Measurement Setup Response
Roles assigned to responders
Trigger based sensing measurement
Trigger frame (Collaborative sensing info)
R2I NDP
NDP
NDPA
I2R NDP
Reporting Phase
Sensing Report Trigger frame
Sensing Measurement Report frame (R2R measurement report)
1500

Figure 15

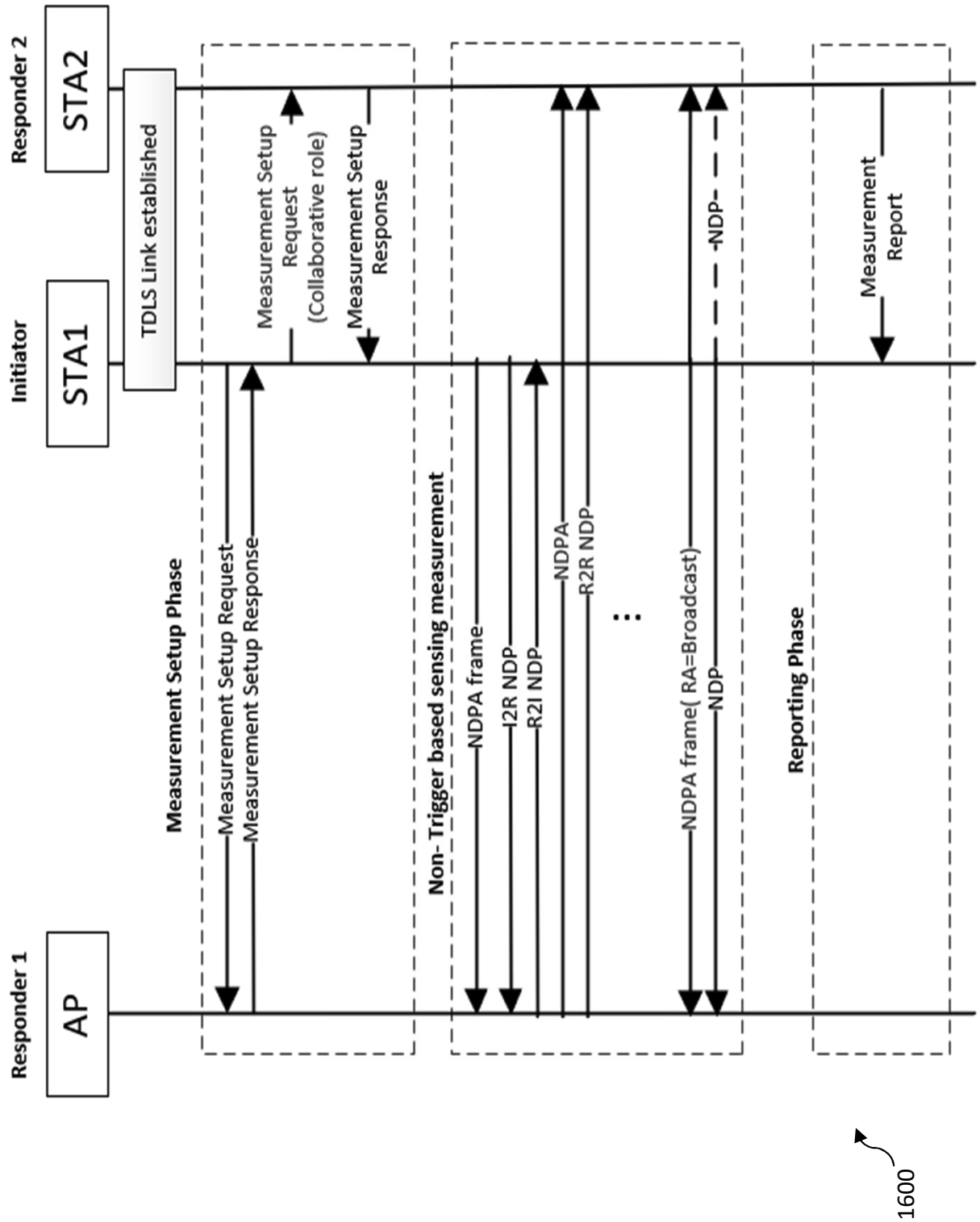

Responder 1
AP
Initiator
STA1
Responder 2
STA2
TDLS Link established
Measurement Setup Phase
Measurement Setup Request
Measurement Setup Response
Measurement Setup Request (Collaborative role)
Measurement Setup Response
Non- Trigger based sensing measurement
NDPA frame
I2R NDP
R2I NDP
NDPA
R2R NDP
NDPA frame(RA=Broadcast)
NDP
NDP
Reporting Phase
Measurement Report
1600

Figure 16

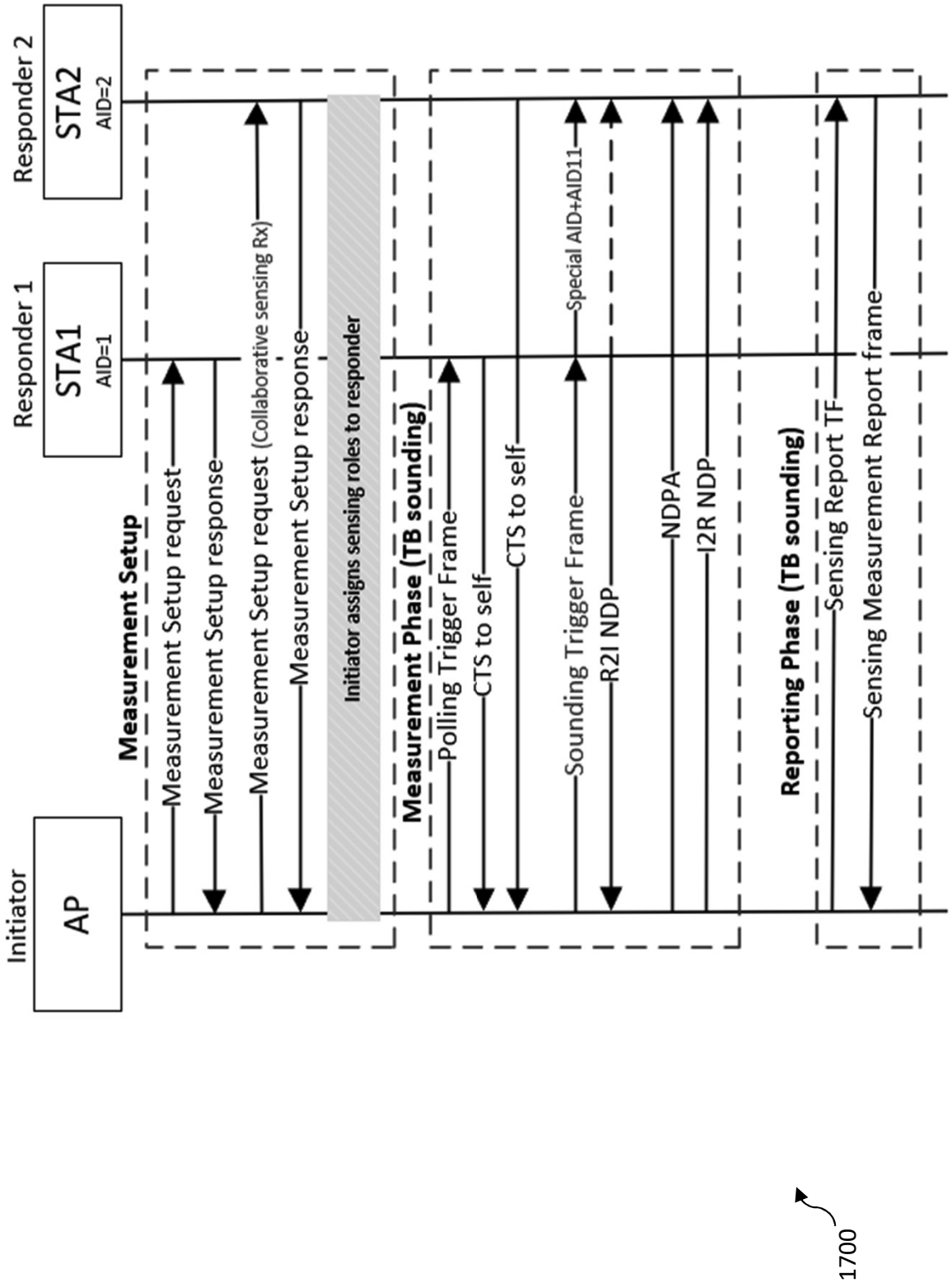

Initiator
AP
Responder 1
STA1
AID=1
Responder 2
STA2
AID=2
Measurement Setup
Measurement Setup request
Measurement Setup response
Measurement Setup request (Collaborative sensing Rx)
Measurement Setup response
Initiator assigns sensing roles to responder
Measurement Phase (TB sounding)
Polling Trigger Frame
CTS to self
CTS to self
Sounding Trigger Frame
Special AID+AID11
R2I NDP
NDPA
I2R NDP
Reporting Phase (TB sounding)
Sensing Report TF
Sensing Measurement Report frame
1700

Figure 17

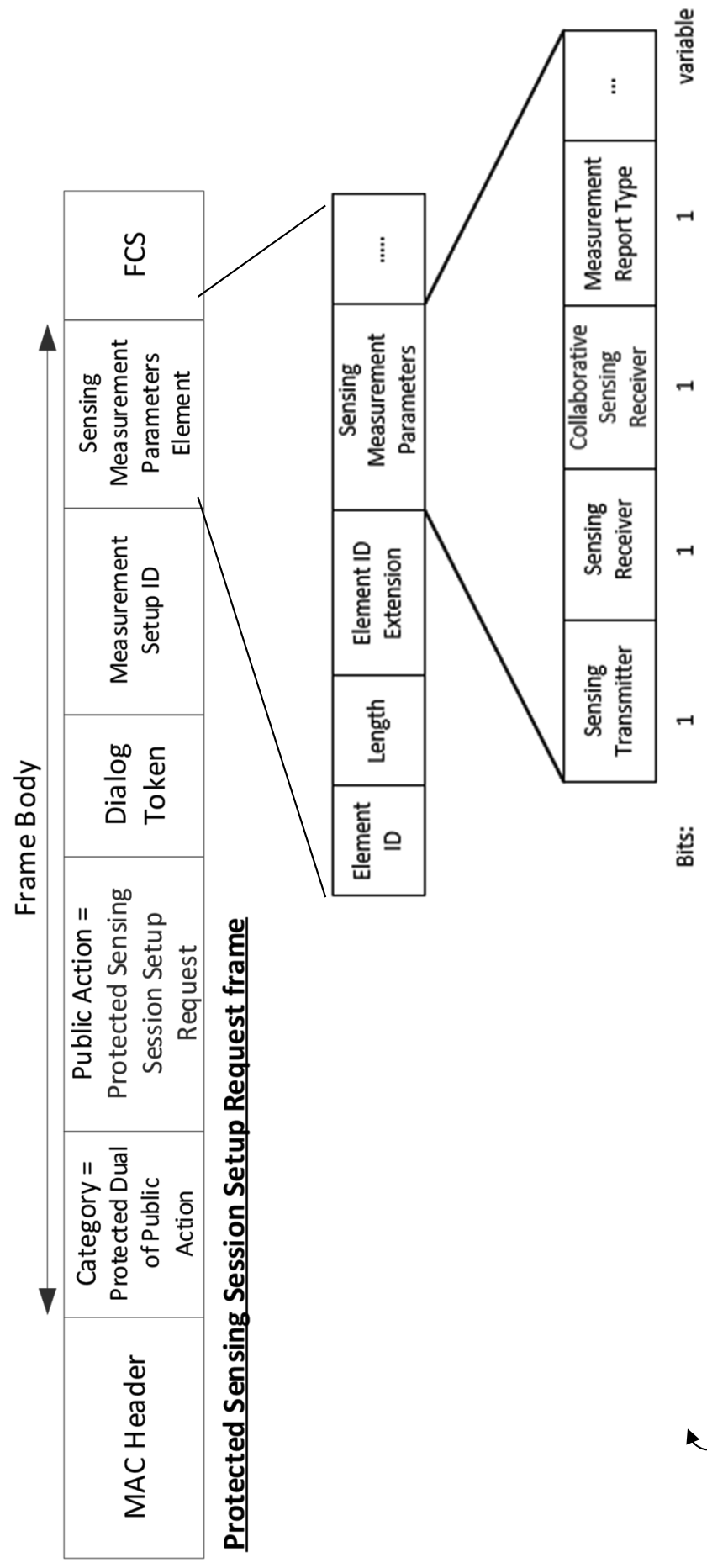
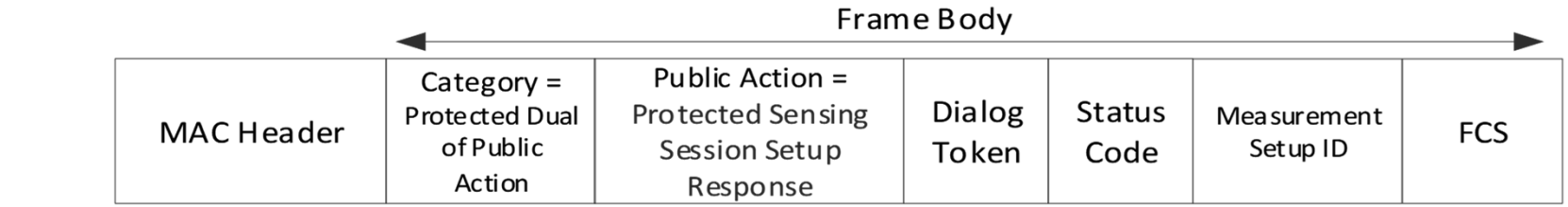

Protected Sensing Session Setup Request frame
Frame Body
MAC Header
Category = Protected Dual of Public Action
Public Action = Protected Sensing Session Setup Request
Dialog Token
Measurement Setup ID
Sensing Measurement Parameters Element
FCS
Element ID
Length
Element ID Extension
Sensing Measurement Parameters
.....
Sensing Transmitter
Sensing Receiver
Collaborative Sensing Receiver
Measurement Report Type
...
Bits:
1
1
1
1
1
variable
1800

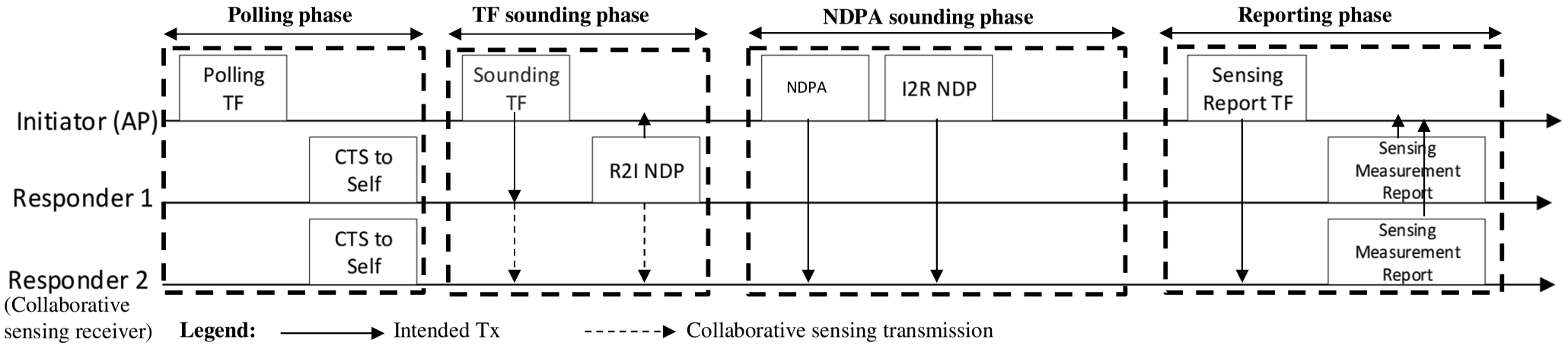
Figure 18



Protected Sensing Session Setup Response frame

1900

Figure 19



2000

Figure 20

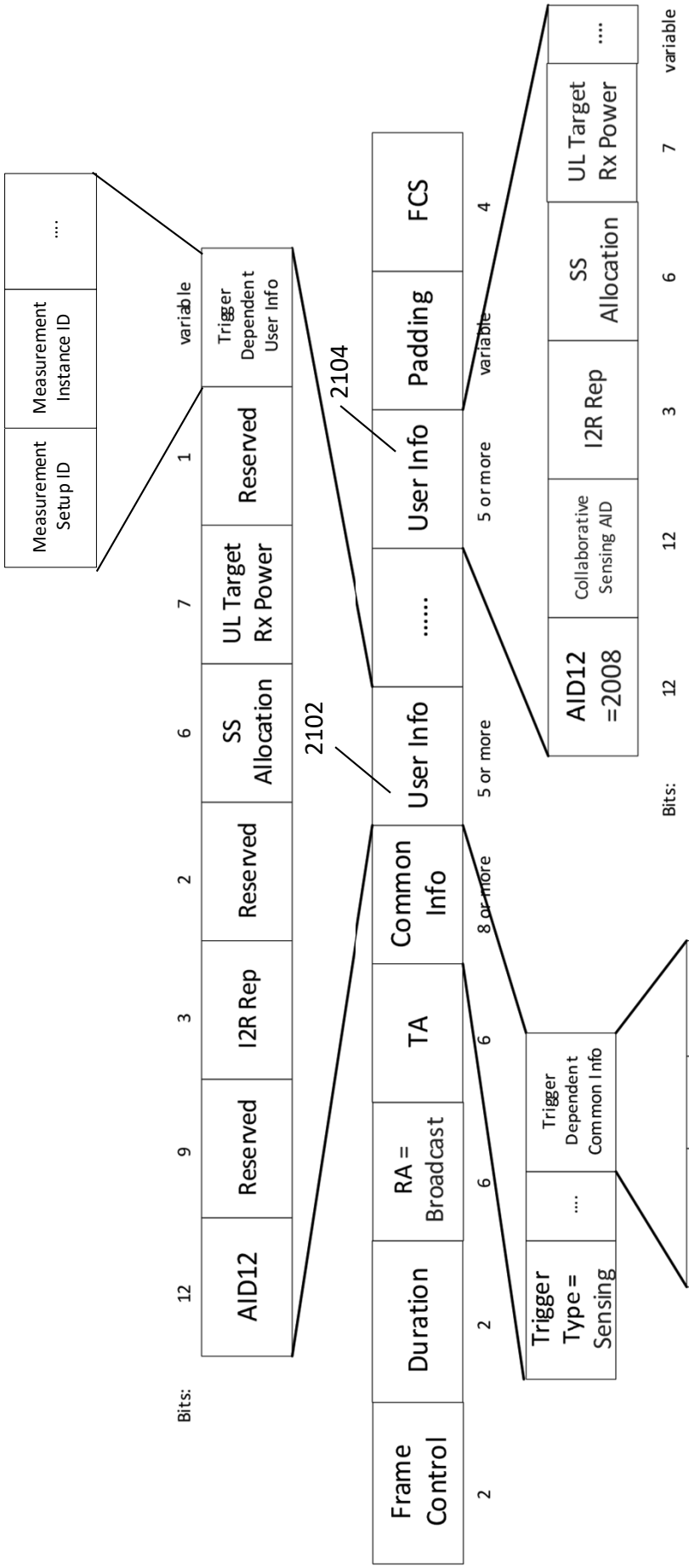

Frame Control
Duration
RA = Broadcast
TA
Common Info
User Info
.....
User Info
Padding
FCS
Octets:
2
2
6
6
8 or more
5 or more
5 or more
variable
4
Trigger Type = Sensing
....
Trigger Dependent Common Info
Sensing Trigger Subtype = Sounding
Dialog Token
Reserved
AID12
Reserved
I2R Rep
Reserved
SS Allocation
UL Target Rx Power
Reserved
Trigger Dependent User Info
variable
Measurement Setup ID
Measurement Instance ID
....
AID12 =2008
Collaborative Sensing AID
I2R Rep
SS Allocation
UL Target Rx Power
....
variable
Bits:
12
9
3
2
6
7
1
Bits:
12
12
3
6
7
2102
2104
2100

Figure 21

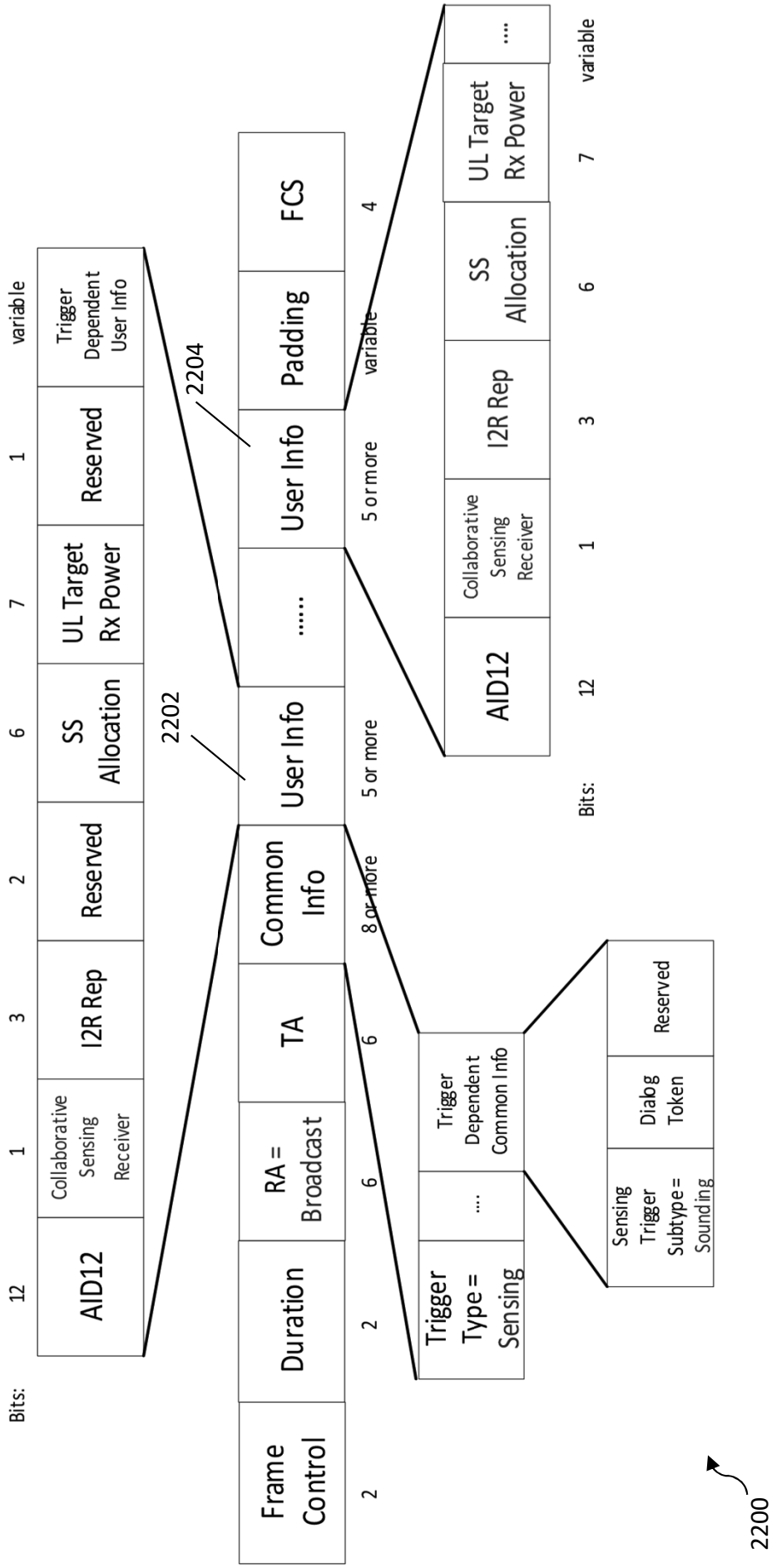

Frame Control
Duration
RA = Broadcast
TA
Common Info
User Info
.....
User Info
Padding
FCS
AID12
Collaborative Sensing Receiver
I2R Rep
Reserved
SS Allocation
UL Target Rx Power
Reserved
Trigger Dependent User Info
Trigger Type = Sensing
....
Trigger Dependent Common Info
Sensing Trigger Subtype = Sounding
Dialog Token
Reserved
AID12
Collaborative Sensing Receiver
I2R Rep
SS Allocation
UL Target Rx Power
....
Octets:
Bits:
2
2
6
6
8 or more
5 or more
variable
5 or more
variable
12
1
3
6
7
1
variable
2202
2204
2200

Figure 22

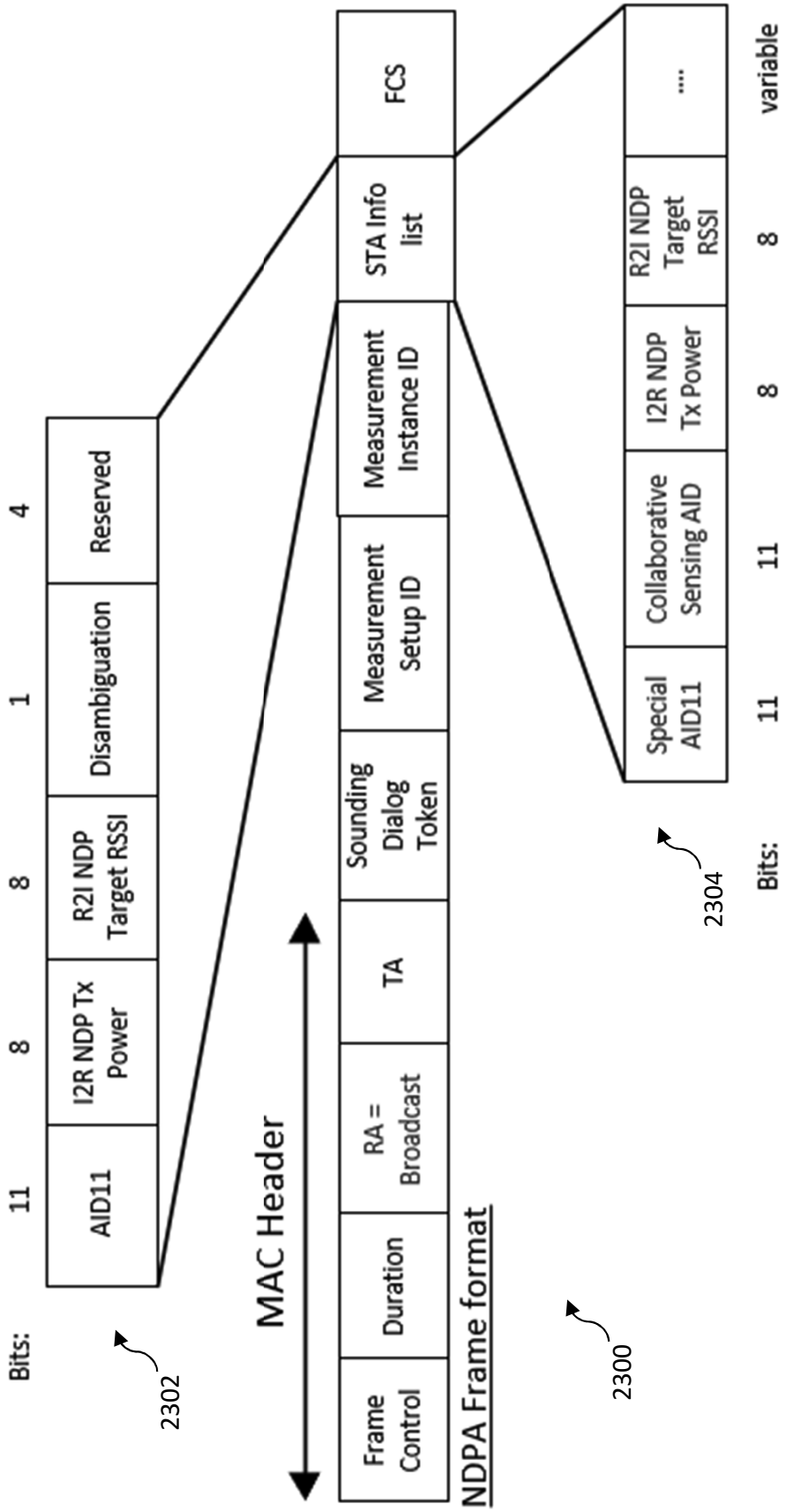

NDPA Frame format
Frame Control
Duration
RA = Broadcast
TA
Sounding Dialog Token
Measurement Setup ID
Measurement Instance ID
STA Info list
FCS
MAC Header
Bits:
11
8
8
1
4
AID11
I2R NDP Tx Power
R2I NDP Target RSSI
Disambiguation
Reserved
2300
2302
Special AID11
Collaborative Sensing AID
I2R NDP Tx Power
R2I NDP Target RSSI
....
Bits:
11
11
8
8
variable
2304

Figure 23

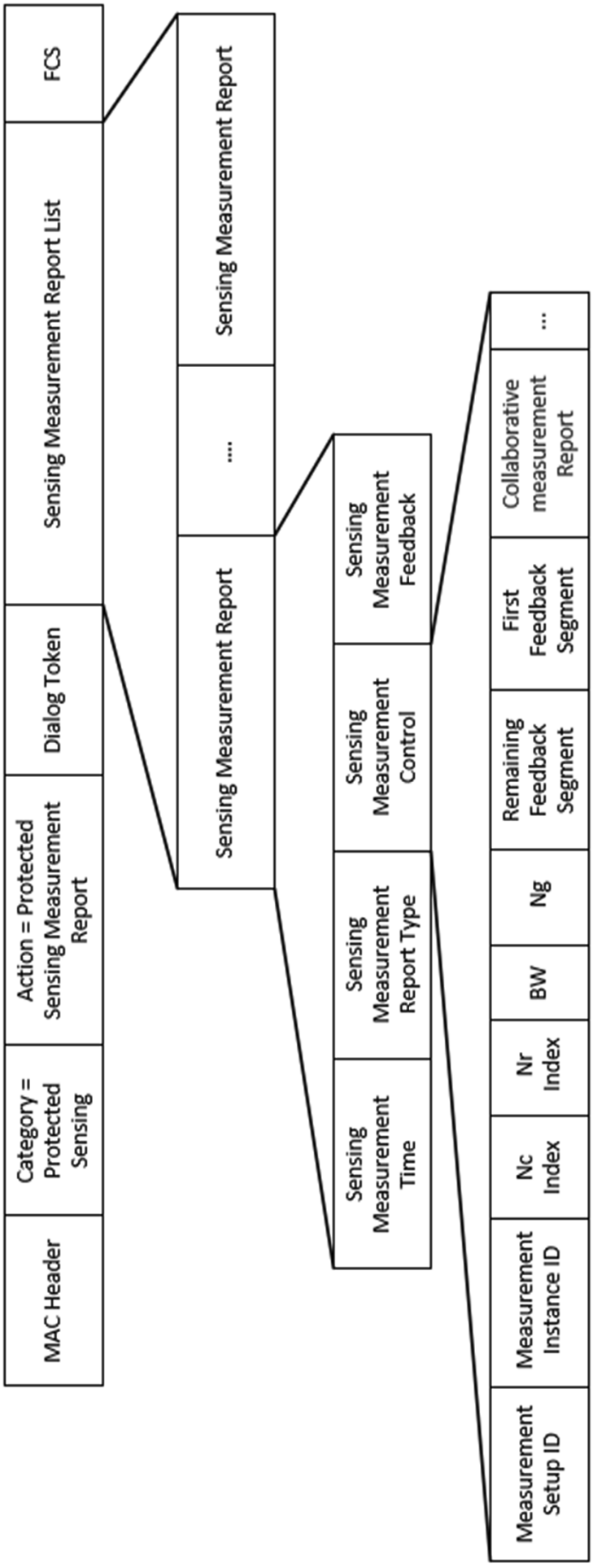

MAC Header
Category = Protected Sensing
Action = Protected Sensing Measurement Report
Dialog Token
Sensing Measurement Report List
FCS
Sensing Measurement Report
....
Sensing Measurement Report
Sensing Measurement Time
Sensing Measurement Report Type
Sensing Measurement Control
Sensing Measurement Feedback
Measurement Setup ID
Measurement Instance ID
Nc Index
Nr Index
BW
Ng
Remaining Feedback Segment
First Feedback Segment
Collaborative measurement Report
...
2400

Figure 24

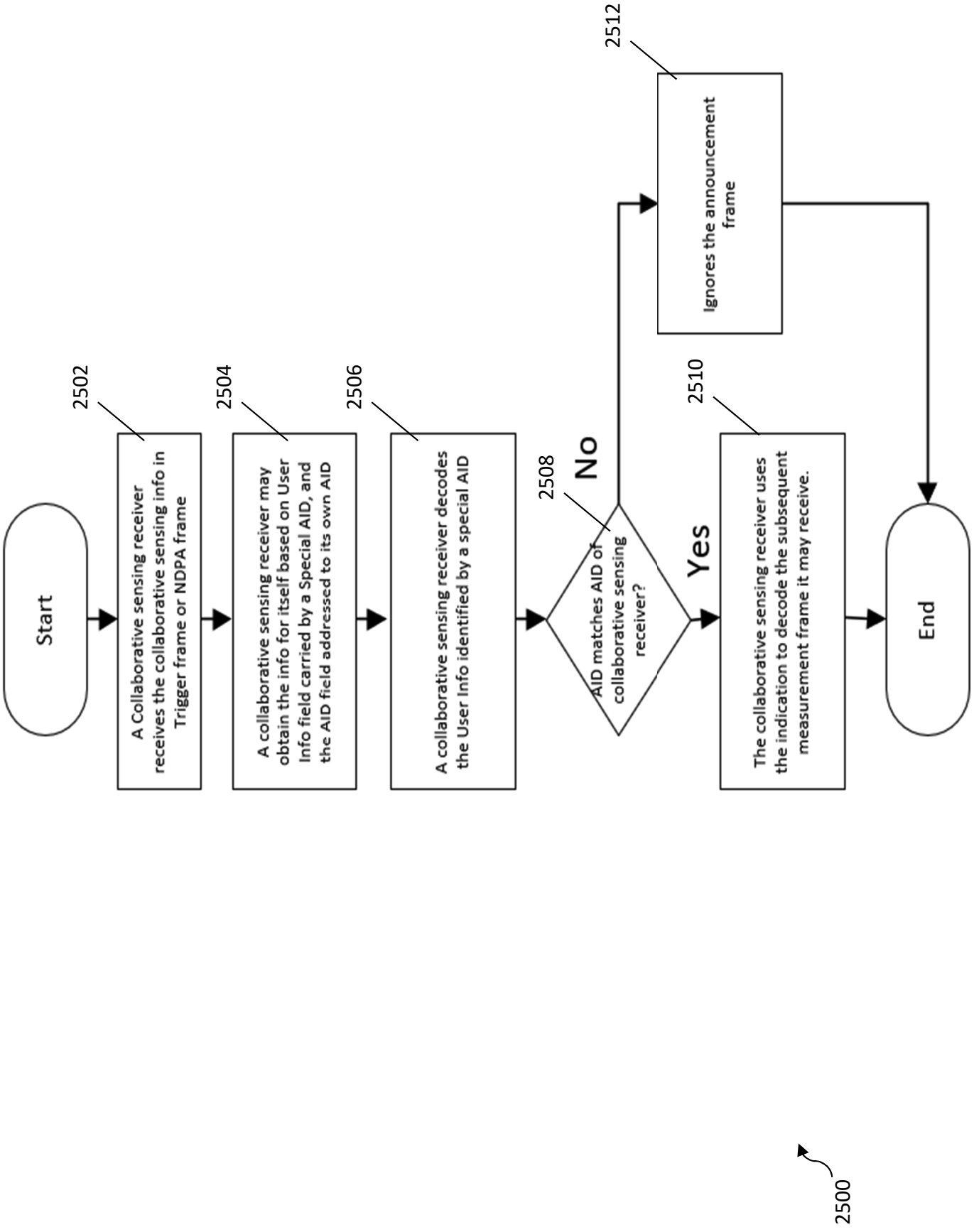

Start
A Collaborative sensing receiver receives the collaborative sensing info in Trigger frame or NDPA frame
2502
A collaborative sensing receiver may obtain the info for itself based on User Info field carried by a Special AID, and the AID field addressed to its own AID
2504
A collaborative sensing receiver decodes the User Info identified by a special AID
2506
AID matches AID of collaborative sensing receiver?
2508
No
Yes
Ignores the announcement frame
2512
The collaborative sensing receiver uses the indication to decode the subsequent measurement frame it may receive.
2510
End
2500

Figure 25

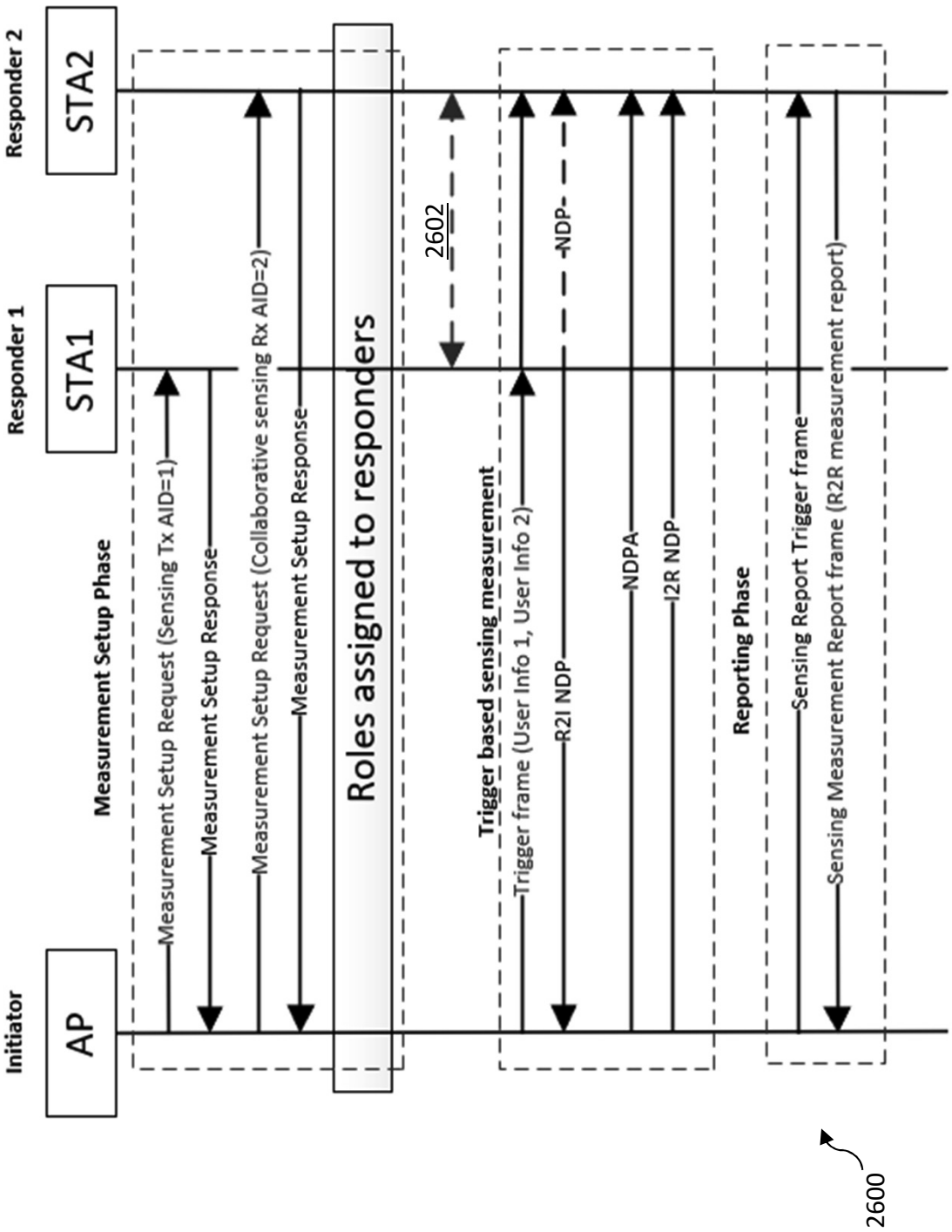

Initiator
AP
Responder 1
STA1
Responder 2
STA2
Measurement Setup Phase
Measurement Setup Request (Sensing Tx AID=1)
Measurement Setup Response
Measurement Setup Request (Collaborative sensing Rx AID=2)
Measurement Setup Response
Roles assigned to responders
2602
Trigger based sensing measurement
Trigger frame (User Info 1, User Info 2)
R2I NDP
NDP
NDPA
I2R NDP
Reporting Phase
Sensing Report Trigger frame
Sensing Measurement Report frame (R2R measurement report)
2600

Figure 26

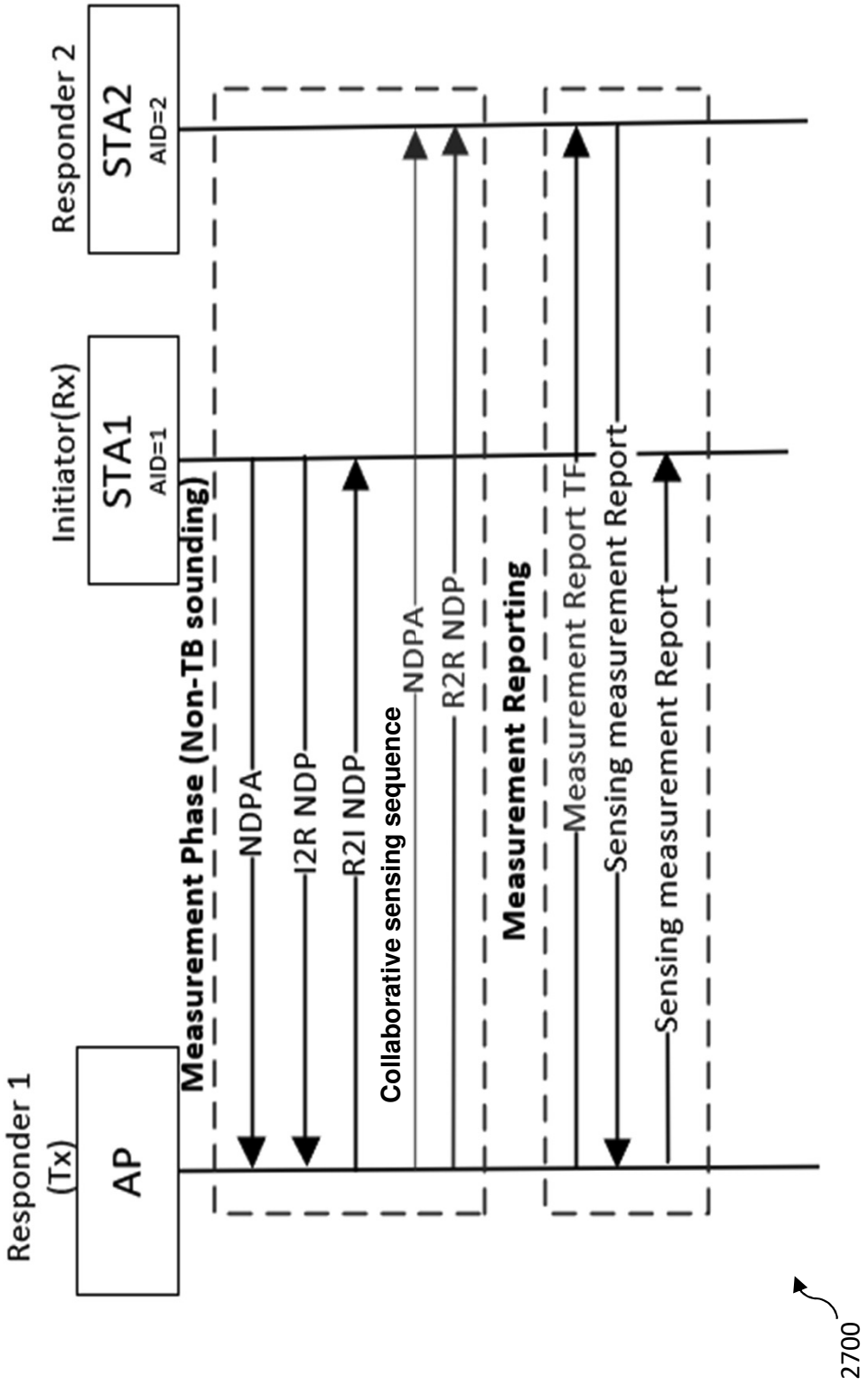

Responder 1
(Tx)
AP
Initiator(Rx)
STA1
AID=1
Responder 2
STA2
AID=2
Measurement Phase (Non-TB sounding)
NDPA
I2R NDP
R2I NDP
Collaborative sensing sequence
NDPA
R2R NDP
Measurement Reporting
Measurement Report TF
Sensing measurement Report
Sensing measurement Report
2700

Figure 27

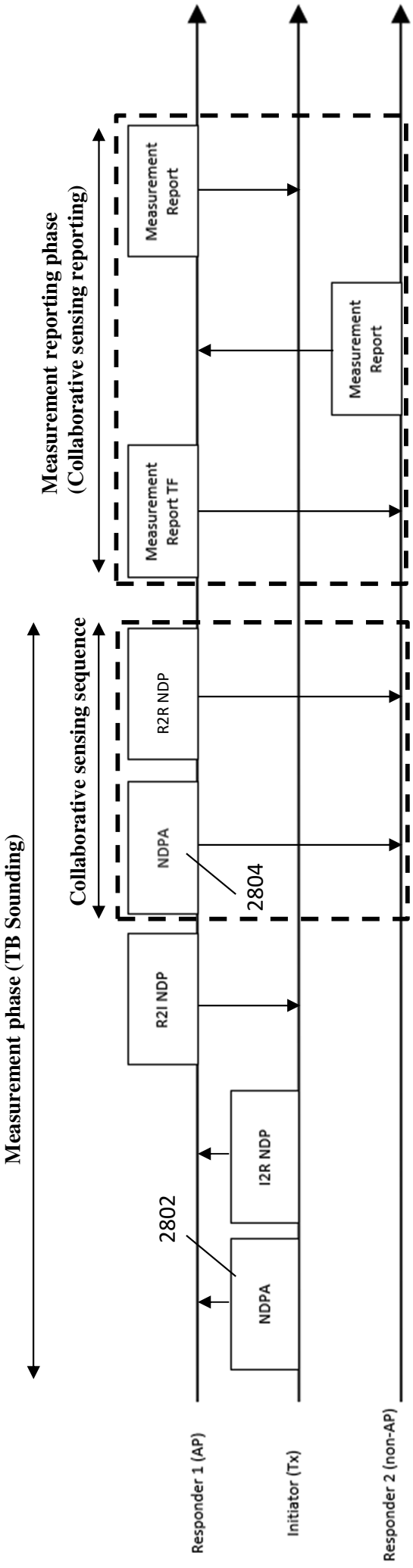

Measurement phase (TB Sounding)
Collaborative sensing sequence
Measurement reporting phase
(Collaborative sensing reporting)
R2I NDP
NDPA
R2R NDP
NDPA
Measurement Report TF
Measurement Report
Measurement Report
I2R NDP
2802
2804
Responder 1 (AP)
Initiator (Tx)
Responder 2 (non-AP)
2800

Figure 28

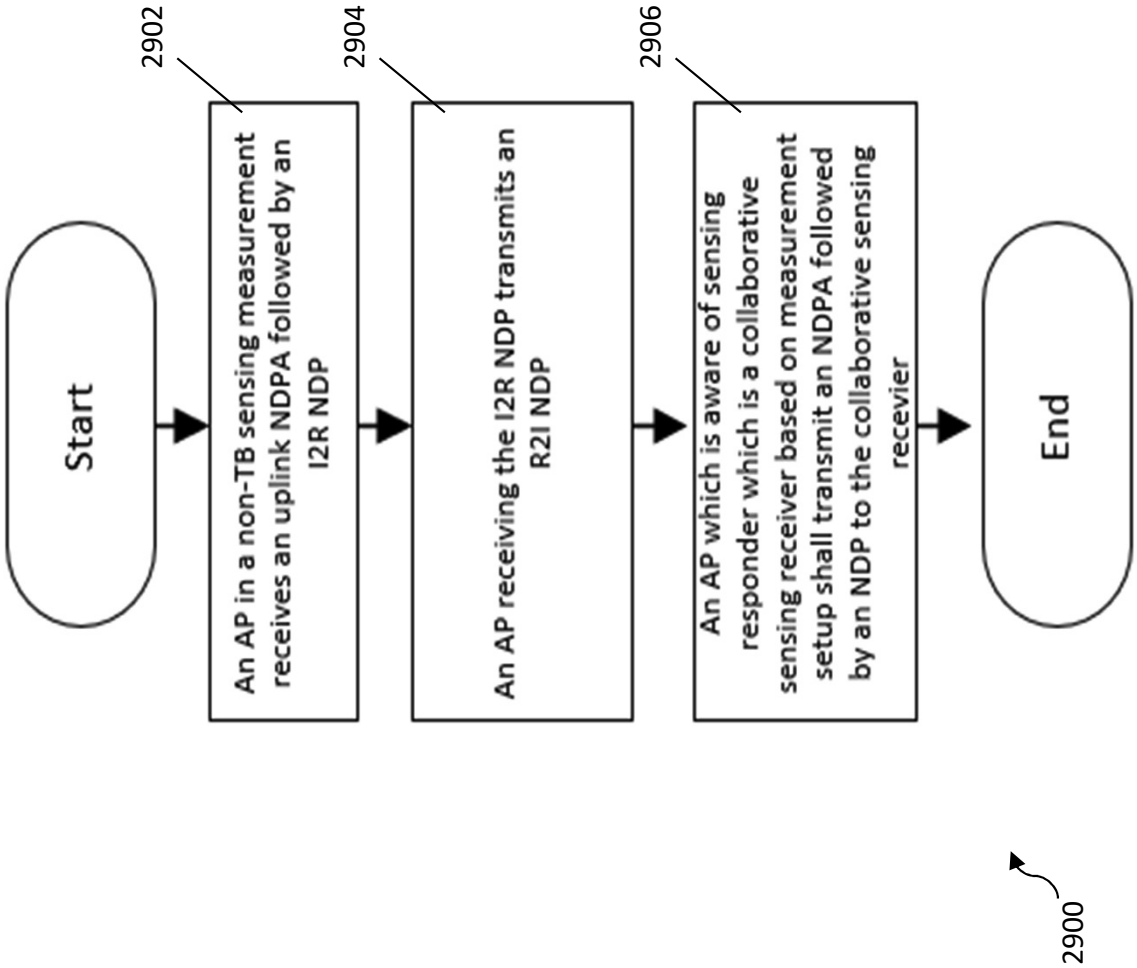

Start
2902
An AP in a non-TB sensing measurement receives an uplink NDPA followed by an I2R NDP
2904
An AP receiving the I2R NDP transmits an R2I NDP
2906
An AP which is aware of sensing responder which is a collaborative sensing receiver based on measurement setup shall transmit an NDPA followed by an NDP to the collaborative sensing recevier
End
2900

Figure 29

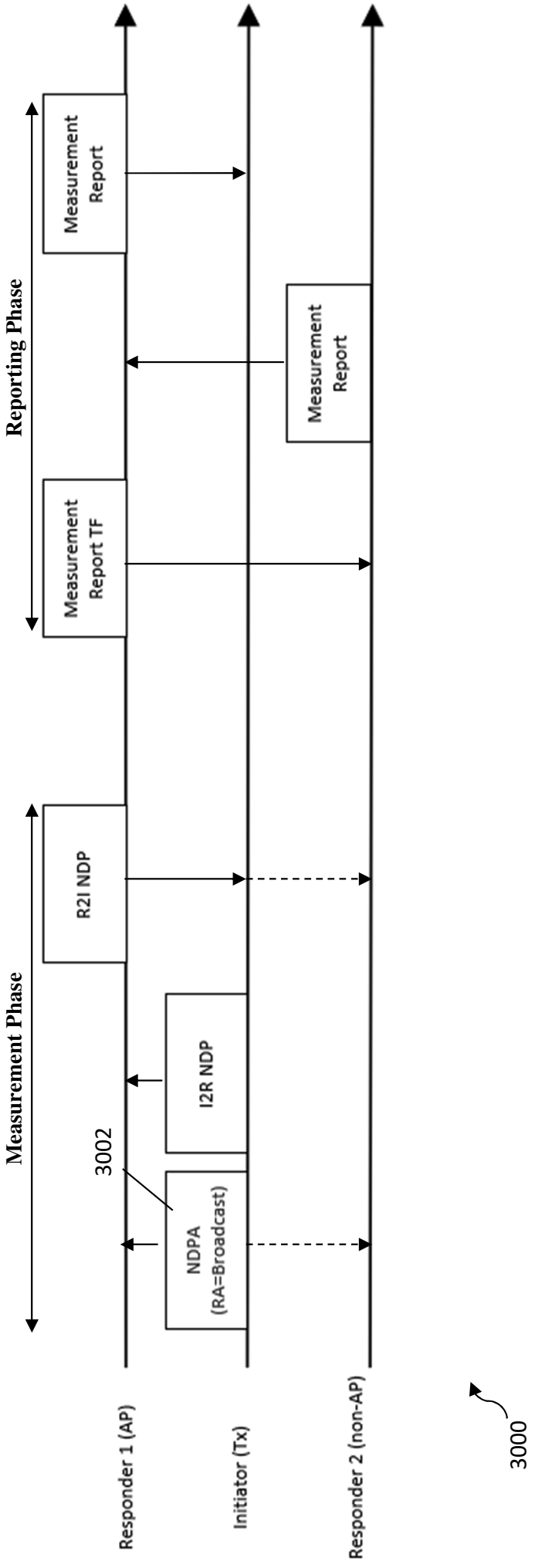

Measurement Phase
Reporting Phase
R2I NDP
I2R NDP
NDPA
(RA=Broadcast)
Measurement
Report TF
Measurement
Report
Measurement
Report
3002
Responder 1 (AP)
Initiator (Tx)
Responder 2 (non-AP)
3000

Figure 30

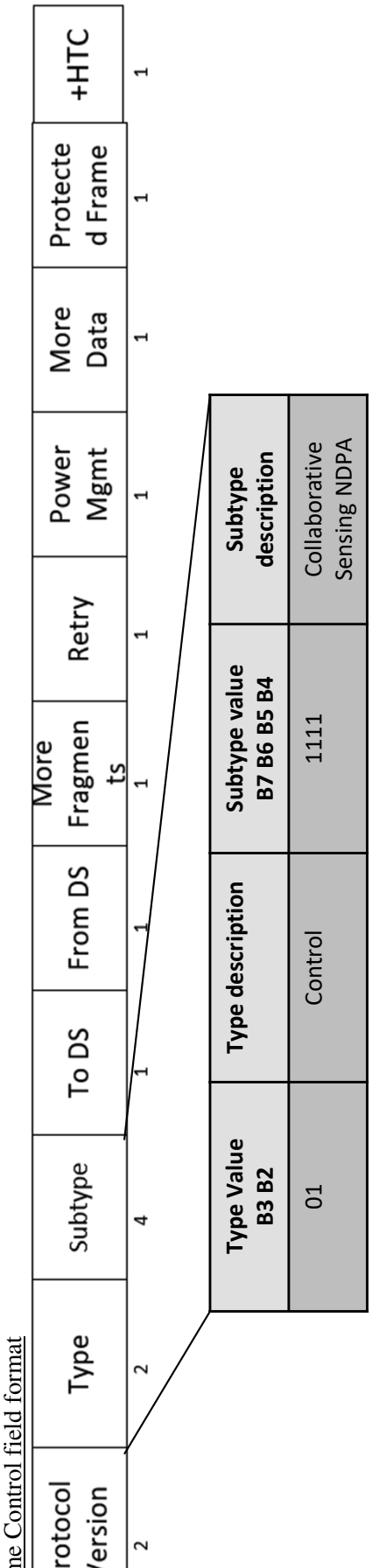

Frame Control field format
Protocol Version
Type
Subtype
To DS
From DS
More Fragments
Retry
Power Mgmt
More Data
Protected Frame
+HTC
Bits:
2
2
4
1
1
1
1
1
1
1
1
Type Value B3 B2
Type description
Subtype value B7 B6 B5 B4
Subtype description
01
Control
1111
Collaborative Sensing NDPA
3100

Figure 31

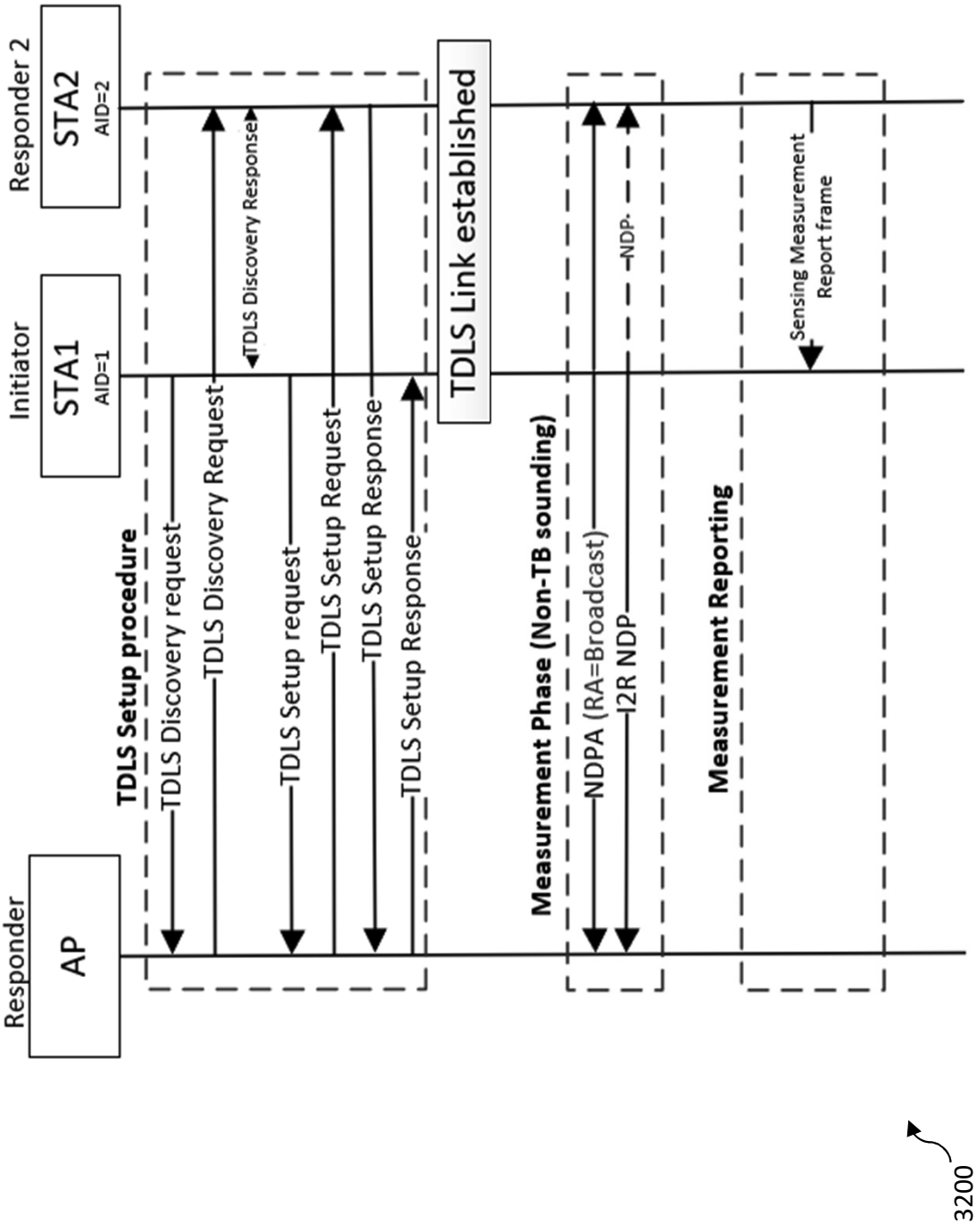

Responder
AP
Initiator
STA1
AID=1
Responder 2
STA2
AID=2
TDLS Setup procedure
TDLS Discovery request
TDLS Discovery Request
TDLS Discovery Response
TDLS Setup request
TDLS Setup Request
TDLS Setup Response
TDLS Setup Response
TDLS Link established
Measurement Phase (Non-TB sounding)
NDPA (RA=Broadcast)
I2R NDP
NDP
Measurement Reporting
Sensing Measurement Report frame
3200

Figure 32

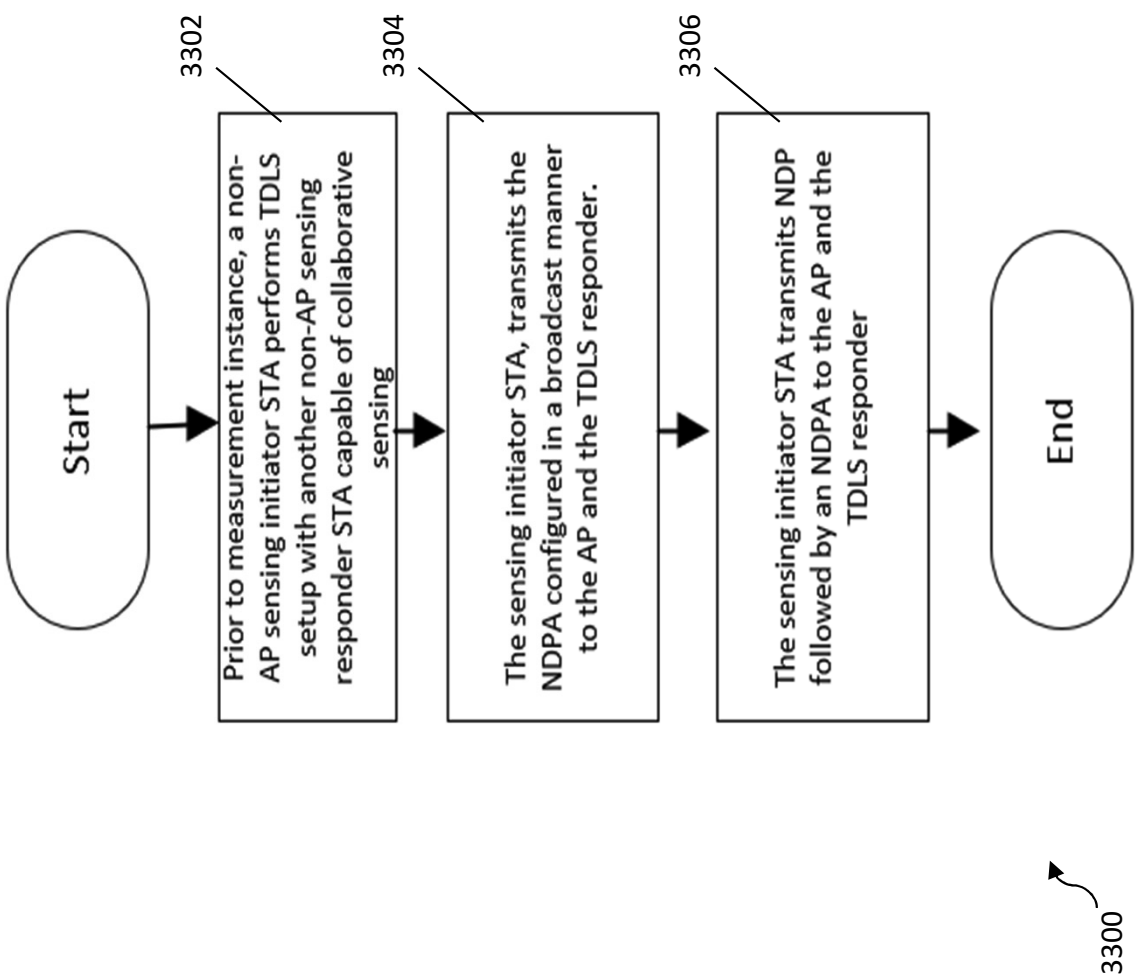

Start
3302
Prior to measurement instance, a non-AP sensing initiator STA performs TDLS setup with another non-AP sensing responder STA capable of collaborative sensing
3304
The sensing initiator STA, transmits the NDPA configured in a broadcast manner to the AP and the TDLS responder.
3306
The sensing initiator STA transmits NDP followed by an NDPA to the AP and the TDLS responder
End
3300

Figure 33

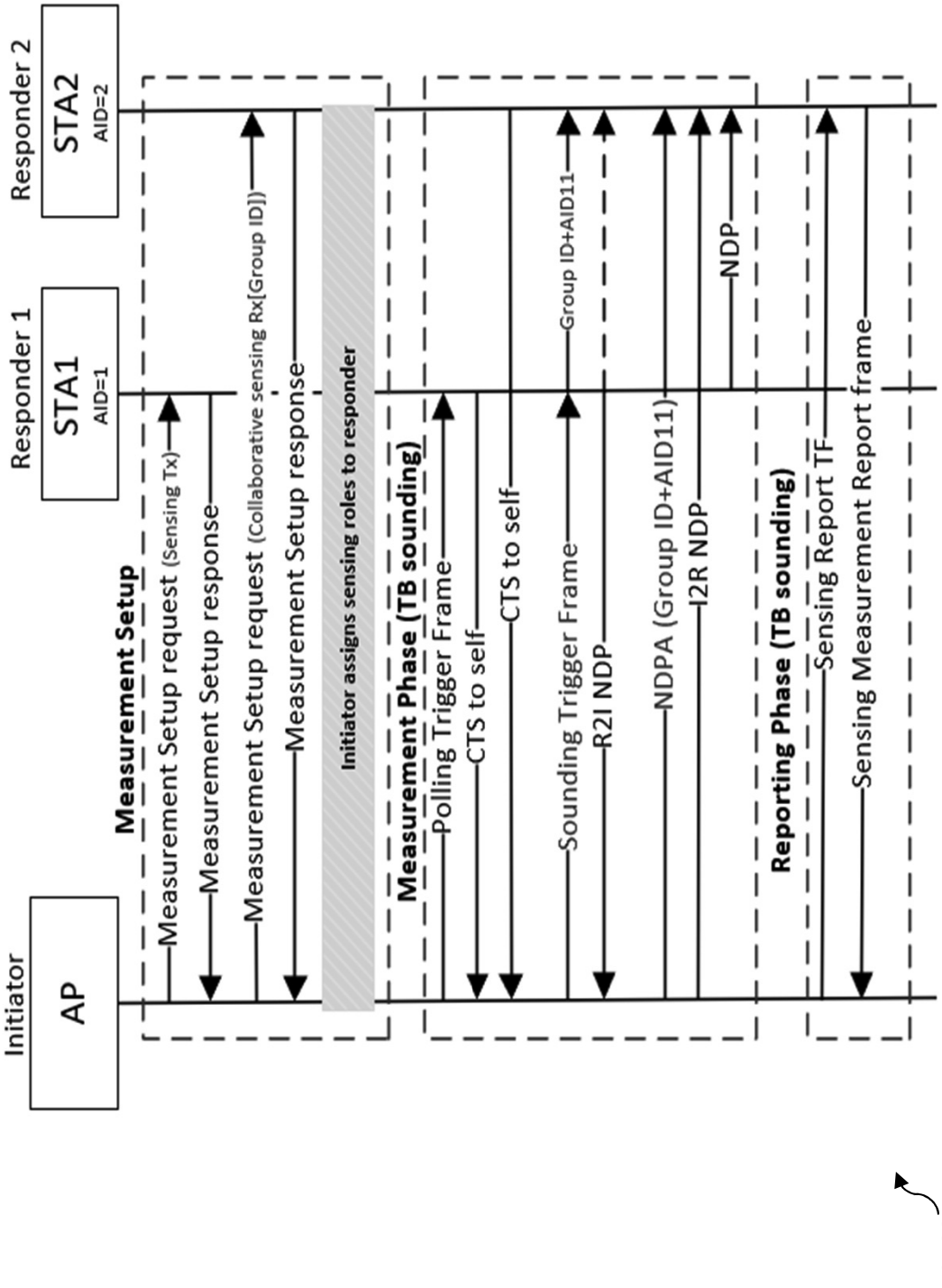

Initiator
AP
Responder 1
STA1
AID=1
Responder 2
STA2
AID=2
Measurement Setup
Measurement Setup request (Sensing Tx)
Measurement Setup response
Measurement Setup request (Collaborative sensing Rx[Group ID])
Measurement Setup response
Initiator assigns sensing roles to responder
Measurement Phase (TB sounding)
Polling Trigger Frame
CTS to self
CTS to self
Sounding Trigger Frame
Group ID+AID11
R2I NDP
NDPA (Group ID+AID11)
I2R NDP
NDP
Reporting Phase (TB sounding)
Sensing Report TF
Sensing Measurement Report frame
3400

Figure 34

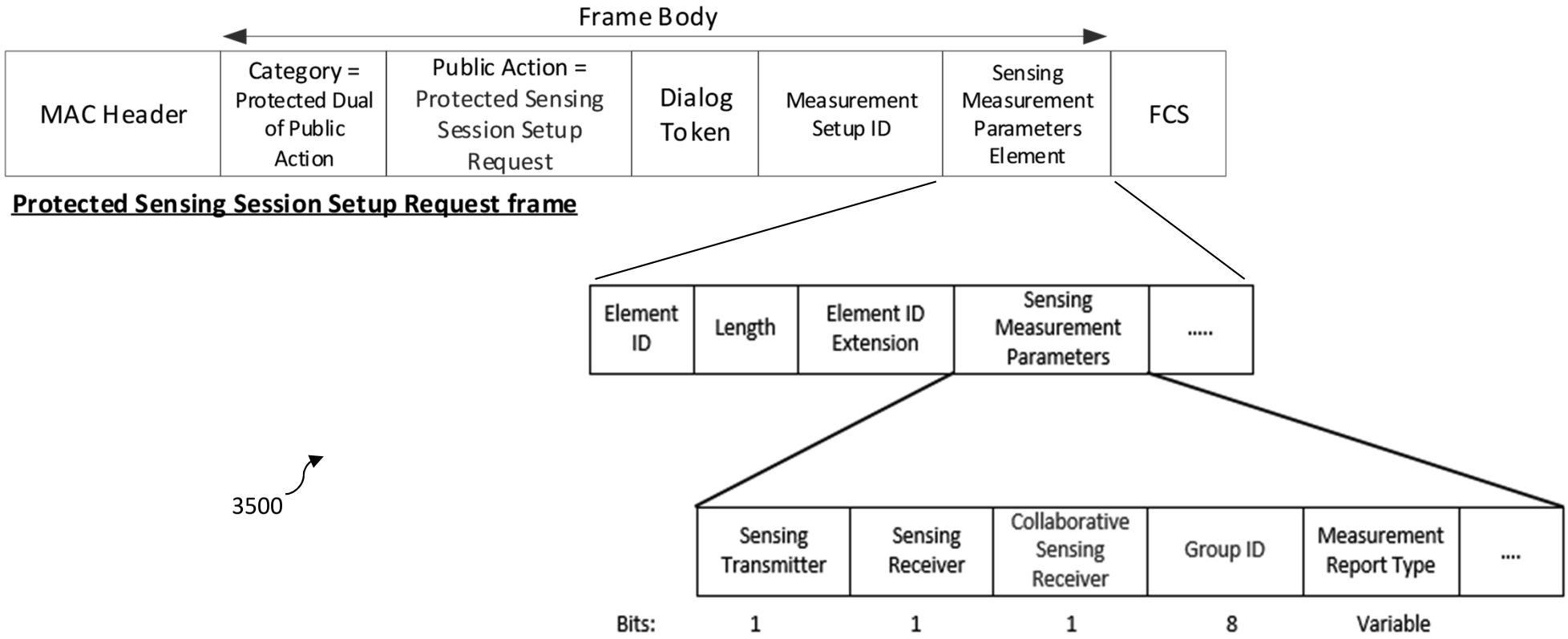

Frame Body
MAC Header
Category = Protected Dual of Public Action
Public Action = Protected Sensing Session Setup Request
Dialog Token
Measurement Setup ID
Sensing Measurement Parameters Element
FCS
Protected Sensing Session Setup Request frame
Element ID
Length
Element ID Extension
Sensing Measurement Parameters
.....
3500
Sensing Transmitter
Sensing Receiver
Collaborative Sensing Receiver
Group ID
Measurement Report Type
....
Bits:
1
1
1
8
Variable

Figure 35

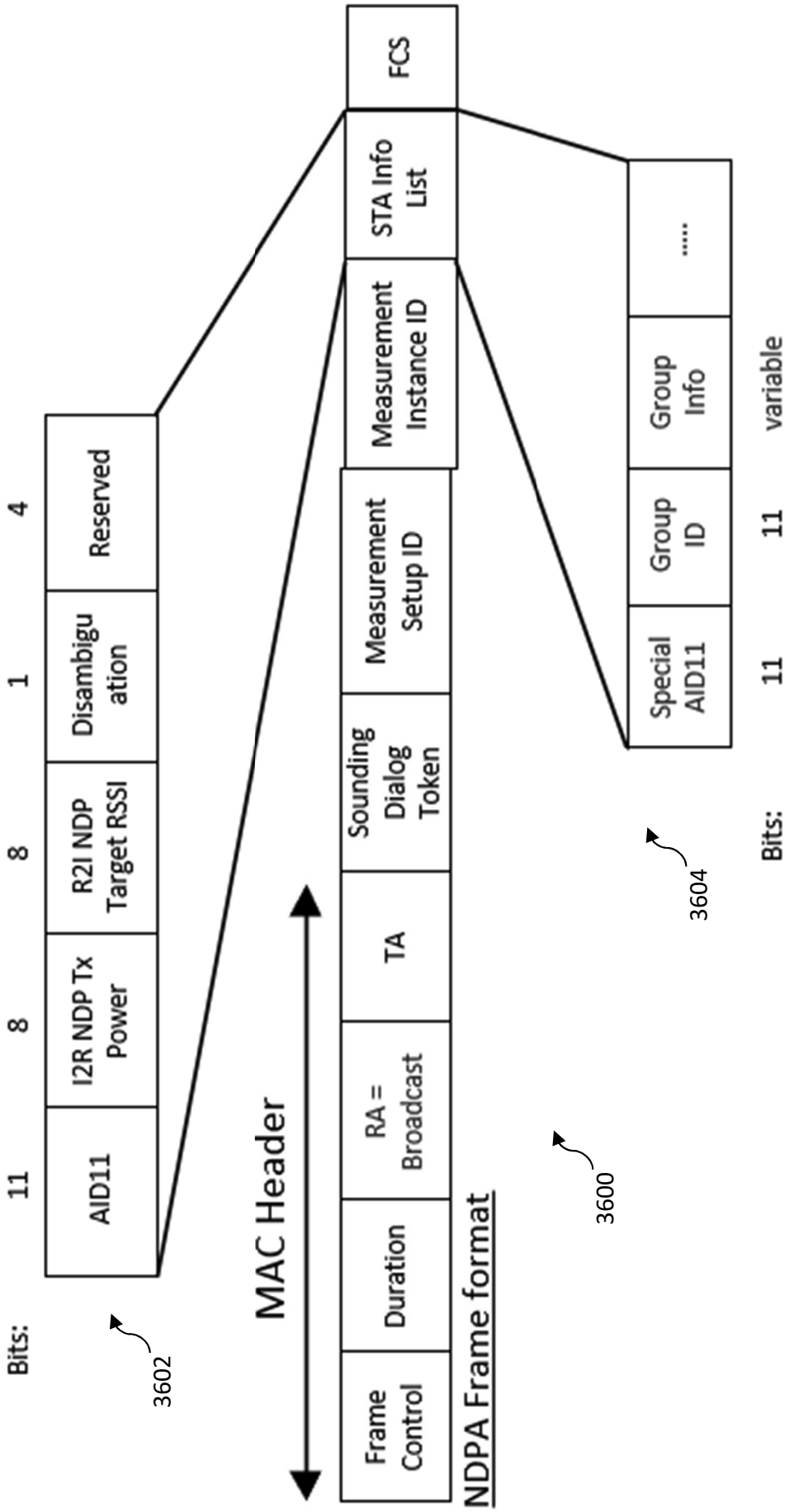

NDPA Frame format
MAC Header
Frame Control
Duration
RA = Broadcast
TA
Sounding Dialog Token
Measurement Setup ID
Measurement Instance ID
STA Info List
FCS
AID11
I2R NDP Tx Power
R2I NDP Target RSSI
Disambigu ation
Reserved
Special AID11
Group ID
Group Info
.....
Bits:
11
8
8
1
4
11
11
variable
3600
3602
3604

Figure 36

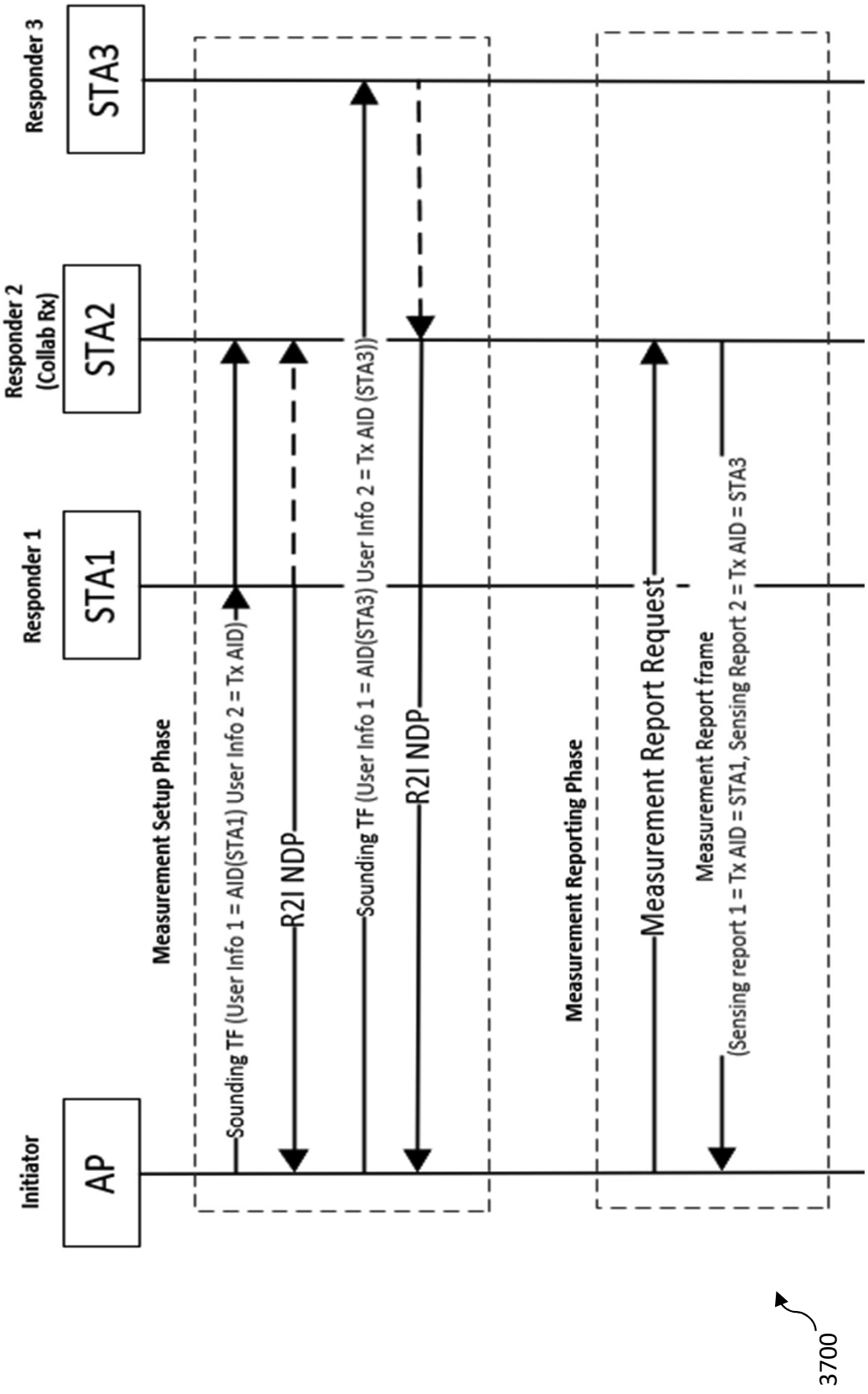

Initiator
AP
Responder 1
STA1
Responder 2
(Collab Rx)
STA2
Responder 3
STA3
Measurement Setup Phase
Sounding TF (User Info 1 = AID(STA1) User Info 2 = Tx AID)
R2I NDP
Sounding TF (User Info 1 = AID(STA3) User Info 2 = Tx AID (STA3))
R2I NDP
Measurement Reporting Phase
Measurement Report Request
Measurement Report frame
(Sensing report 1 = Tx AID = STA1, Sensing Report 2 = Tx AID = STA3
3700

Figure 37

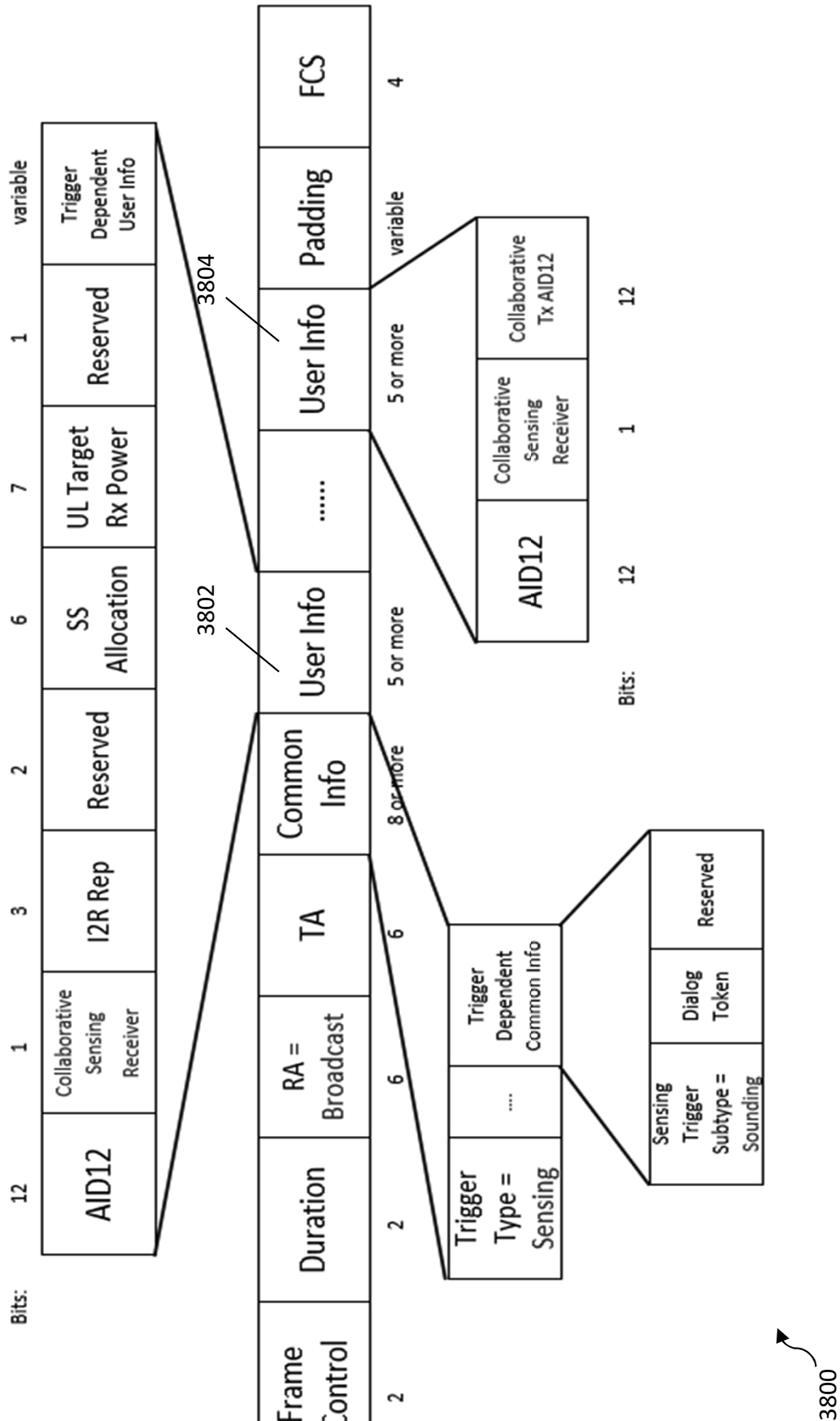

3800
3802
3804
Octets:
Bits:
Frame Control
Duration
RA = Broadcast
TA
Common Info
User Info
.....
User Info
Padding
FCS
2
2
6
6
8 or more
5 or more
5 or more
variable
4
Trigger Type = Sensing
....
Trigger Dependent Common Info
AID12
Collaborative Sensing Receiver
Collaborative Tx AID12
Sensing Trigger Subtype = Sounding
Dialog Token
Reserved
12
1
1
12
12
1
1
2
3
6
7
1
variable
AID12
Collaborative Sensing Receiver
I2R Rep
Reserved
SS Allocation
UL Target Rx Power
Reserved
Trigger Dependent User Info

Figure 38

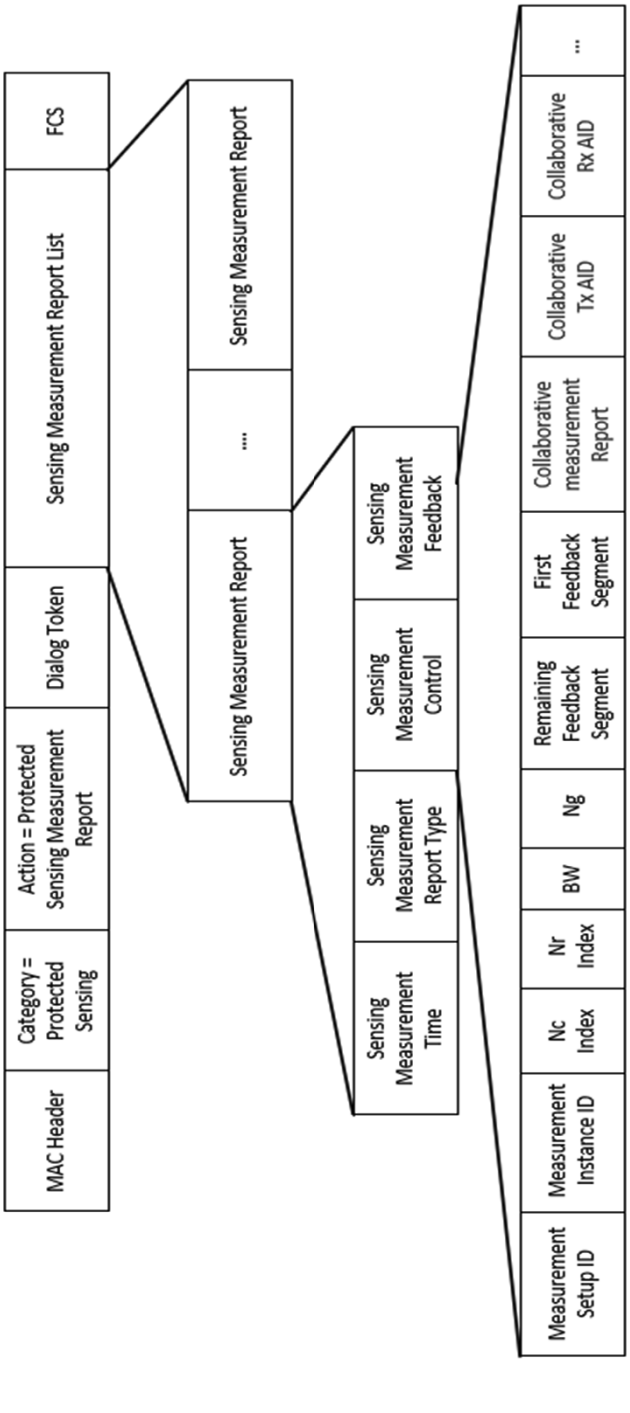

MAC Header
Category = Protected Sensing
Action = Protected Sensing Measurement Report
Dialog Token
Sensing Measurement Report List
FCS
Sensing Measurement Report
....
Sensing Measurement Report
Sensing Measurement Time
Sensing Measurement Report Type
Sensing Measurement Control
Sensing Measurement Feedback
Measurement Setup ID
Measurement Instance ID
Nc Index
Nr Index
BW
Ng
Remaining Feedback Segment
First Feedback Segment
Collaborative measurement Report
Collaborative Tx AID
Collaborative Rx AID
...
3900

Figure 39

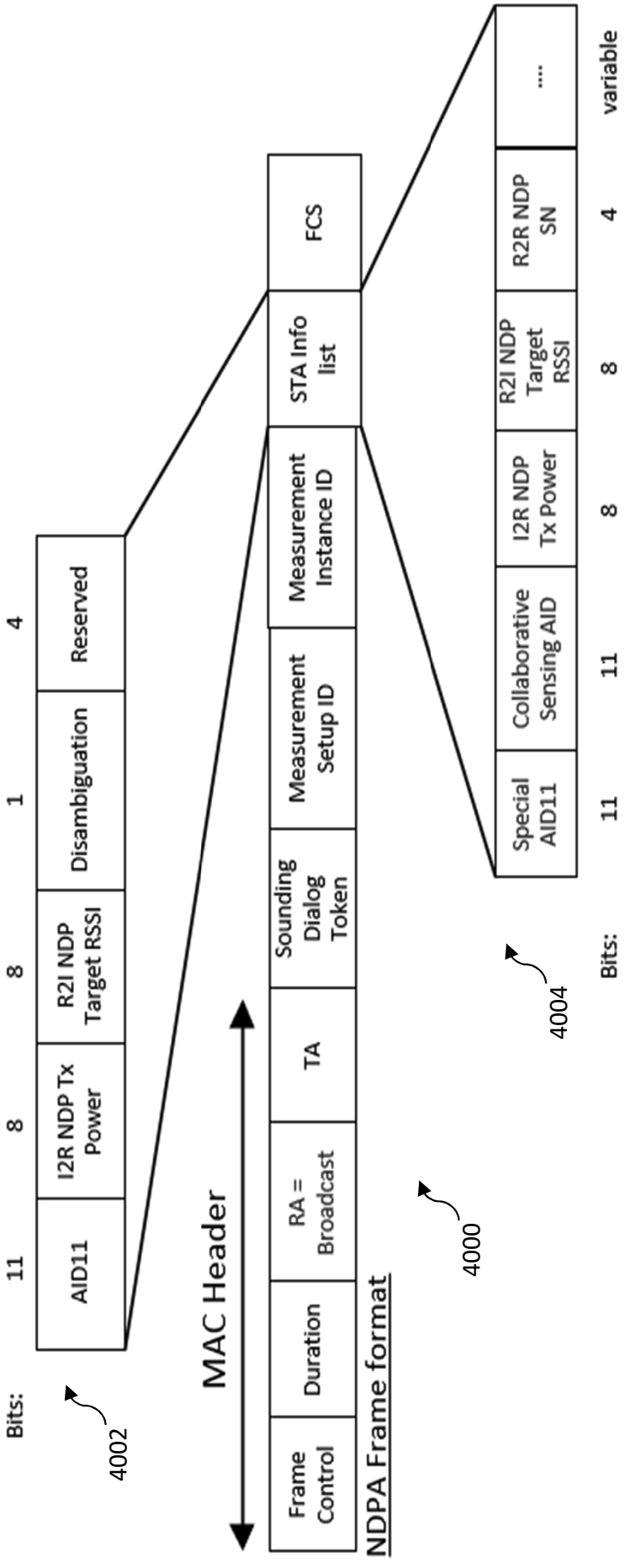

NDPA Frame format
MAC Header
Frame Control
Duration
RA = Broadcast
TA
Sounding Dialog Token
Measurement Setup ID
Measurement Instance ID
STA Info list
FCS
Bits:
11
8
8
1
4
AID11
I2R NDP Tx Power
R2I NDP Target RSSI
Disambiguation
Reserved
4002
4000
4004
Special AID11
Collaborative Sensing AID
I2R NDP Tx Power
R2I NDP Target RSSI
R2R NDP SN
....
variable

Figure 40

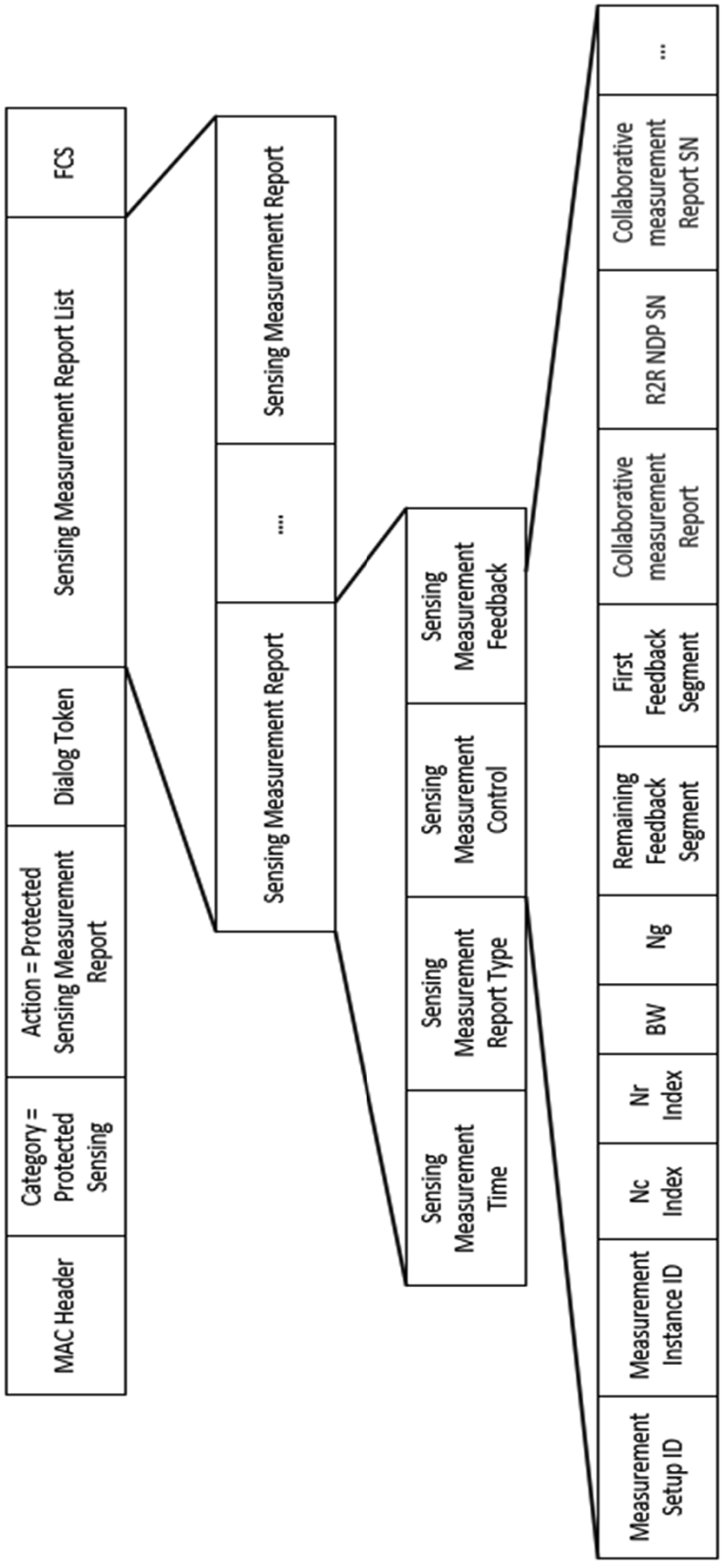

MAC Header
Category = Protected Sensing
Action = Protected Sensing Measurement Report
Dialog Token
Sensing Measurement Report List
FCS
Sensing Measurement Report
....
Sensing Measurement Report
Sensing Measurement Time
Sensing Measurement Report Type
Sensing Measurement Control
Sensing Measurement Feedback
Measurement Setup ID
Measurement Instance ID
Nc Index
Nr Index
BW
Ng
Remaining Feedback Segment
First Feedback Segment
Collaborative measurement Report
R2R NDP SN
Collaborative measurement Report SN
...
4100

Figure 41

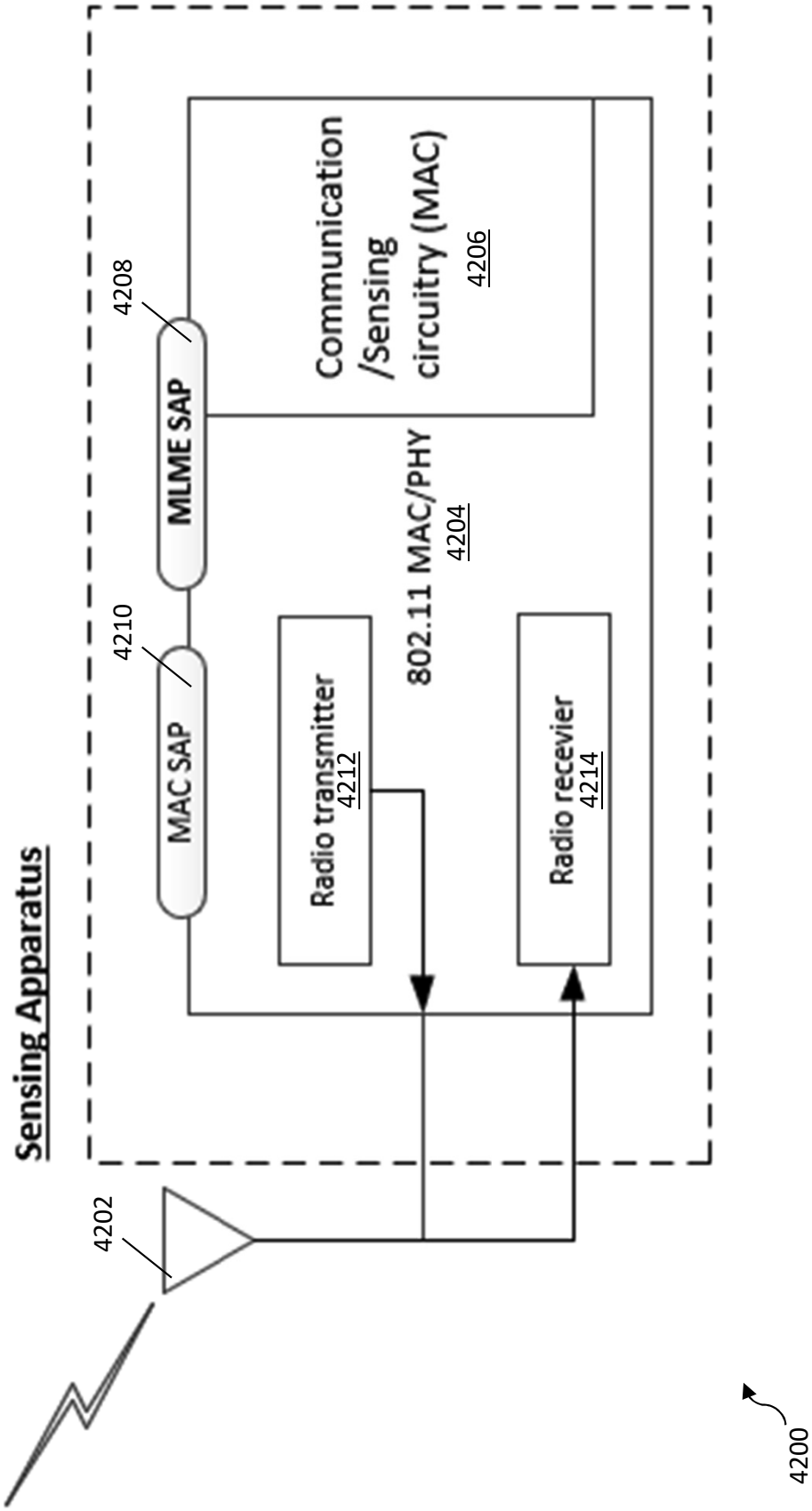

Sensing Apparatus
4202
4208
MLME SAP
4210
MAC SAP
Communication /Sensing circuitry (MAC)
4206
802.11 MAC/PHY
4204
Radio transmitter
4212
Radio recevier
4214
4200

Figure 42