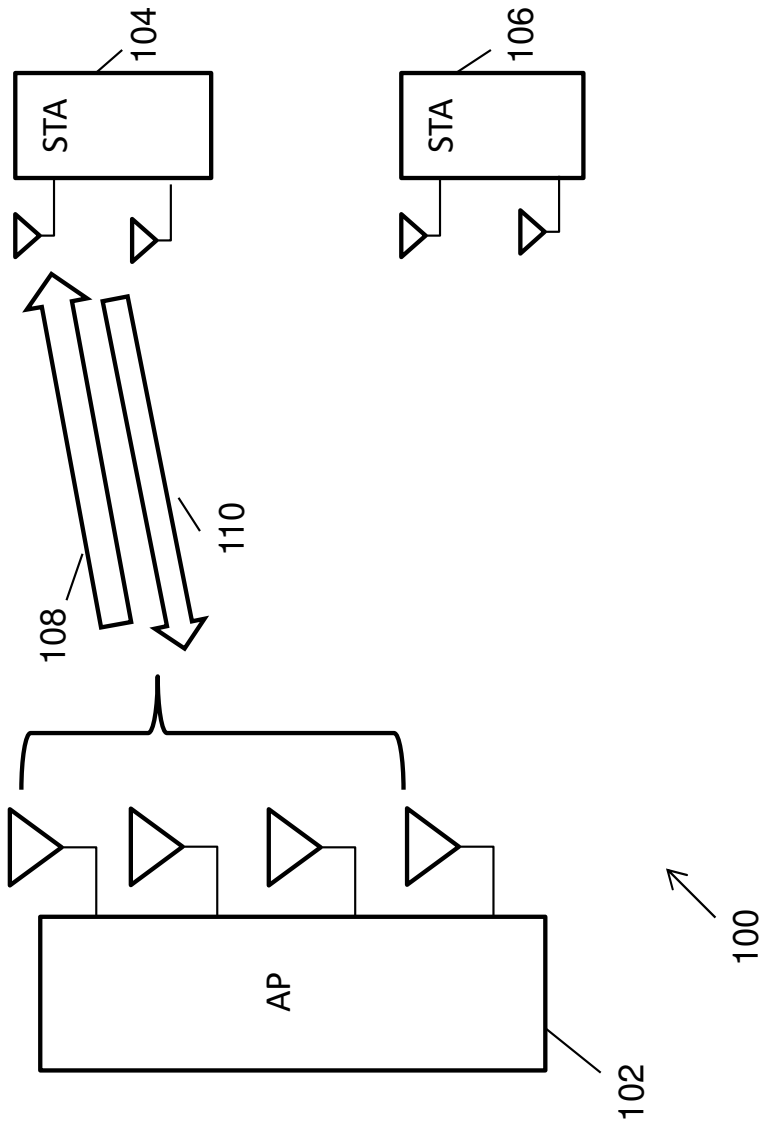


Figure 1

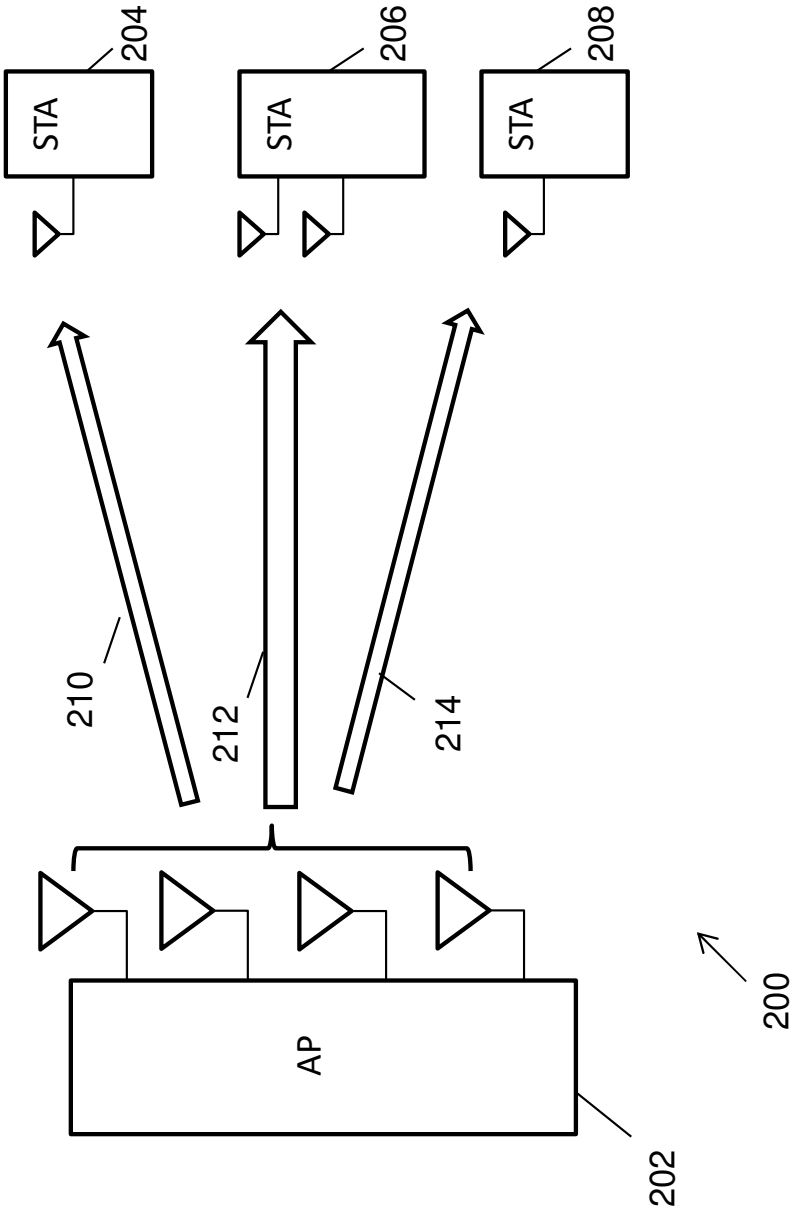


Figure 2

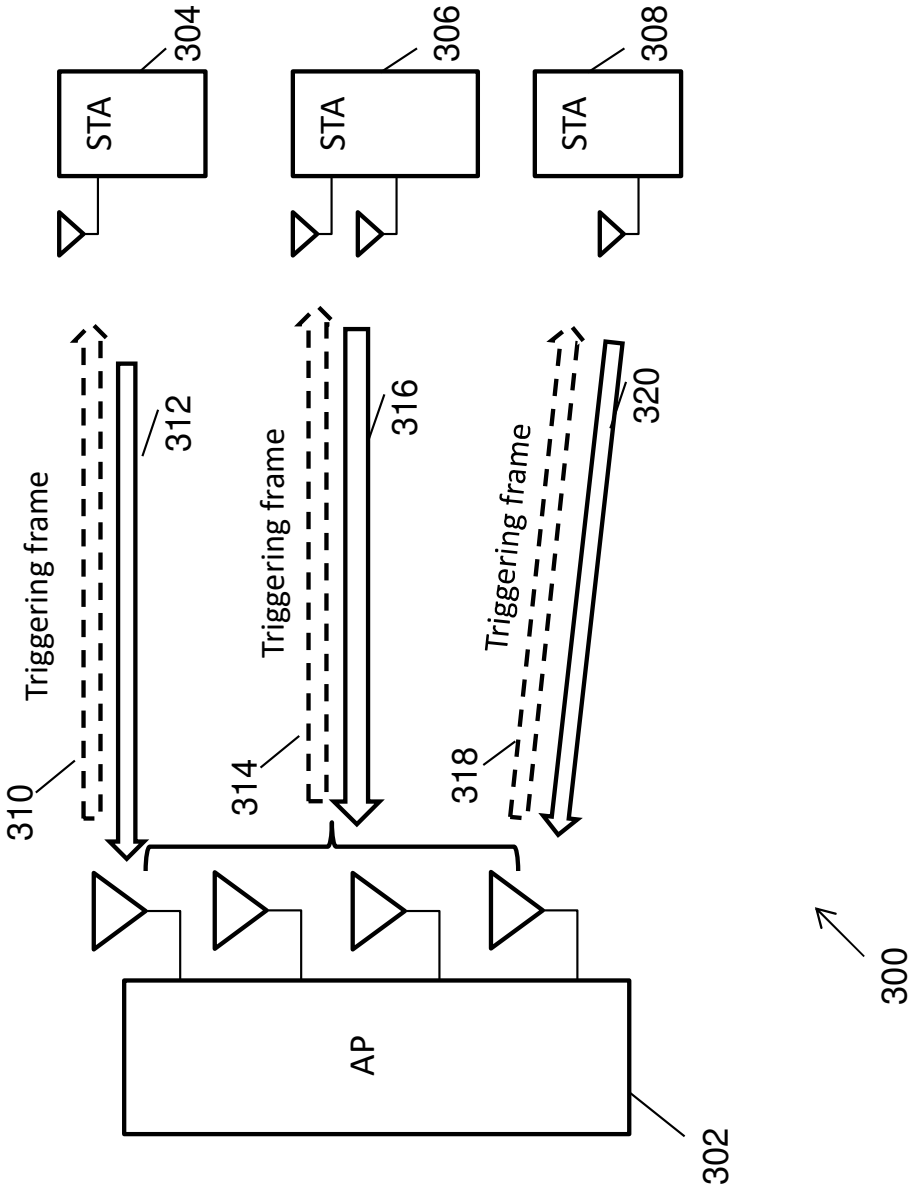

STA
304
STA
306
STA
308
Triggering frame
310
312
Triggering frame
314
316
Triggering frame
318
320
AP
302
300

Figure 3

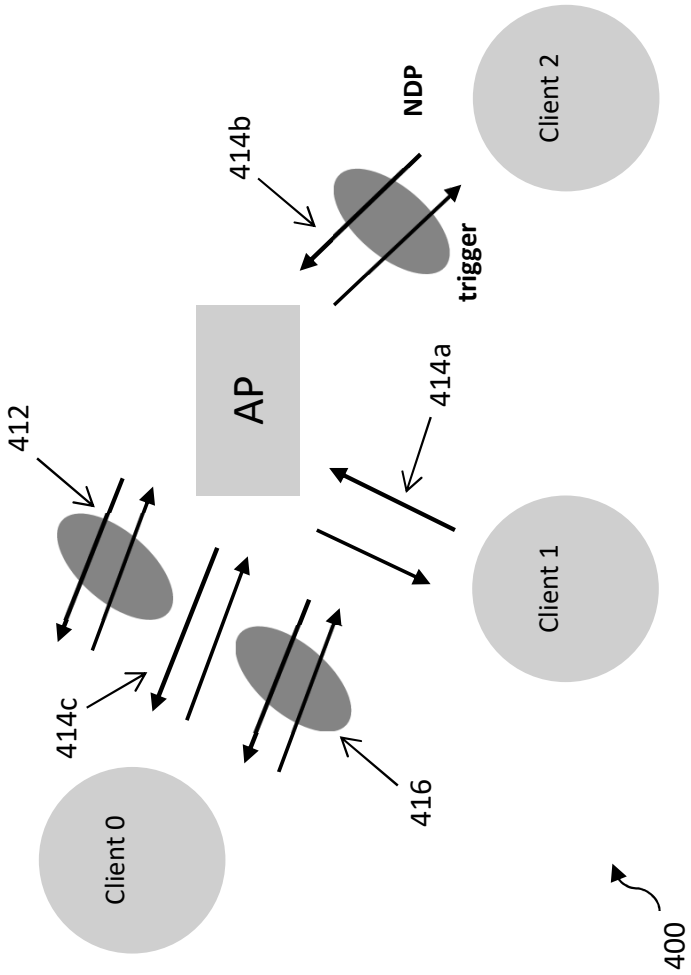

Client 2
NDP
414b
trigger
AP
414a
412
Client 1
414c
Client 0
416
400

Figure 4

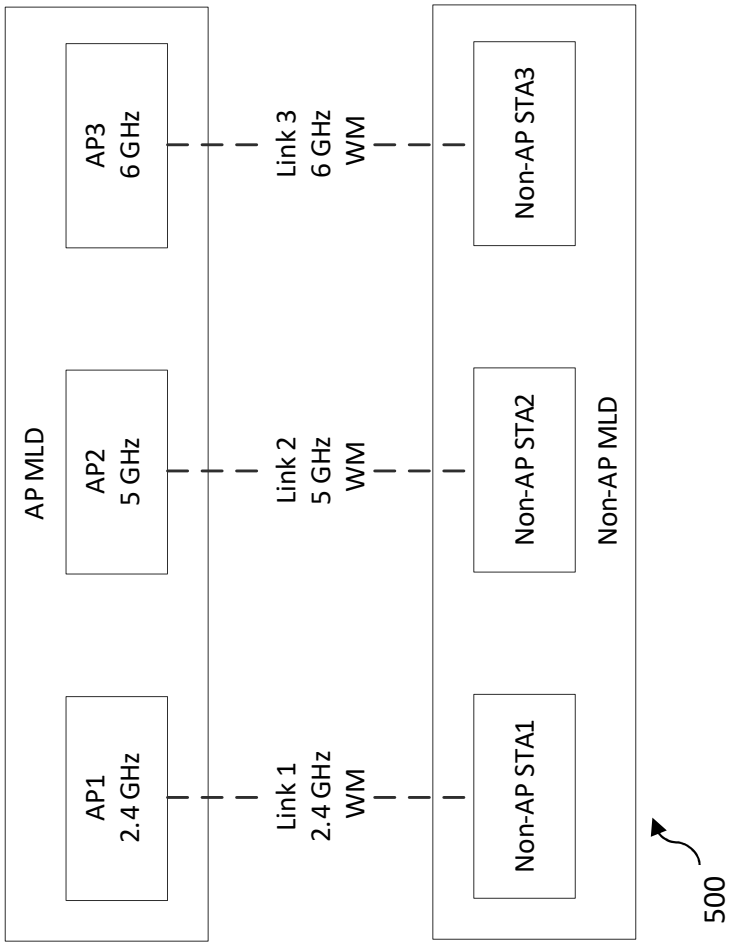

AP MLD
AP1
2.4 GHz
AP2
5 GHz
AP3
6 GHz
Link 1
2.4 GHz
WM
Link 2
5 GHz
WM
Link 3
6 GHz
WM
Non-AP STA1
Non-AP STA2
Non-AP STA3
Non-AP MLD
500

Figure 5

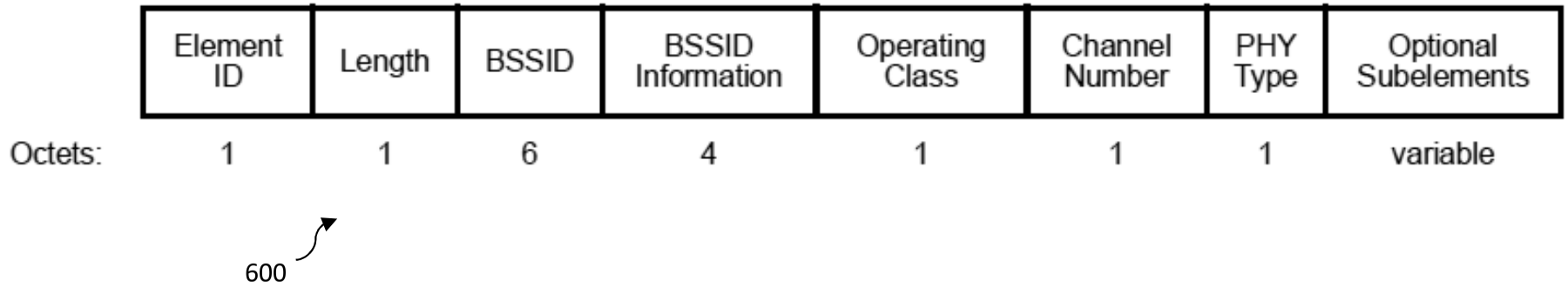


Figure 6A

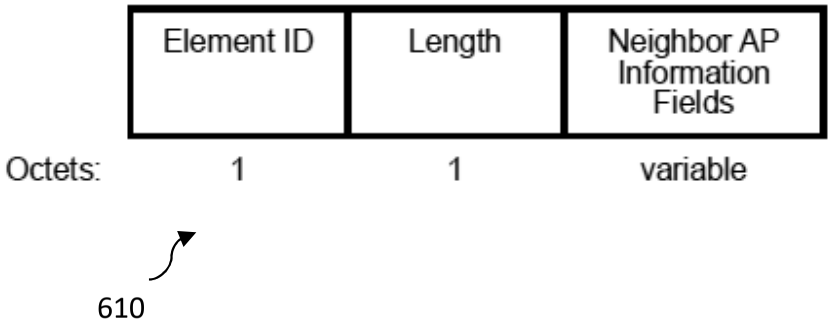


Figure 6B

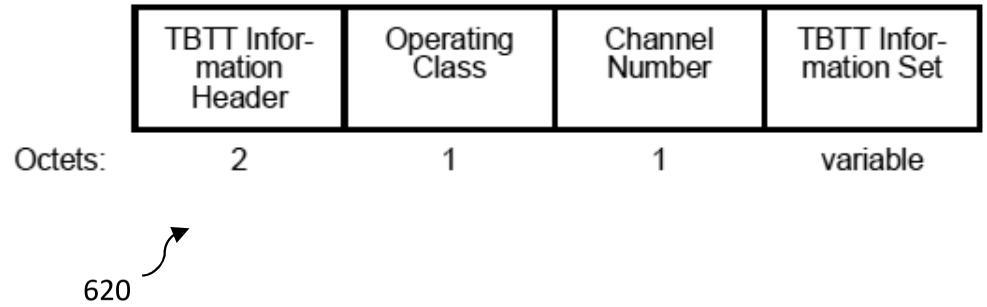


Figure 6C

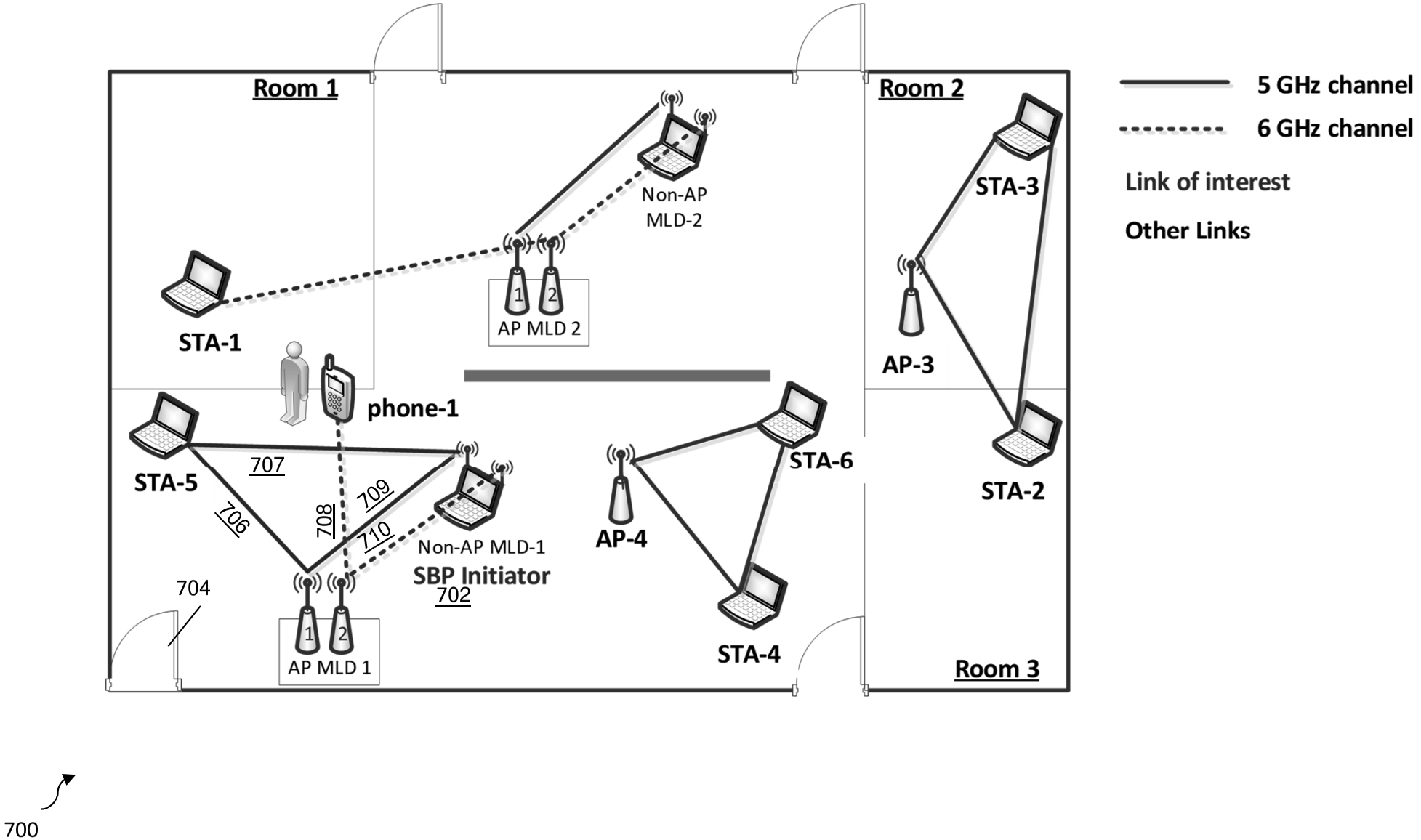

Room 1
Room 2
Room 3
Non-AP
MLD-2
AP MLD 2
STA-1
phone-1
STA-3
AP-3
STA-2
STA-5
707
706
708
709
710
Non-AP MLD-1
SBP Initiator
702
704
AP MLD 1
AP-4
STA-6
STA-4
5 GHz channel
6 GHz channel
Link of interest
Other Links
700

Figure 7

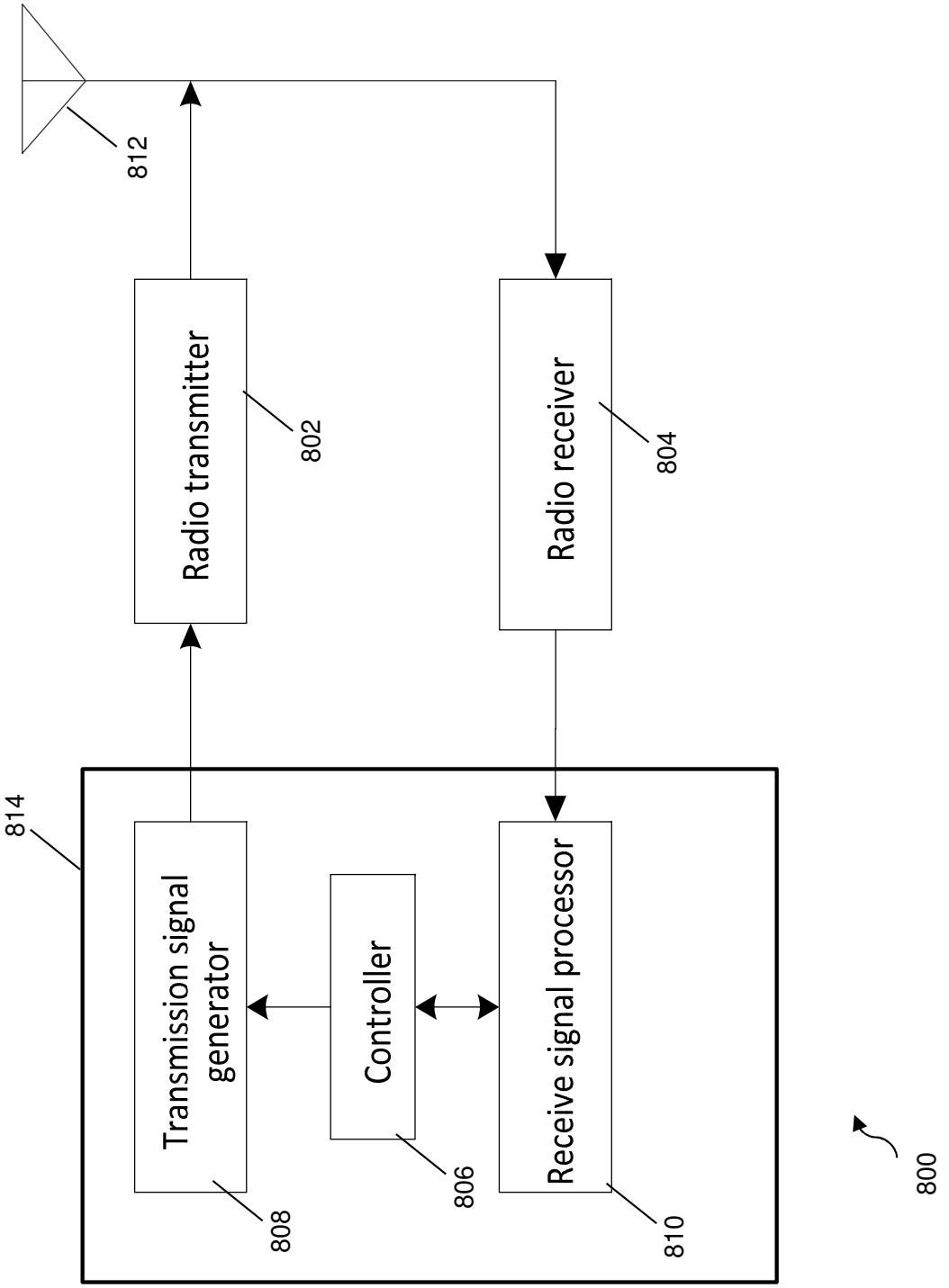

812
Radio transmitter
802
Radio receiver
804
814
Transmission signal generator
Controller
Receive signal processor
808
806
810
800

Figure 8

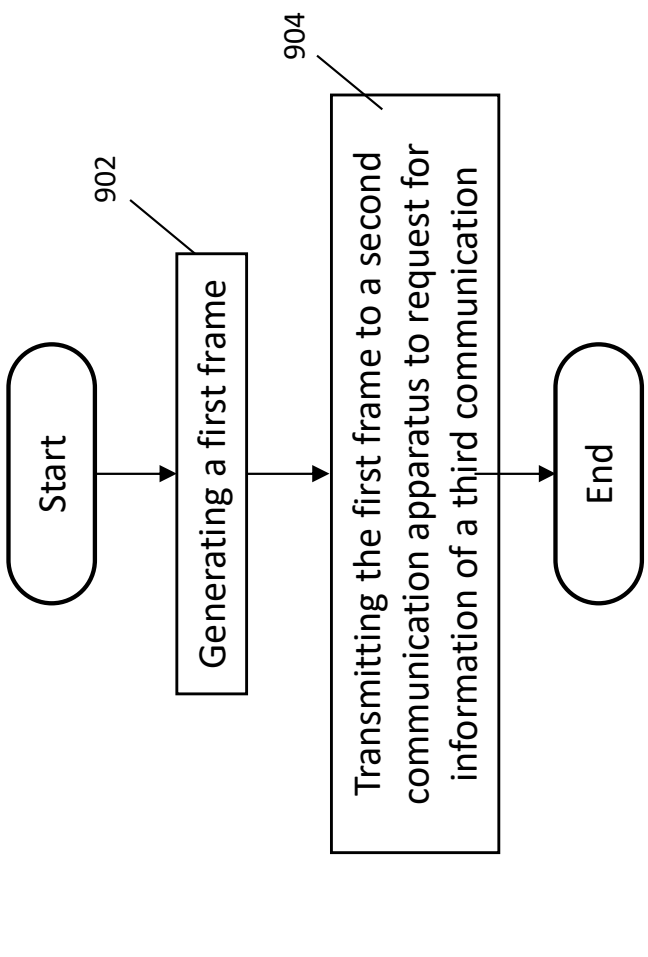

Start
902
Generating a first frame
904
Transmitting the first frame to a second communication apparatus to request for information of a third communication
End
900

Figure 9

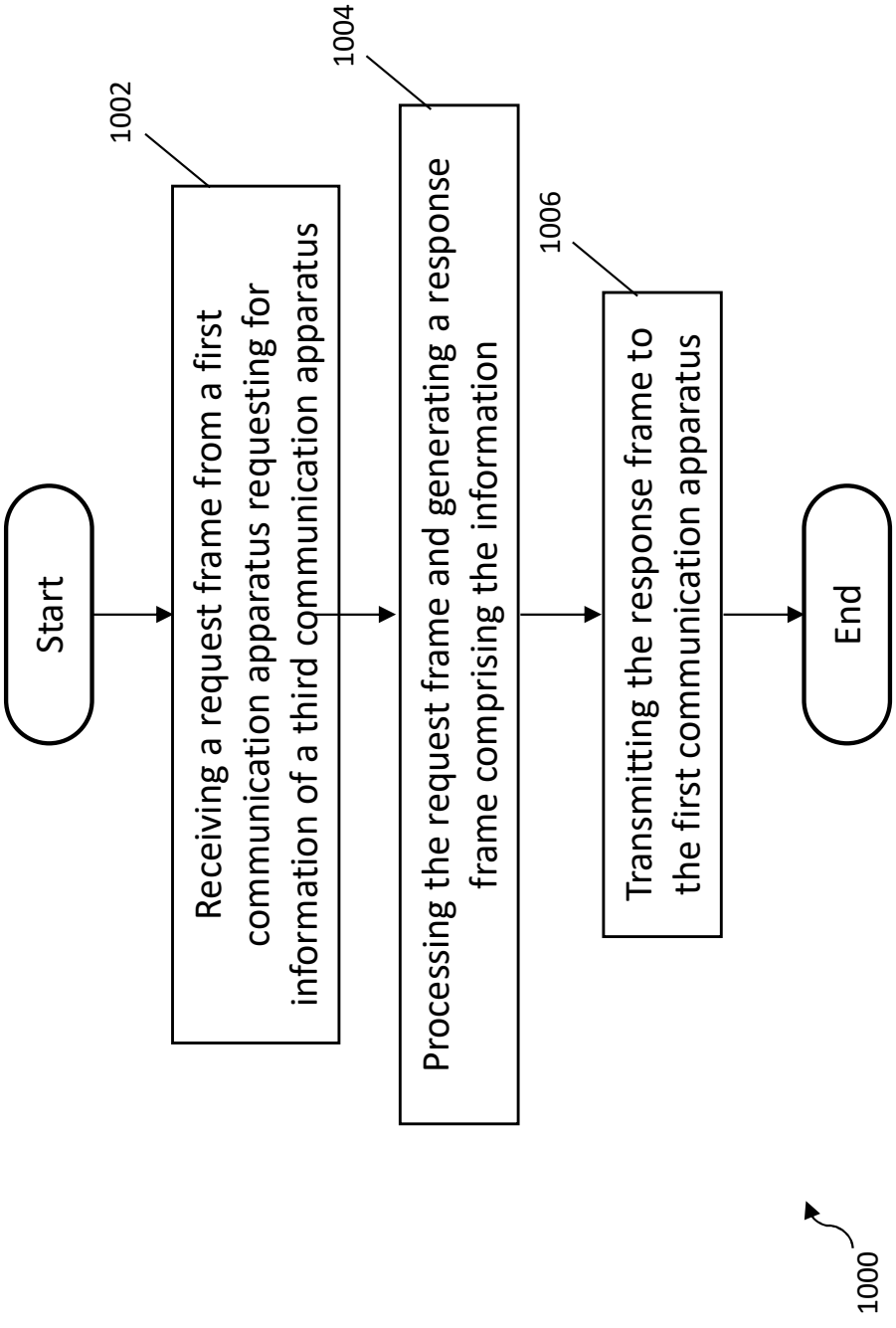

Start
Receiving a request frame from a first communication apparatus requesting for information of a third communication apparatus
Processing the request frame and generating a response frame comprising the information
Transmitting the response frame to the first communication apparatus
End
1000
1002
1004
1006

Figure 10

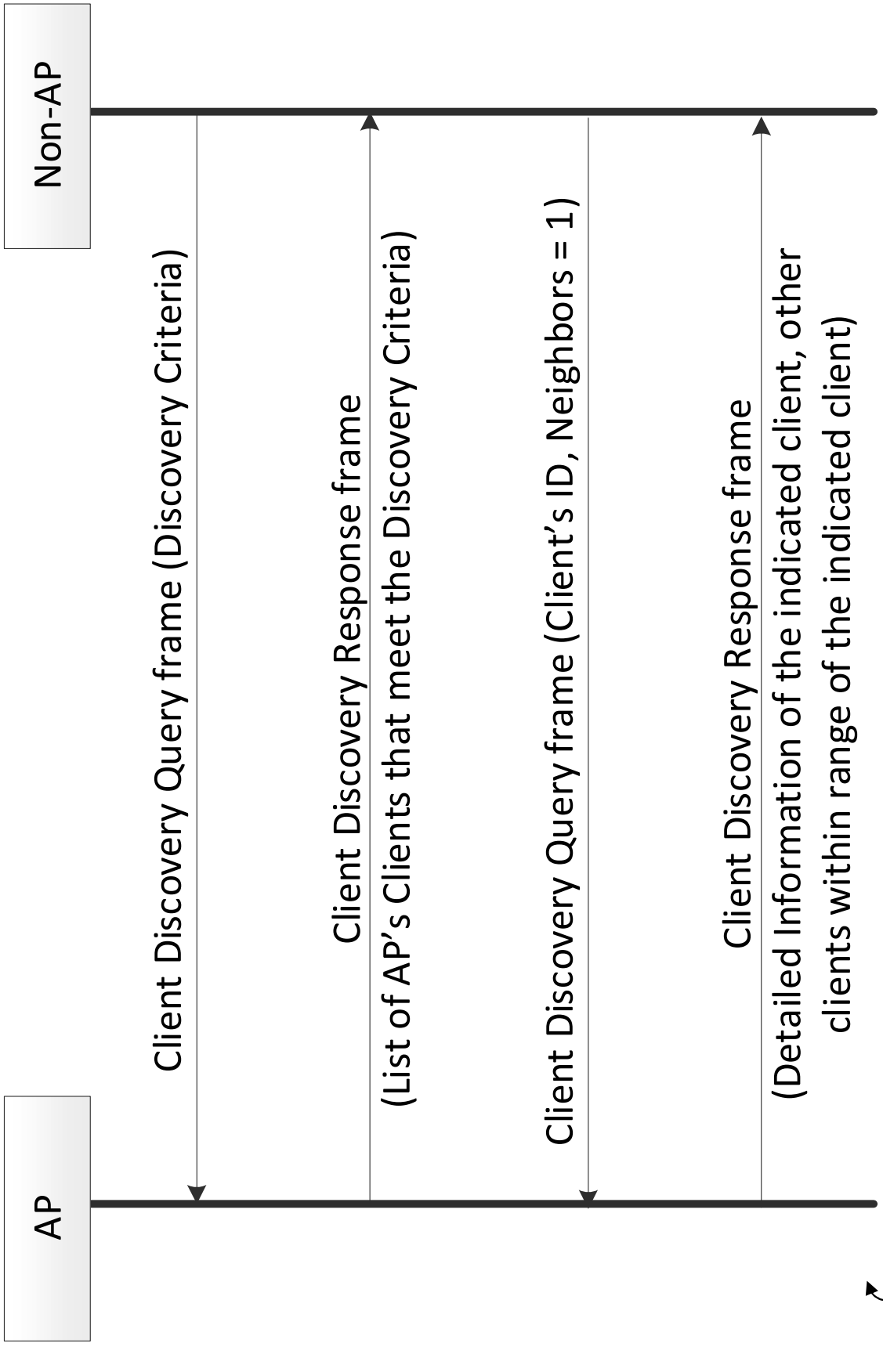

Non-AP
AP
Client Discovery Query frame (Discovery Criteria)
Client Discovery Response frame
(List of AP's Clients that meet the Discovery Criteria)
Client Discovery Query frame (Client's ID, Neighbors = 1)
Client Discovery Response frame
(Detailed Information of the indicated client, other clients within range of the indicated client)
1100

Figure 11

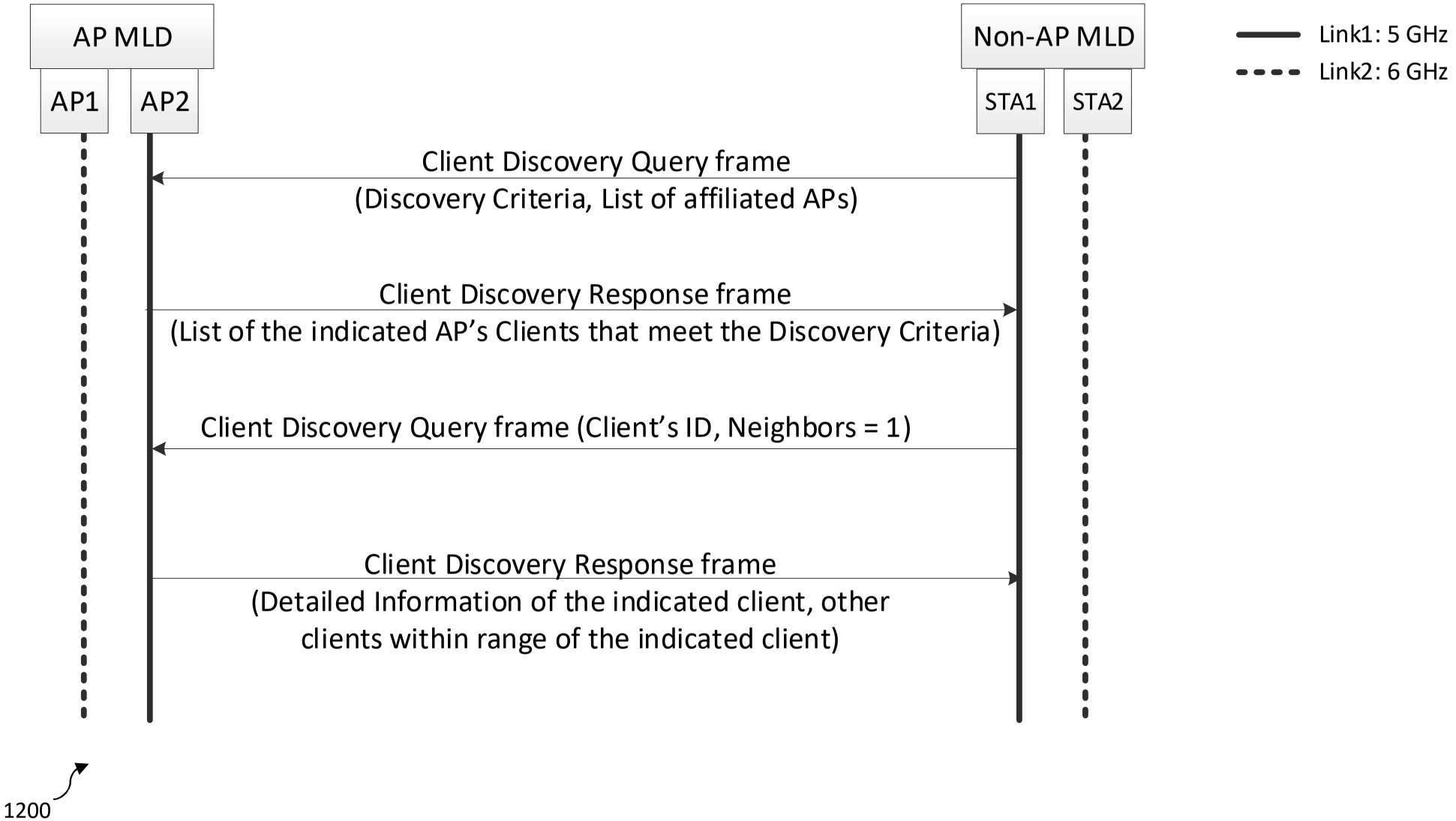

AP MLD
AP1
AP2
Non-AP MLD
STA1
STA2
Link1: 5 GHz
Link2: 6 GHz
Client Discovery Query frame
(Discovery Criteria, List of affiliated APs)
Client Discovery Response frame
(List of the indicated AP's Clients that meet the Discovery Criteria)
Client Discovery Query frame (Client's ID, Neighbors = 1)
Client Discovery Response frame
(Detailed Information of the indicated client, other clients within range of the indicated client)
1200

Figure 12

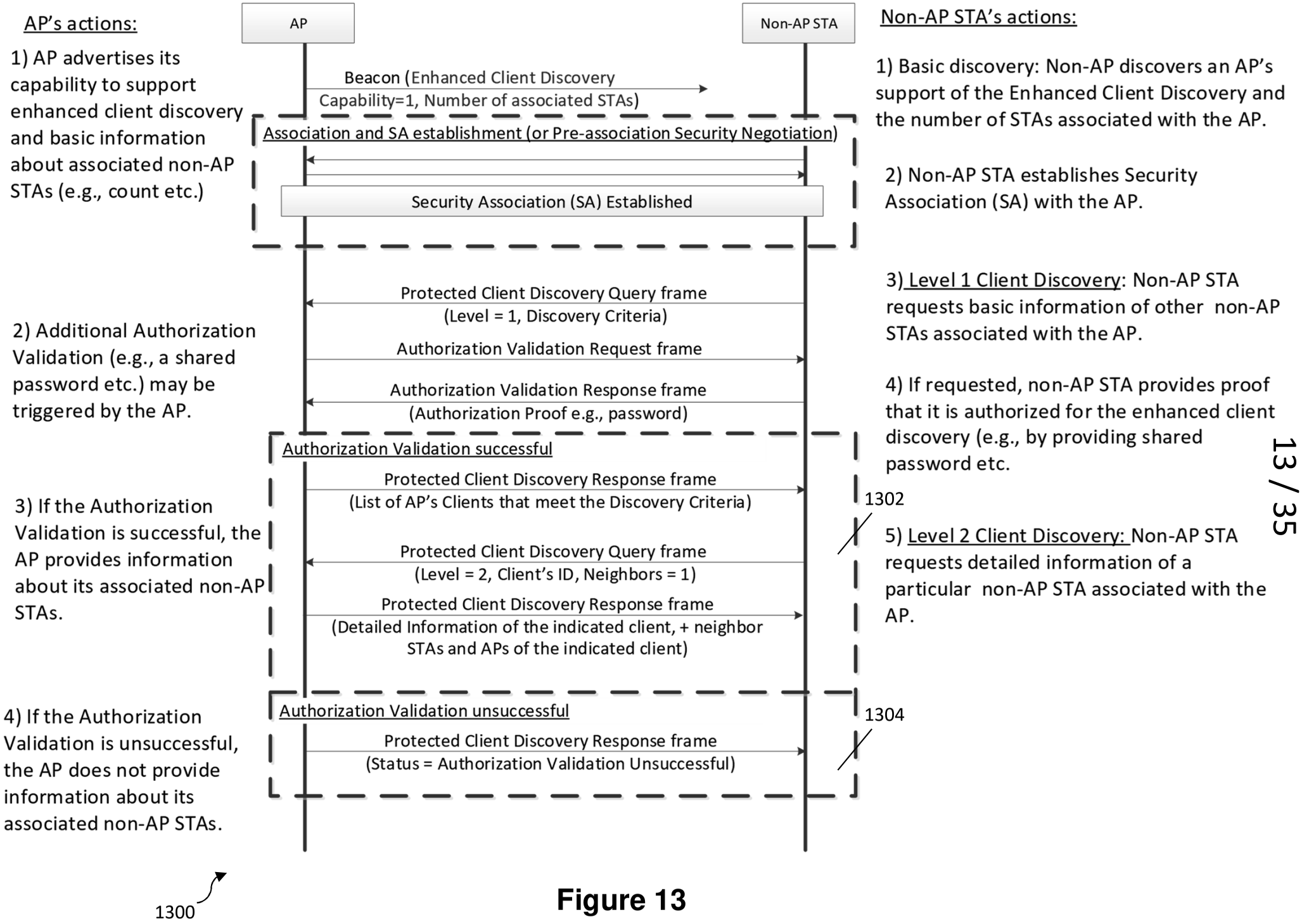

AP's actions:
1) AP advertises its capability to support enhanced client discovery and basic information about associated non-AP STAs (e.g., count etc.)
2) Additional Authorization Validation (e.g., a shared password etc.) may be triggered by the AP.
3) If the Authorization Validation is successful, the AP provides information about its associated non-AP STAs.
4) If the Authorization Validation is unsuccessful, the AP does not provide information about its associated non-AP STAs.
AP
Non-AP STA
Beacon (Enhanced Client Discovery Capability=1, Number of associated STAs)
Association and SA establishment (or Pre-association Security Negotiation)
Security Association (SA) Established
Protected Client Discovery Query frame (Level = 1, Discovery Criteria)
Authorization Validation Request frame
Authorization Validation Response frame (Authorization Proof e.g., password)
Authorization Validation successful
Protected Client Discovery Response frame (List of AP's Clients that meet the Discovery Criteria)
Protected Client Discovery Query frame (Level = 2, Client's ID, Neighbors = 1)
Protected Client Discovery Response frame (Detailed Information of the indicated client, + neighbor STAs and APs of the indicated client)
Authorization Validation unsuccessful
Protected Client Discovery Response frame (Status = Authorization Validation Unsuccessful)
1302
1304
Non-AP STA's actions:
1) Basic discovery: Non-AP discovers an AP's support of the Enhanced Client Discovery and the number of STAs associated with the AP.
2) Non-AP STA establishes Security Association (SA) with the AP.
3) Level 1 Client Discovery: Non-AP STA requests basic information of other non-AP STAs associated with the AP.
4) If requested, non-AP STA provides proof that it is authorized for the enhanced client discovery (e.g., by providing shared password etc.
5) Level 2 Client Discovery: Non-AP STA requests detailed information of a particular non-AP STA associated with the AP.
1300

Figure 13

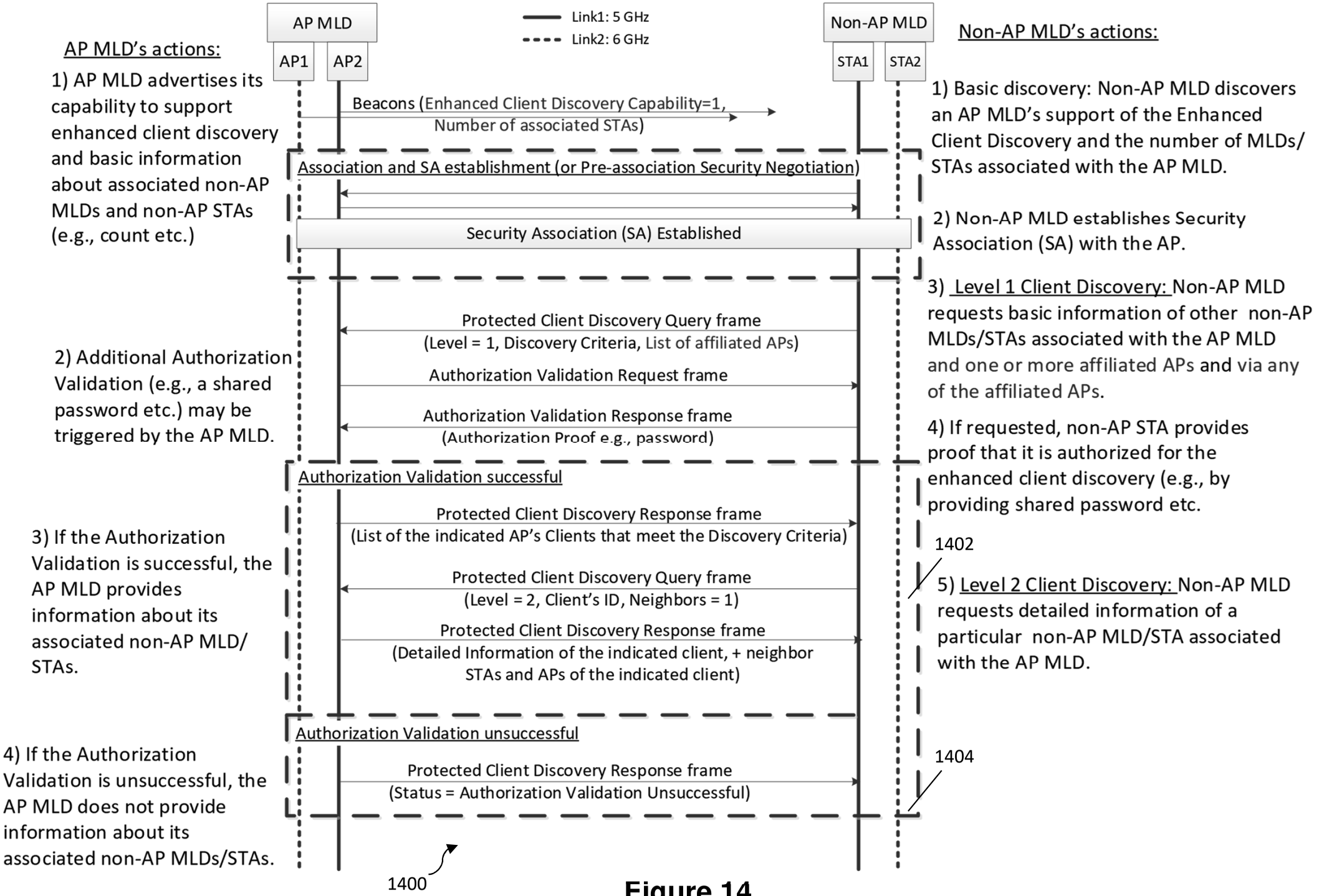

AP MLD
AP1
AP2
Link1: 5 GHz
Link2: 6 GHz
Non-AP MLD
STA1
STA2
AP MLD's actions:
1) AP MLD advertises its capability to support enhanced client discovery and basic information about associated non-AP MLDs and non-AP STAs (e.g., count etc.)
Beacons (Enhanced Client Discovery Capability=1, Number of associated STAs)
Association and SA establishment (or Pre-association Security Negotiation)
Security Association (SA) Established
Non-AP MLD's actions:
1) Basic discovery: Non-AP MLD discovers an AP MLD's support of the Enhanced Client Discovery and the number of MLDs/ STAs associated with the AP MLD.
2) Non-AP MLD establishes Security Association (SA) with the AP.
3) Level 1 Client Discovery: Non-AP MLD requests basic information of other non-AP MLDs/STAs associated with the AP MLD and one or more affiliated APs and via any of the affiliated APs.
Protected Client Discovery Query frame
(Level = 1, Discovery Criteria, List of affiliated APs)
2) Additional Authorization Validation (e.g., a shared password etc.) may be triggered by the AP MLD.
Authorization Validation Request frame
Authorization Validation Response frame
(Authorization Proof e.g., password)
4) If requested, non-AP STA provides proof that it is authorized for the enhanced client discovery (e.g., by providing shared password etc.
Authorization Validation successful
Protected Client Discovery Response frame
(List of the indicated AP's Clients that meet the Discovery Criteria)
1402
3) If the Authorization Validation is successful, the AP MLD provides information about its associated non-AP MLD/ STAs.
Protected Client Discovery Query frame
(Level = 2, Client's ID, Neighbors = 1)
5) Level 2 Client Discovery: Non-AP MLD requests detailed information of a particular non-AP MLD/STA associated with the AP MLD.
Protected Client Discovery Response frame
(Detailed Information of the indicated client, + neighbor STAs and APs of the indicated client)
Authorization Validation unsuccessful
1404
4) If the Authorization Validation is unsuccessful, the AP MLD does not provide information about its associated non-AP MLDs/STAs.
Protected Client Discovery Response frame
(Status = Authorization Validation Unsuccessful)
1400

Figure 14

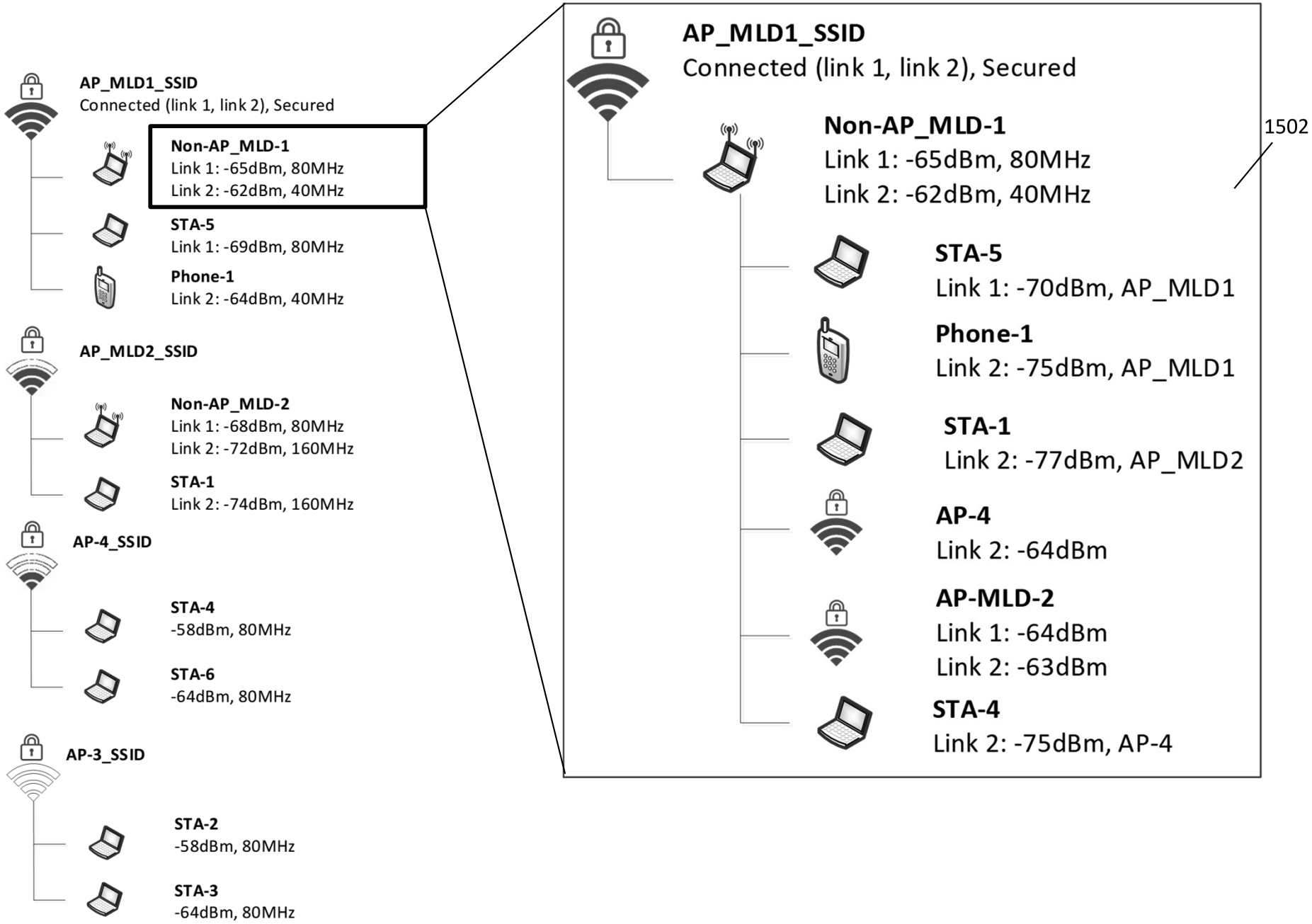

AP_MLD1_SSID
Connected (link 1, link 2), Secured
Non-AP_MLD-1
Link 1: -65dBm, 80MHz
Link 2: -62dBm, 40MHz
STA-5
Link 1: -69dBm, 80MHz
Phone-1
Link 2: -64dBm, 40MHz
AP_MLD2_SSID
Non-AP_MLD-2
Link 1: -68dBm, 80MHz
Link 2: -72dBm, 160MHz
STA-1
Link 2: -74dBm, 160MHz
AP-4_SSID
STA-4
-58dBm, 80MHz
STA-6
-64dBm, 80MHz
AP-3_SSID
STA-2
-58dBm, 80MHz
STA-3
-64dBm, 80MHz
AP_MLD1_SSID
Connected (link 1, link 2), Secured
Non-AP_MLD-1
Link 1: -65dBm, 80MHz
Link 2: -62dBm, 40MHz
1502
STA-5
Link 1: -70dBm, AP_MLD1
Phone-1
Link 2: -75dBm, AP_MLD1
STA-1
Link 2: -77dBm, AP_MLD2
AP-4
Link 2: -64dBm
AP-MLD-2
Link 1: -64dBm
Link 2: -63dBm
STA-4
Link 2: -75dBm, AP-4

Figure 15

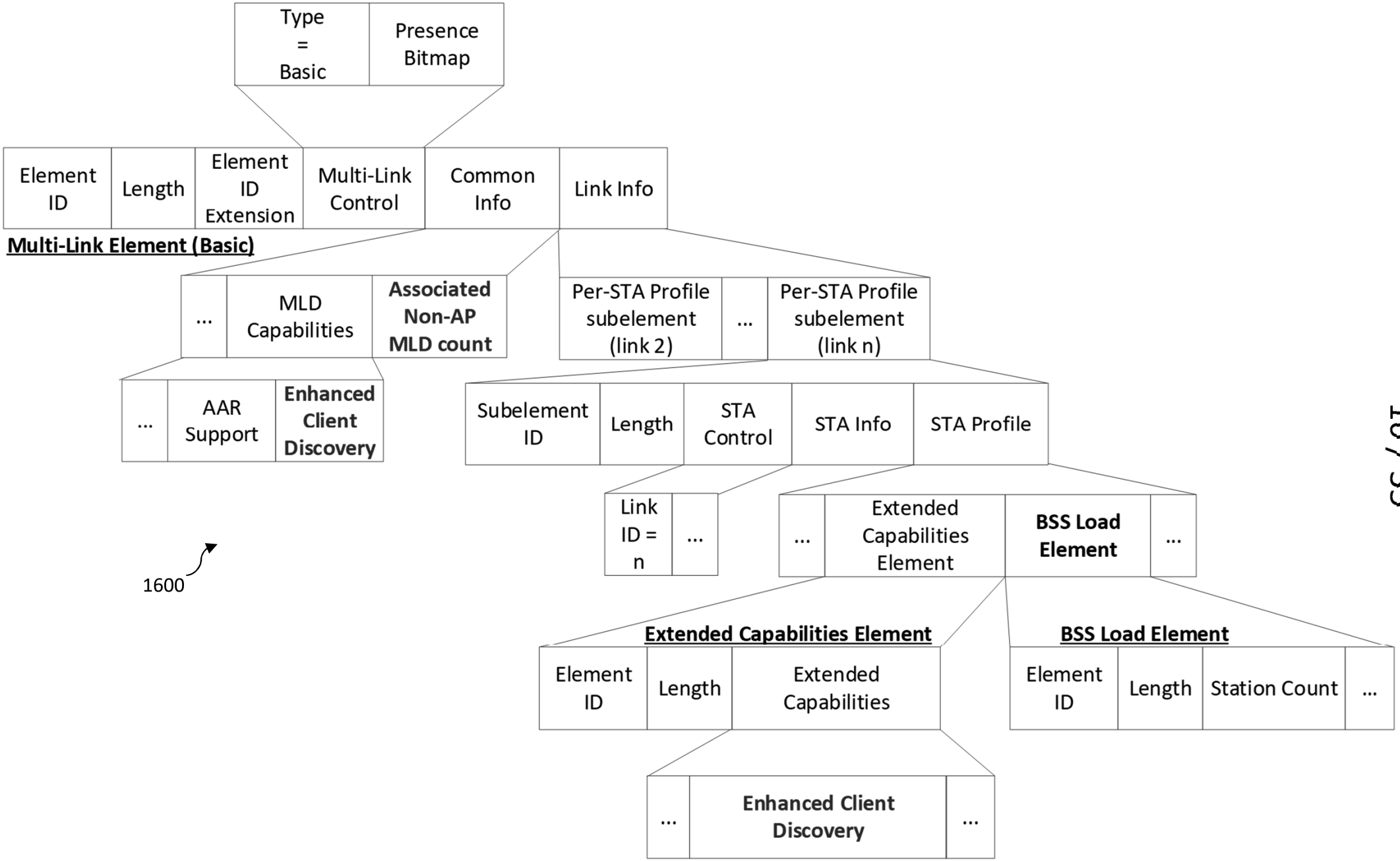

Type = Basic
Presence Bitmap
Element ID
Length
Element ID Extension
Multi-Link Control
Common Info
Link Info
Multi-Link Element (Basic)
...
MLD Capabilities
Associated Non-AP MLD count
Per-STA Profile subelement (link 2)
...
Per-STA Profile subelement (link n)
...
AAR Support
Enhanced Client Discovery
Subelement ID
Length
STA Control
STA Info
STA Profile
Link ID = n
...
...
Extended Capabilities Element
BSS Load Element
...
1600
Extended Capabilities Element
Element ID
Length
Extended Capabilities
...
Enhanced Client Discovery
...
BSS Load Element
Element ID
Length
Station Count
...

Figure 16

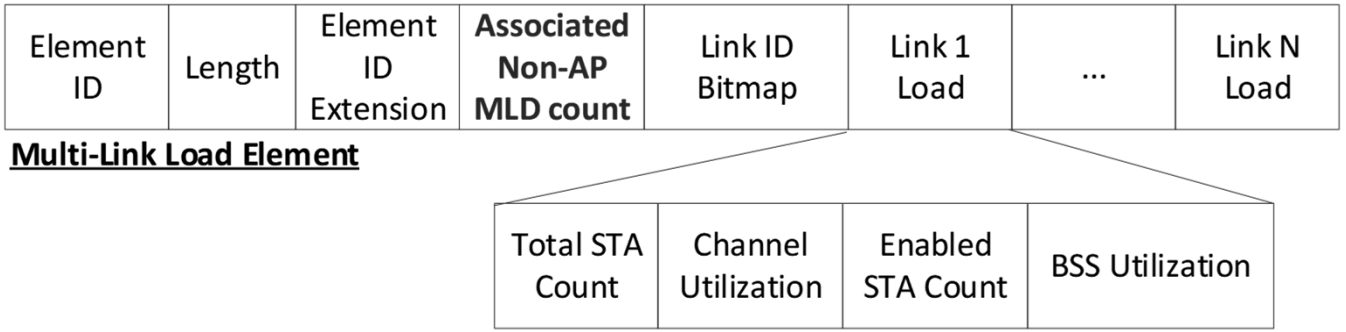

Element ID
Length
Element ID Extension
Associated Non-AP MLD count
Link ID Bitmap
Link 1 Load
...
Link N Load
Multi-Link Load Element
Total STA Count
Channel Utilization
Enabled STA Count
BSS Utilization
1700

Figure 17

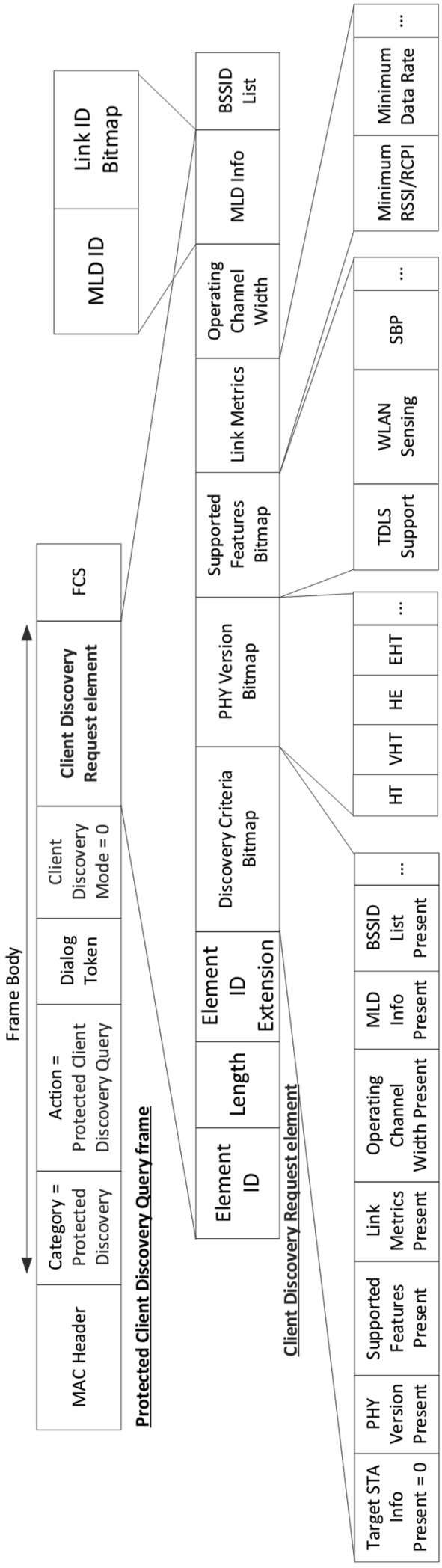
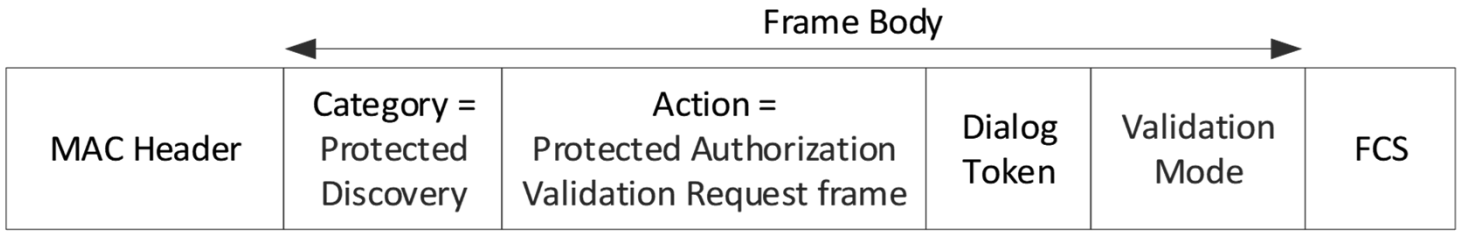

Frame Body
MAC Header
Category = Protected Discovery
Action = Protected Client Discovery Query
Dialog Token
Client Discovery Mode = 0
Client Discovery Request element
FCS
Protected Client Discovery Query frame
Element ID
Length
Element ID Extension
Discovery Criteria Bitmap
PHY Version Bitmap
Supported Features Bitmap
Link Metrics
Operating Channel Width
MLD Info
BSSID List
MLD ID
Link ID Bitmap
Client Discovery Request element
Target STA Info Present = 0
PHY Version Present
Supported Features Present
Link Metrics Present
Operating Channel Width Present
MLD Info Present
BSSID List Present
...
HT
VHT
HE
EHT
...
TDLS Support
WLAN Sensing
SBP
...
Minimum RSSI/RCPI
Minimum Data Rate
...
1800

Figure 18



Protected Authorization Validation Request frame

1900

Figure 19

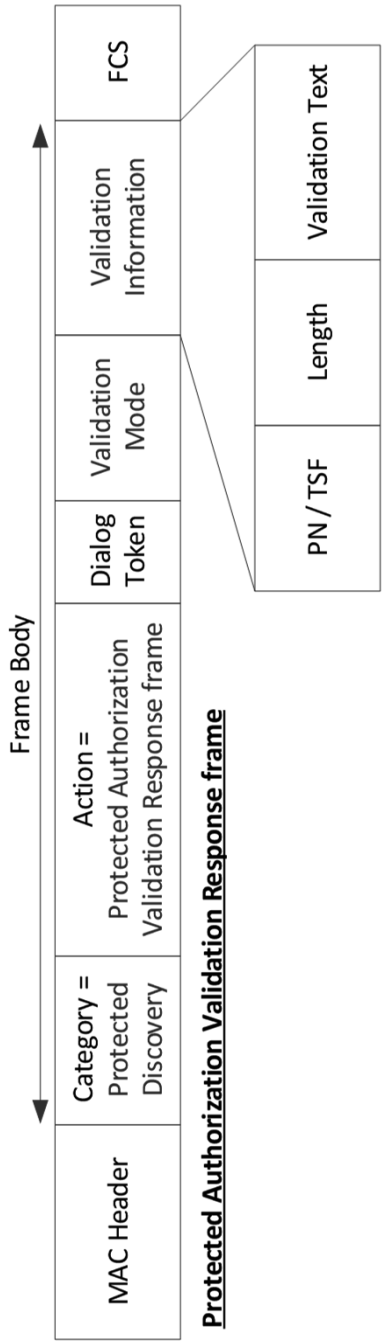

Frame Body
MAC Header
Category = Protected Discovery
Action = Protected Authorization Validation Response frame
Dialog Token
Validation Mode
Validation Information
FCS
PN / TSF
Length
Validation Text
Protected Authorization Validation Response frame
2000

Figure 20

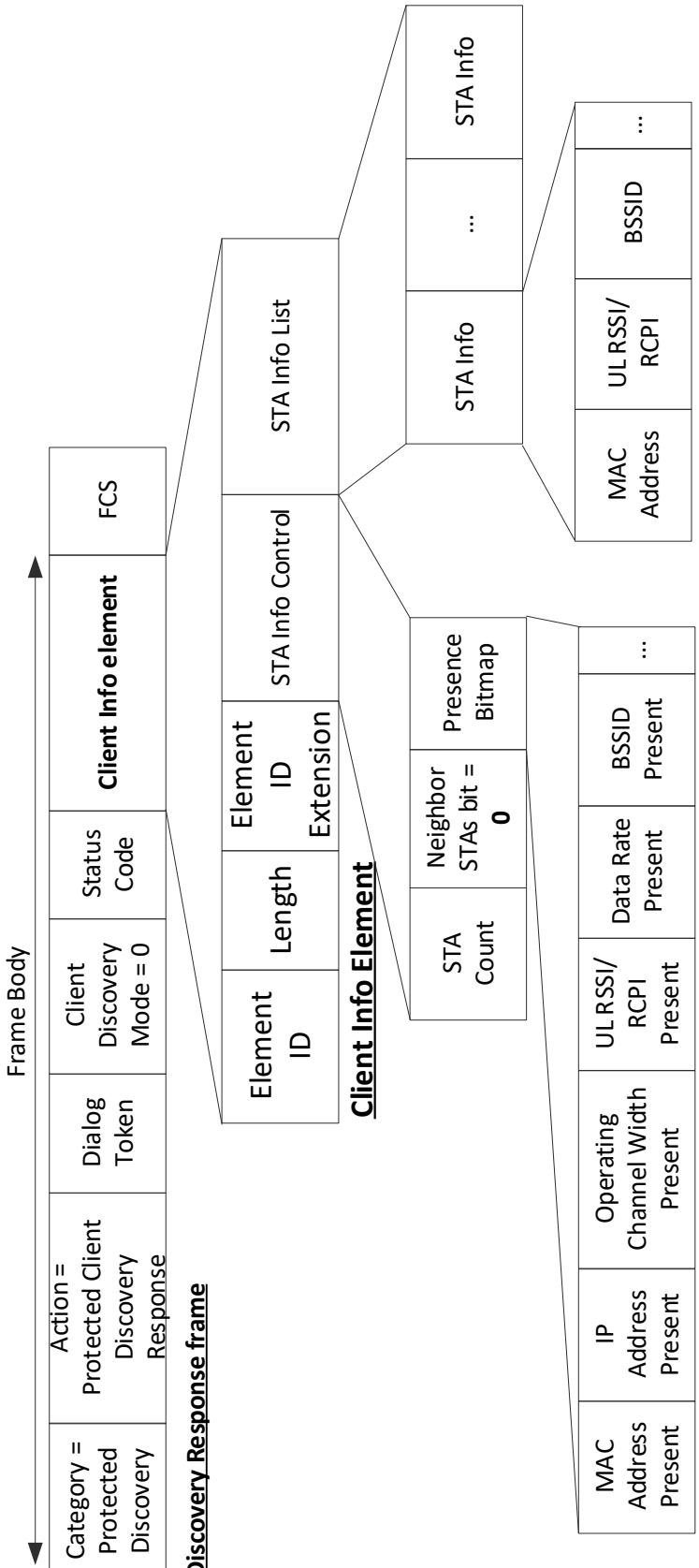

Frame Body
MAC Header
Category = Protected Discovery
Action = Protected Client Discovery Response
Dialog Token
Client Discovery Mode = 0
Status Code
Client Info element
FCS
Protected Client Discovery Response frame
Element ID
Length
Element ID Extension
STA Info Control
STA Info List
Client Info Element
STA Count
Neighbor STAs bit = 0
Presence Bitmap
MAC Address Present
IP Address Present
Operating Channel Width Present
UL RSSI/ RCPI Present
Data Rate Present
BSSID Present
...
MAC Address
UL RSSI/ RCPI
BSSID
...
STA Info
...
STA Info
2100

Figure 21

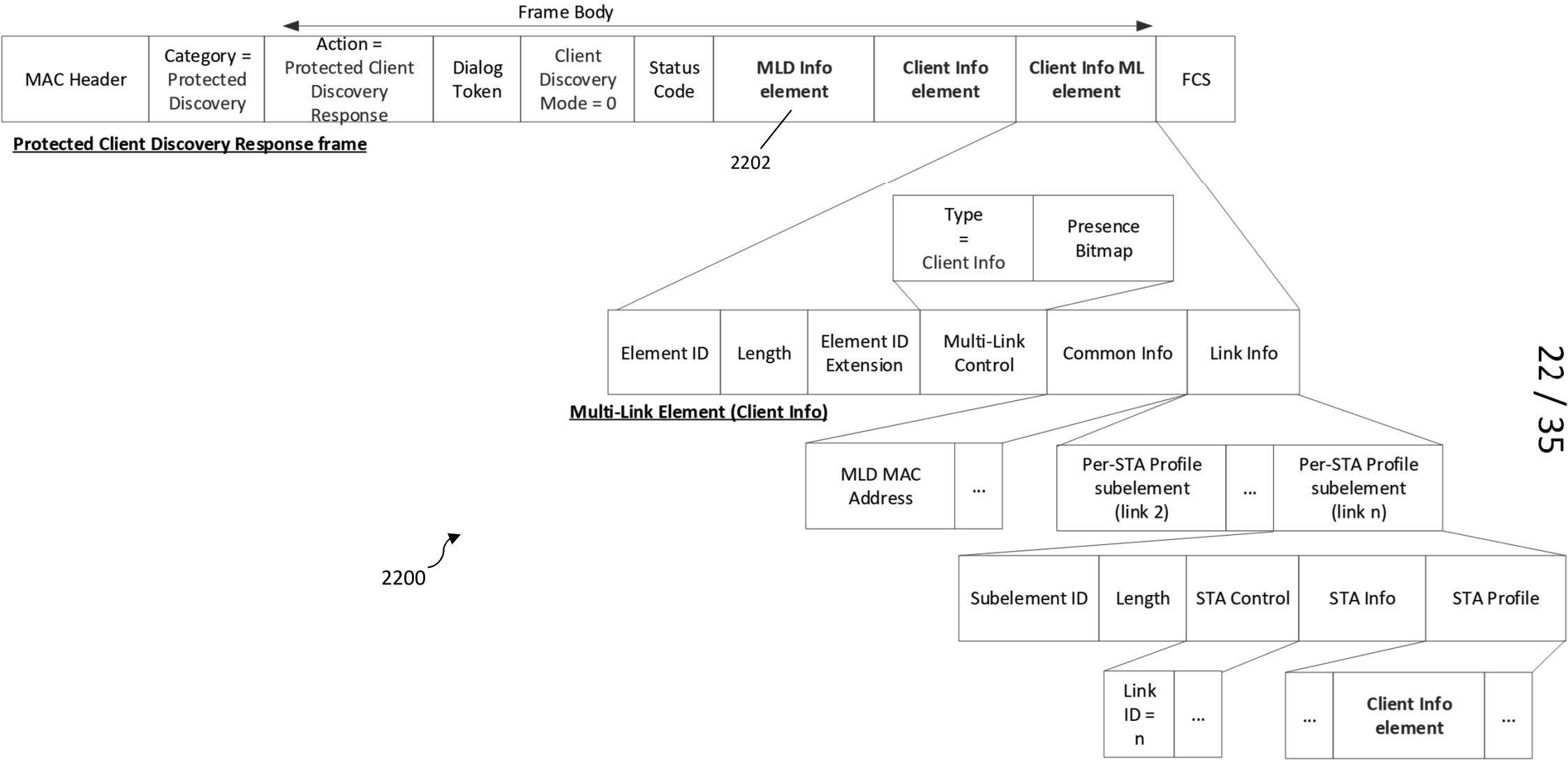

Frame Body
MAC Header
Category = Protected Discovery
Action = Protected Client Discovery Response
Dialog Token
Client Discovery Mode = 0
Status Code
MLD Info element
Client Info element
Client Info ML element
FCS
Protected Client Discovery Response frame
2202
Type = Client Info
Presence Bitmap
Element ID
Length
Element ID Extension
Multi-Link Control
Common Info
Link Info
Multi-Link Element (Client Info)
MLD MAC Address
...
Per-STA Profile subelement (link 2)
...
Per-STA Profile subelement (link n)
2200
Subelement ID
Length
STA Control
STA Info
STA Profile
Link ID = n
...
...
Client Info element
...

Figure 22

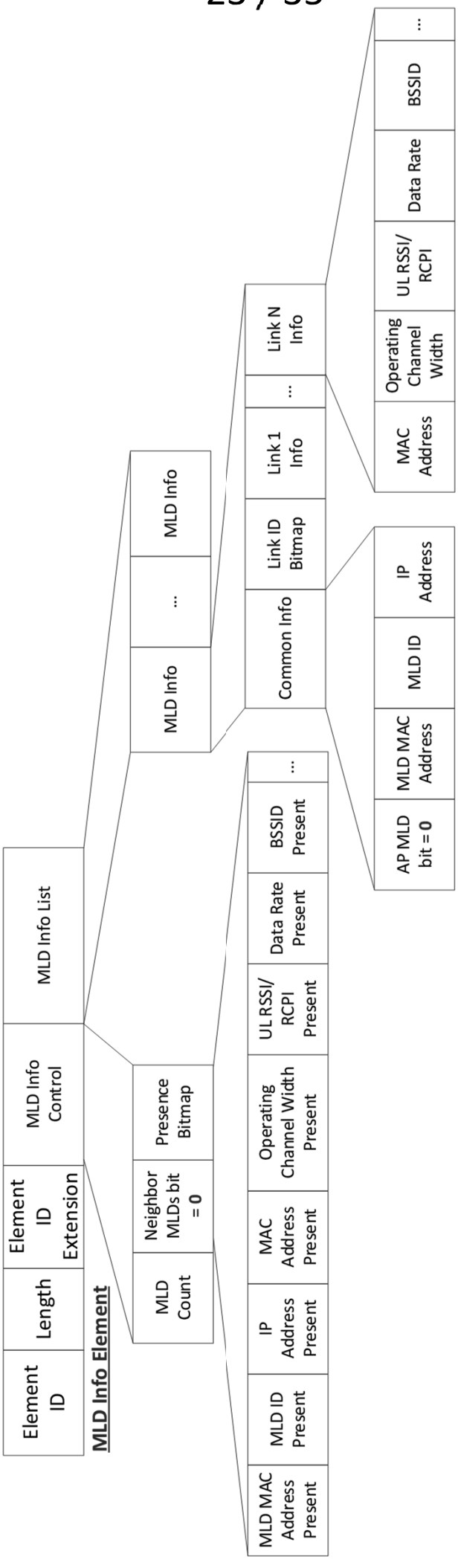

MLD Info Element
Element ID
Length
Element ID Extension
MLD Info Control
MLD Info List
MLD Count
Neighbor MLDs bit = 0
Presence Bitmap
MLD MAC Address Present
MLD ID Present
IP Address Present
MAC Address Present
Operating Channel Width Present
UL RSSI/ RCPI Present
Data Rate Present
BSSID Present
...
MLD Info
...
MLD Info
Common Info
Link ID Bitmap
Link 1 Info
...
Link N Info
AP MLD bit = 0
MLD MAC Address
MLD ID
IP Address
MAC Address
Operating Channel Width
UL RSSI/ RCPI
Data Rate
BSSID
...
2202

Figure 23

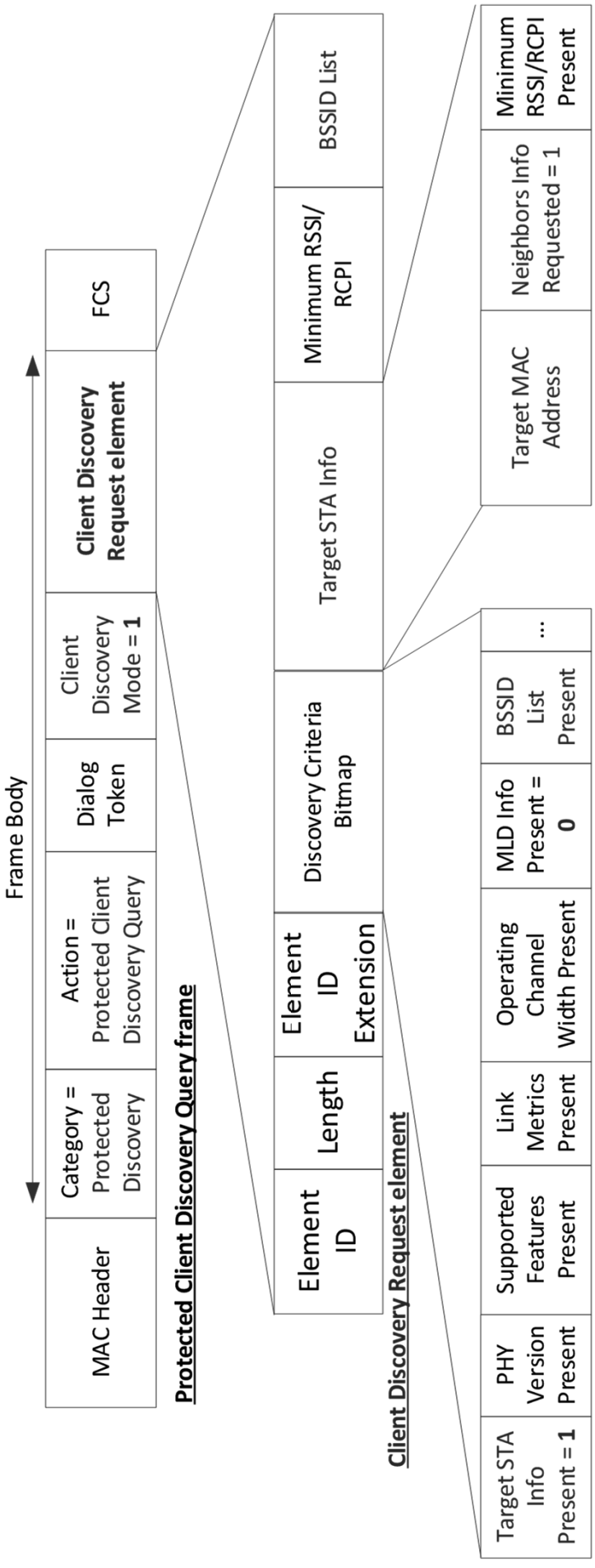

Frame Body
MAC Header
Category = Protected Discovery
Action = Protected Client Discovery Query
Dialog Token
Client Discovery Mode = 1
Client Discovery Request element
FCS
Protected Client Discovery Query frame
Element ID
Length
Element ID Extension
Discovery Criteria Bitmap
Target STA Info
Minimum RSSI/ RCPI
BSSID List
Client Discovery Request element
Target STA Info Present = 1
PHY Version Present
Supported Features Present
Link Metrics Present
Operating Channel Width Present
MLD Info Present = 0
BSSID List Present
...
Target MAC Address
Neighbors Info Requested = 1
Minimum RSSI/RCPI Present
2400

Figure 24

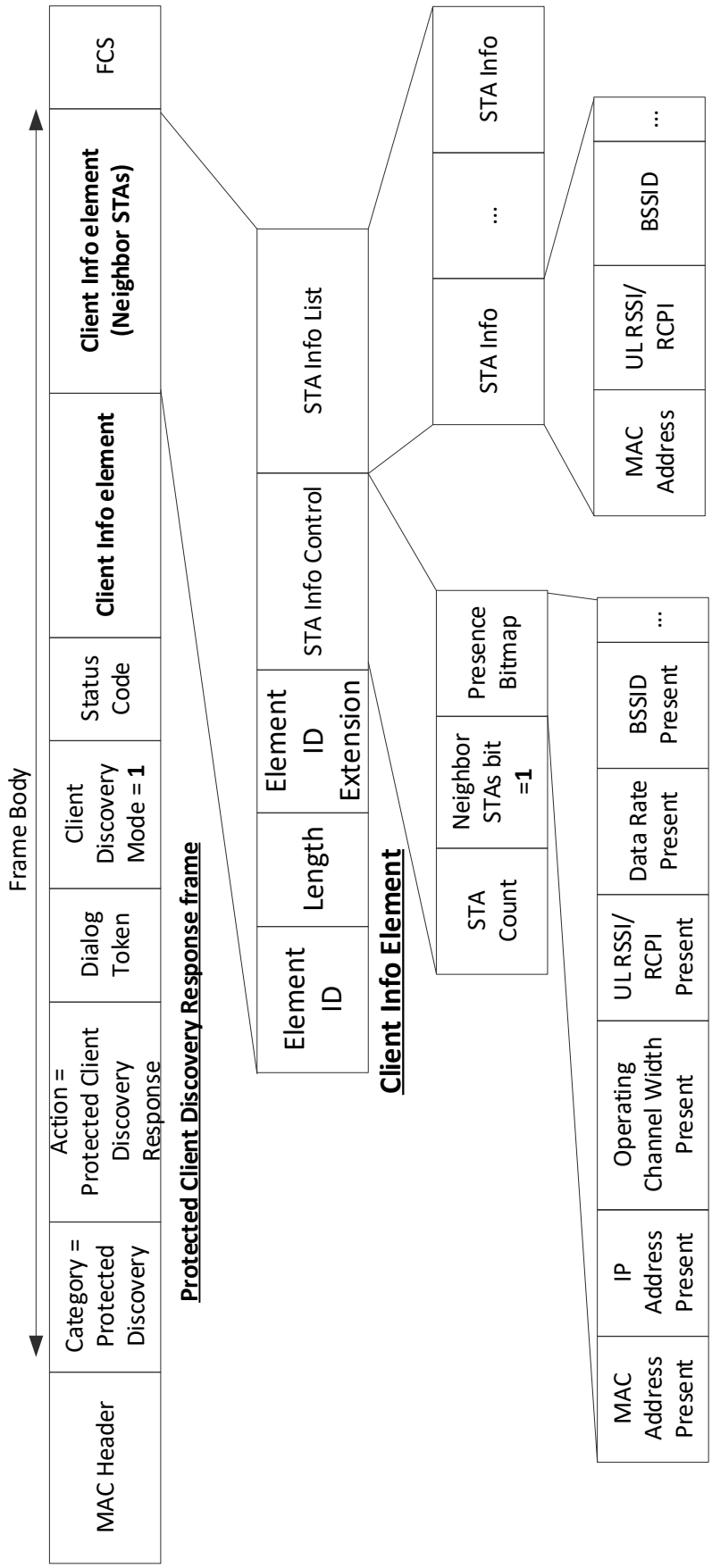

Frame Body
MAC Header
Category = Protected Discovery
Action = Protected Client Discovery Response
Dialog Token
Client Discovery Mode = 1
Status Code
Client Info element
Client Info element (Neighbor STAs)
FCS
Protected Client Discovery Response frame
Element ID
Length
Element ID Extension
STA Info Control
STA Info List
Client Info Element
STA Count
Neighbor STAs bit =1
Presence Bitmap
STA Info
...
STA Info
MAC Address
UL RSSI/ RCPI
BSSID
...
MAC Address Present
IP Address Present
Operating Channel Width Present
UL RSSI/ RCPI Present
Data Rate Present
BSSID Present
...
2500

Figure 25

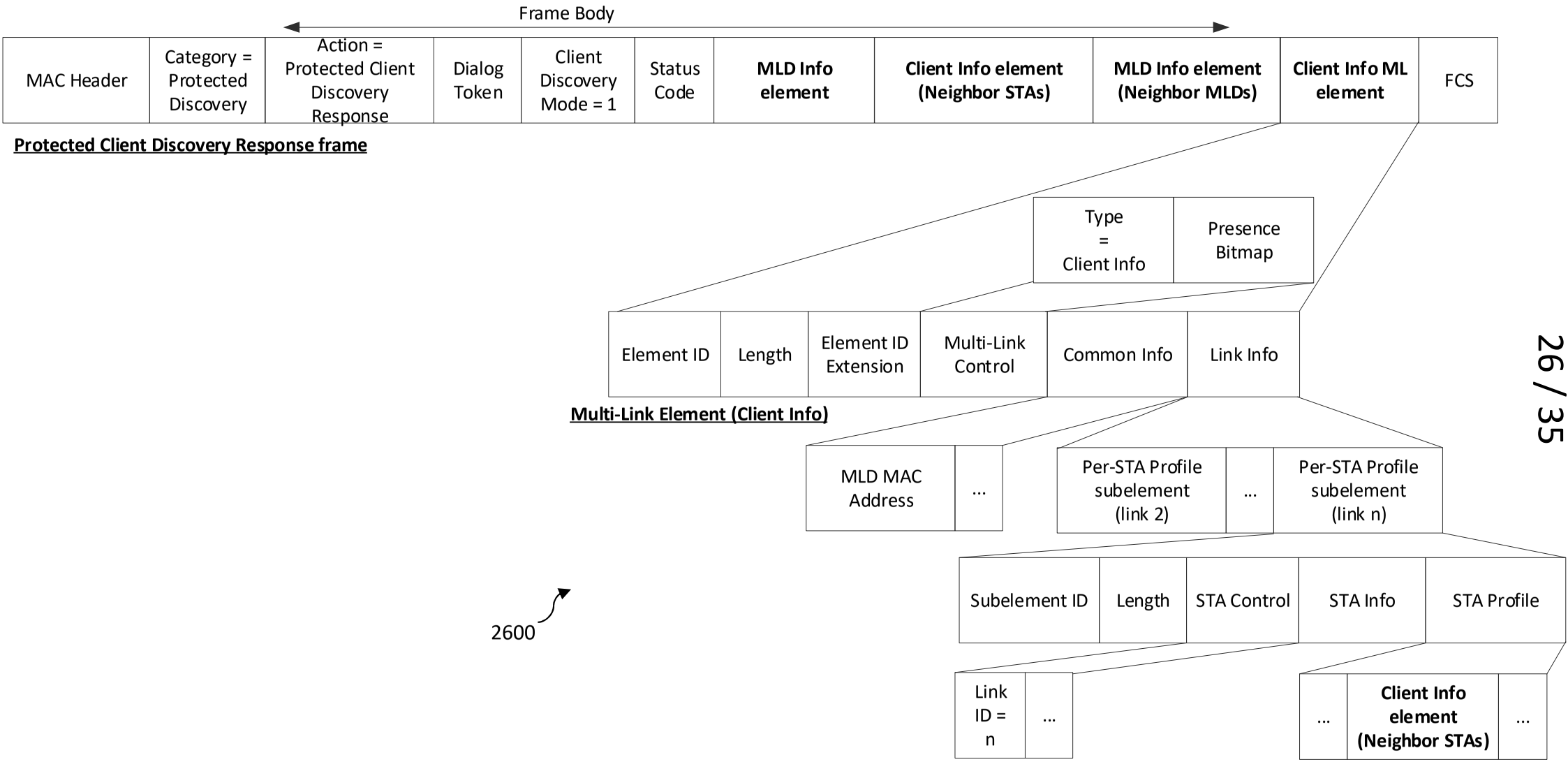

Frame Body
MAC Header
Category = Protected Discovery
Action = Protected Client Discovery Response
Dialog Token
Client Discovery Mode = 1
Status Code
MLD Info element
Client Info element (Neighbor STAs)
MLD Info element (Neighbor MLDs)
Client Info ML element
FCS
Protected Client Discovery Response frame
Type = Client Info
Presence Bitmap
Element ID
Length
Element ID Extension
Multi-Link Control
Common Info
Link Info
Multi-Link Element (Client Info)
MLD MAC Address
...
Per-STA Profile subelement (link 2)
...
Per-STA Profile subelement (link n)
Subelement ID
Length
STA Control
STA Info
STA Profile
Link ID = n
...
...
Client Info element (Neighbor STAs)
...
2600

Figure 26

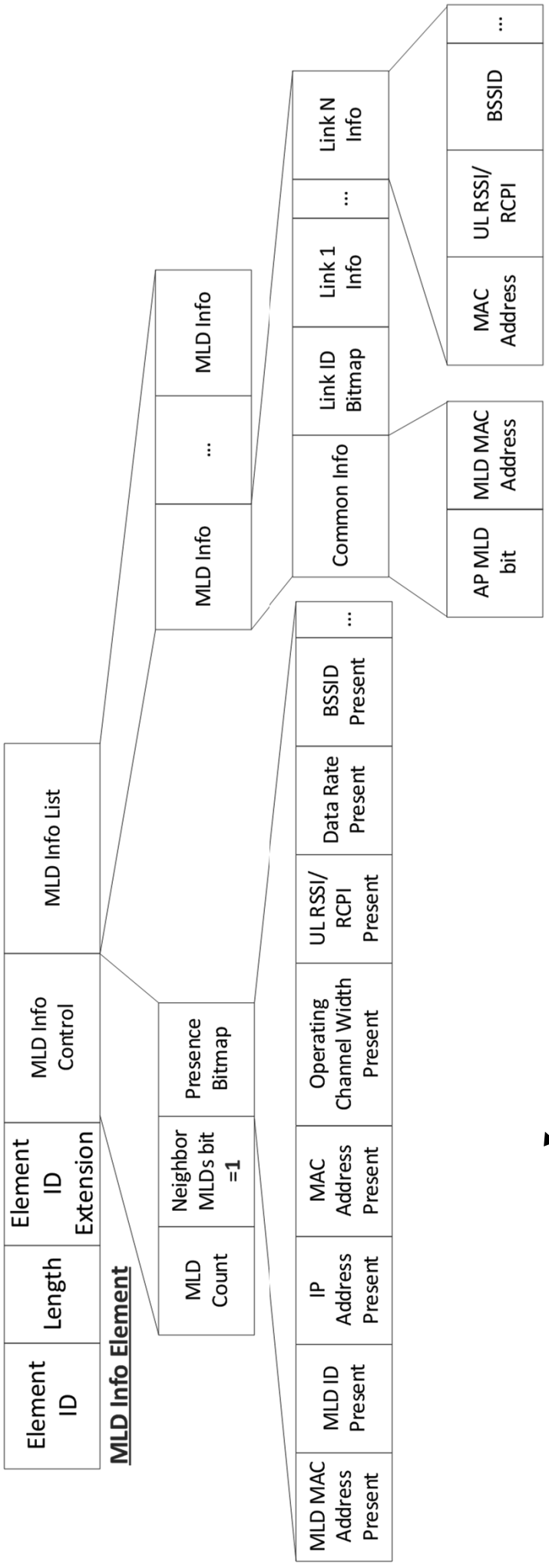

MLD Info Element
Element ID
Length
Element ID Extension
MLD Info Control
MLD Info List
MLD Count
Neighbor MLDs bit =1
Presence Bitmap
MLD MAC Address Present
MLD ID Present
IP Address Present
MAC Address Present
Operating Channel Width Present
UL RSSI/ RCPI Present
Data Rate Present
BSSID Present
...
MLD Info
...
MLD Info
Common Info
AP MLD bit
MLD MAC Address
Link ID Bitmap
Link 1 Info
...
Link N Info
MAC Address
UL RSSI/ RCPI
BSSID
...
2700

Figure 27

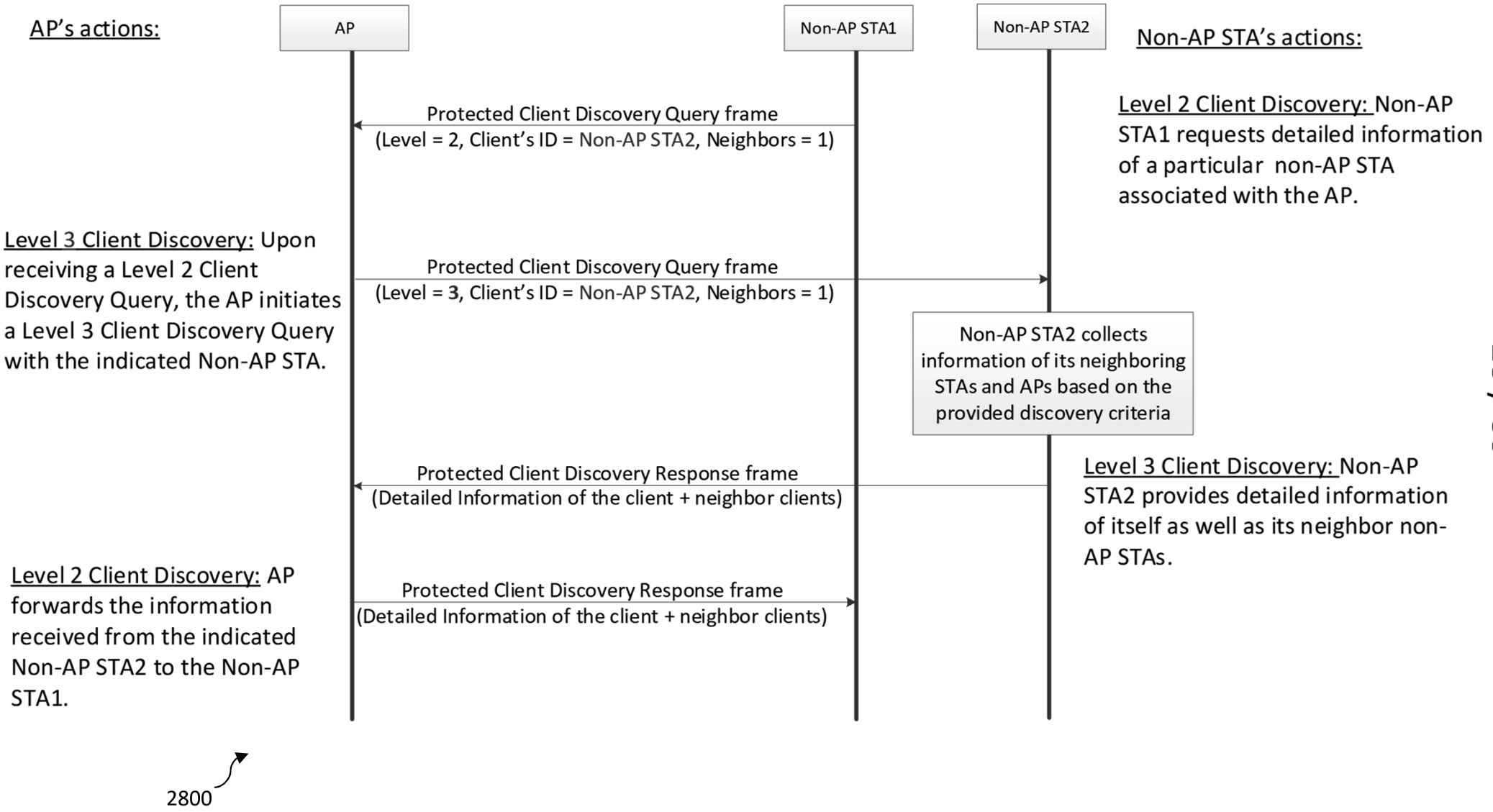

AP's actions:
AP
Non-AP STA1
Non-AP STA2
Non-AP STA's actions:
Level 2 Client Discovery: Non-AP STA1 requests detailed information of a particular non-AP STA associated with the AP.
Protected Client Discovery Query frame
(Level = 2, Client's ID = Non-AP STA2, Neighbors = 1)
Level 3 Client Discovery: Upon receiving a Level 2 Client Discovery Query, the AP initiates a Level 3 Client Discovery Query with the indicated Non-AP STA.
Protected Client Discovery Query frame
(Level = 3, Client's ID = Non-AP STA2, Neighbors = 1)
Non-AP STA2 collects information of its neighboring STAs and APs based on the provided discovery criteria
Protected Client Discovery Response frame
(Detailed Information of the client + neighbor clients)
Level 3 Client Discovery: Non-AP STA2 provides detailed information of itself as well as its neighbor non-AP STAs.
Level 2 Client Discovery: AP forwards the information received from the indicated Non-AP STA2 to the Non-AP STA1.
Protected Client Discovery Response frame
(Detailed Information of the client + neighbor clients)
2800

Figure 28

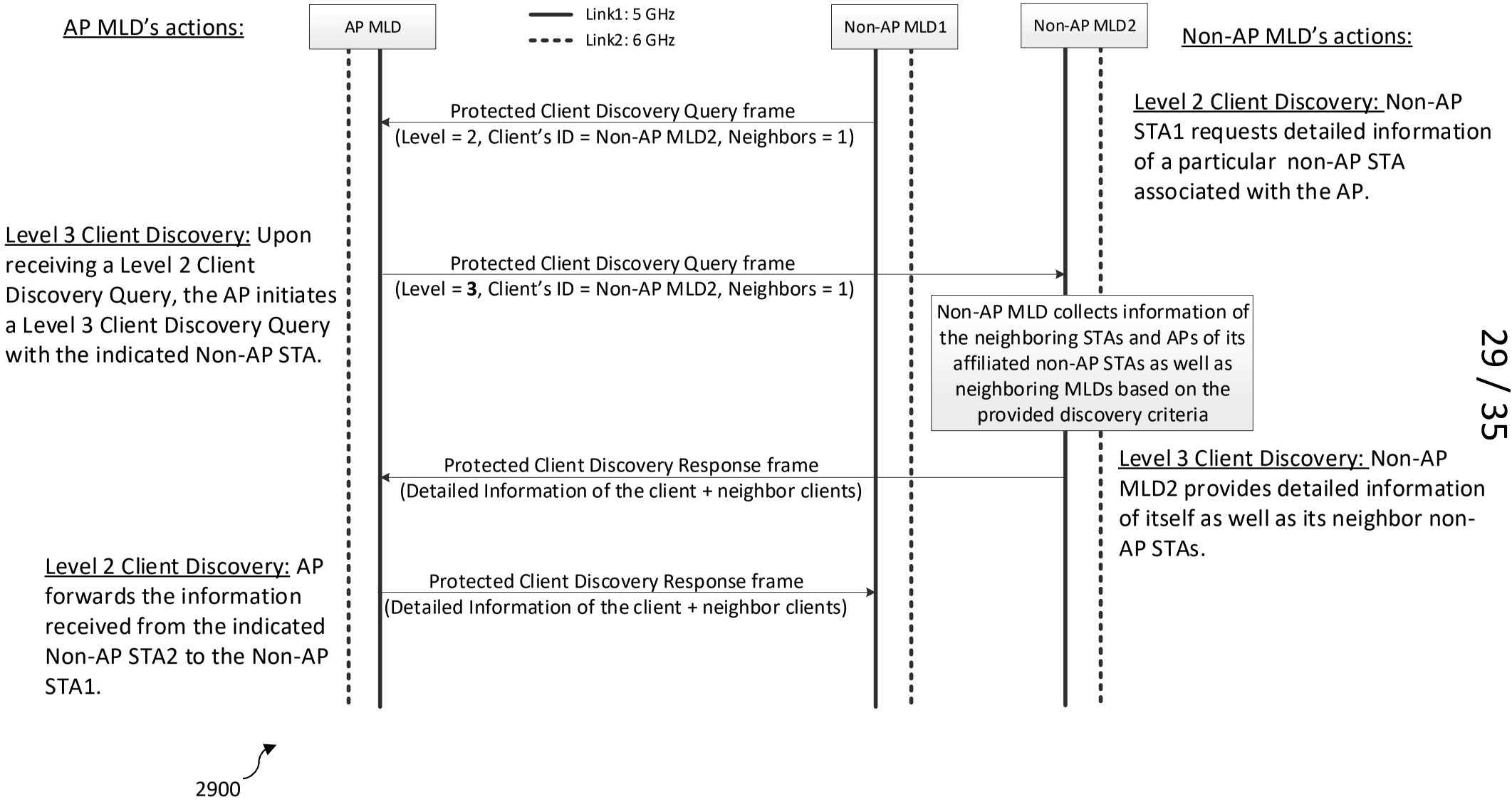

AP MLD's actions:
AP MLD
Link1: 5 GHz
Link2: 6 GHz
Non-AP MLD1
Non-AP MLD2
Non-AP MLD's actions:
Level 2 Client Discovery: Non-AP STA1 requests detailed information of a particular non-AP STA associated with the AP.
Protected Client Discovery Query frame
(Level = 2, Client's ID = Non-AP MLD2, Neighbors = 1)
Level 3 Client Discovery: Upon receiving a Level 2 Client Discovery Query, the AP initiates a Level 3 Client Discovery Query with the indicated Non-AP STA.
Protected Client Discovery Query frame
(Level = 3, Client's ID = Non-AP MLD2, Neighbors = 1)
Non-AP MLD collects information of the neighboring STAs and APs of its affiliated non-AP STAs as well as neighboring MLDs based on the provided discovery criteria
Protected Client Discovery Response frame
(Detailed Information of the client + neighbor clients)
Level 3 Client Discovery: Non-AP MLD2 provides detailed information of itself as well as its neighbor non-AP STAs.
Level 2 Client Discovery: AP forwards the information received from the indicated Non-AP STA2 to the Non-AP STA1.
Protected Client Discovery Response frame
(Detailed Information of the client + neighbor clients)
2900

Figure 29

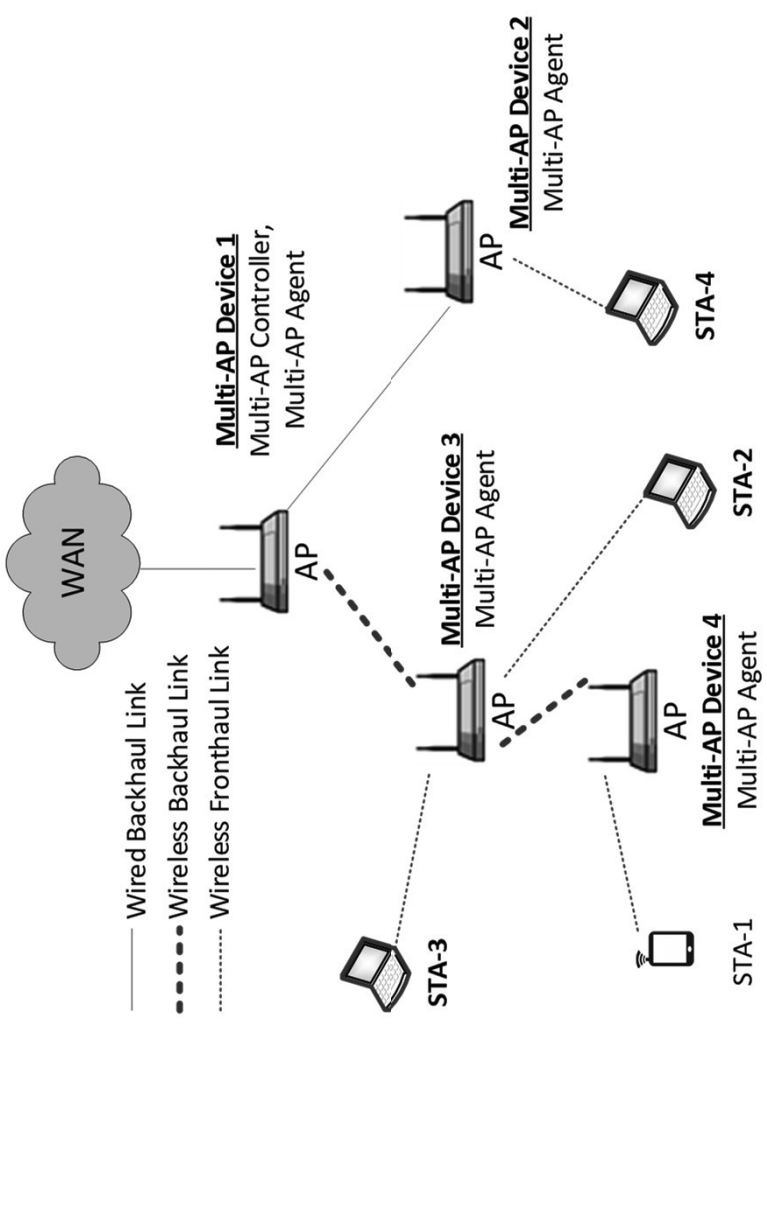

WAN
Wired Backhaul Link
Wireless Backhaul Link
Wireless Fronthaul Link
Multi-AP Device 1
Multi-AP Controller,
Multi-AP Agent
AP
Multi-AP Device 2
Multi-AP Agent
AP
STA-4
Multi-AP Device 3
Multi-AP Agent
AP
STA-2
STA-3
AP
Multi-AP Device 4
Multi-AP Agent
STA-1
3000

Figure 30

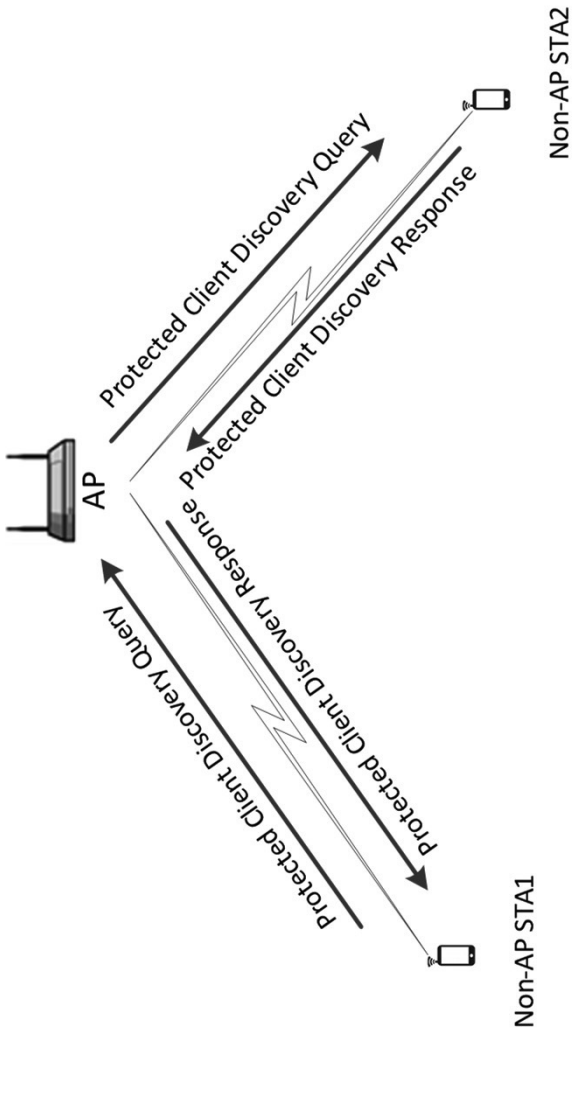

Protected Client Discovery Query
Protected Client Discovery Response
Protected Client Discovery Response
Protected Client Discovery Query
AP
Non-AP STA2
Non-AP STA1
3100

Figure 31

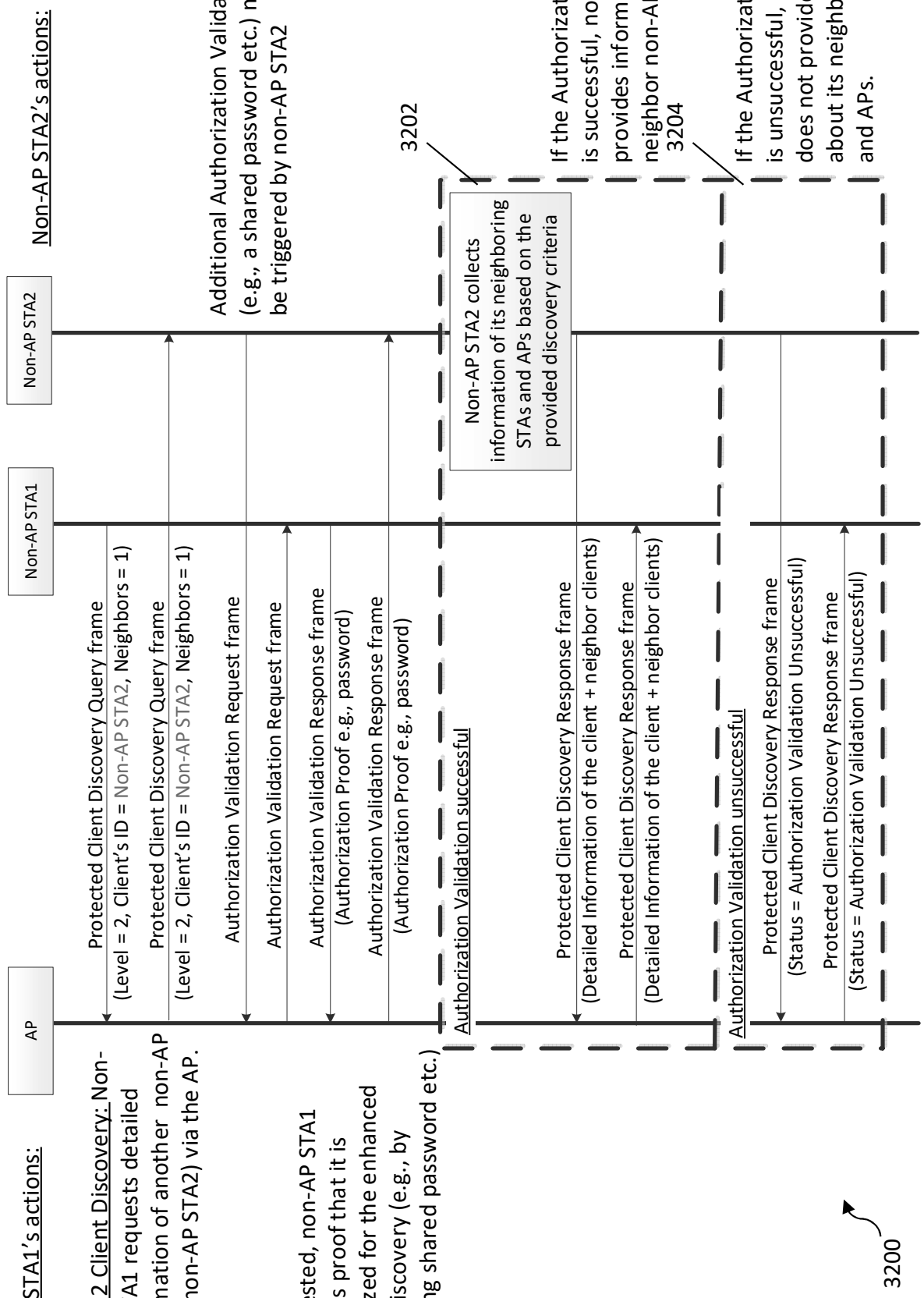

Non-AP STA1's actions:
AP
Non-AP STA1
Non-AP STA2
Non-AP STA2's actions:
Level 2 Client Discovery: Non-AP STA1 requests detailed information of another non-AP STA (non-AP STA2) via the AP.
Protected Client Discovery Query frame
(Level = 2, Client's ID = Non-AP STA2, Neighbors = 1)
Protected Client Discovery Query frame
(Level = 2, Client's ID = Non-AP STA2, Neighbors = 1)
Additional Authorization Validation (e.g., a shared password etc.) may be triggered by non-AP STA2
Authorization Validation Request frame
Authorization Validation Request frame
If requested, non-AP STA1 provides proof that it is authorized for the enhanced client discovery (e.g., by providing shared password etc.)
Authorization Validation Response frame
(Authorization Proof e.g., password)
Authorization Validation Response frame
(Authorization Proof e.g., password)
Authorization Validation successful
3202
Non-AP STA2 collects information of its neighboring STAs and APs based on the provided discovery criteria
Protected Client Discovery Response frame
(Detailed Information of the client + neighbor clients)
Protected Client Discovery Response frame
(Detailed Information of the client + neighbor clients)
If the Authorization Validation is successful, non-AP STA2 provides information about its neighbor non-AP STAs and APs.
3204
Authorization Validation unsuccessful
Protected Client Discovery Response frame
(Status = Authorization Validation Unsuccessful)
Protected Client Discovery Response frame
(Status = Authorization Validation Unsuccessful)
If the Authorization Validation is unsuccessful, non-AP STA2 does not provide information about its neighbor non-AP STAs and APs.
3200

Figure 32

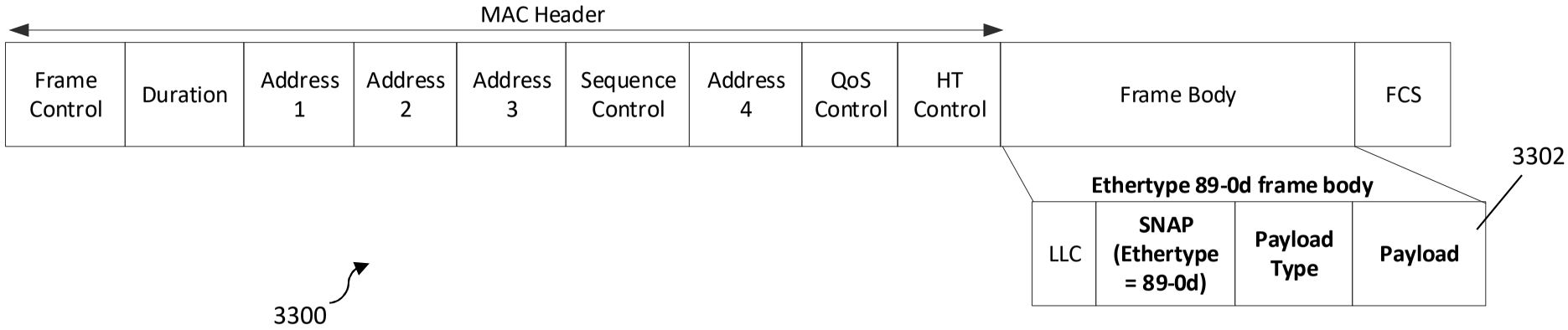


Figure 33A

Payload Content
Protected Client Discovery Query frame
Protected Client Discovery Response frame
Authorization Validation Request frame
Authorization Validation Response frame

3302

Figure 33B

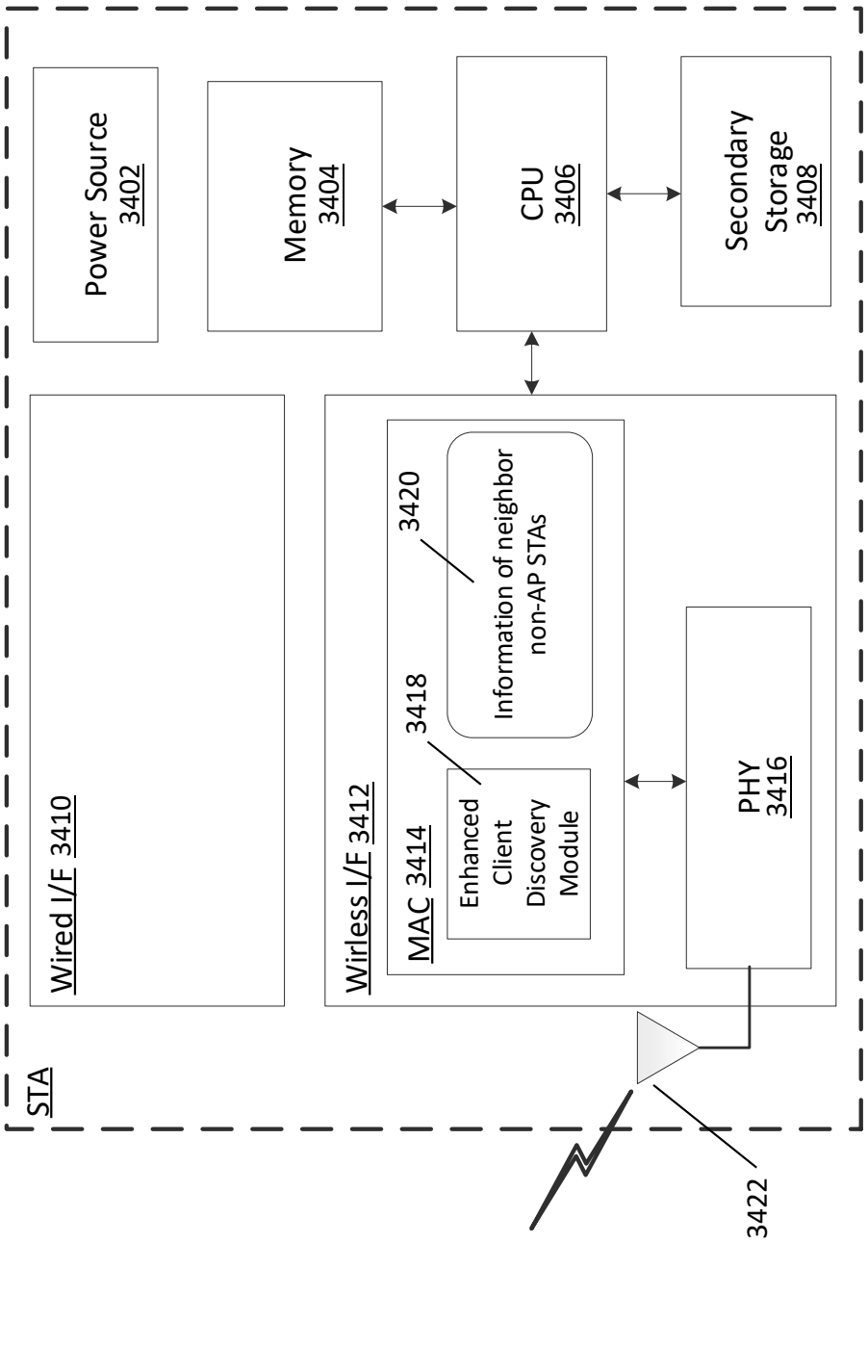

STA
Power Source 3402
Memory 3404
CPU 3406
Secondary Storage 3408
Wired I/F 3410
Wirless I/F 3412
MAC 3414
3418
Enhanced Client Discovery Module
3420
Information of neighbor non-AP STAs
PHY 3416
3422
3400

Figure 34

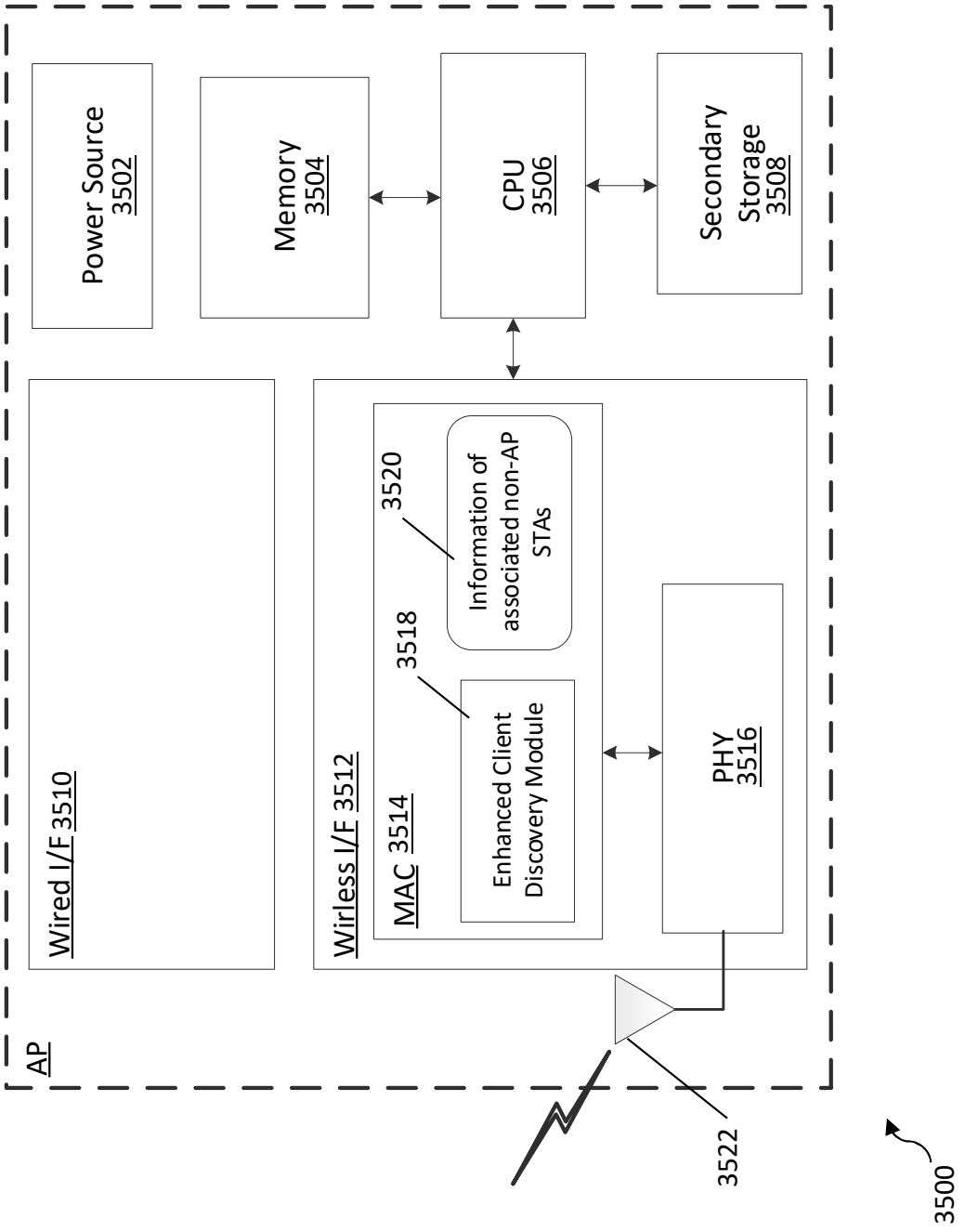

AP
Wired I/F 3510
Wirless I/F 3512
MAC 3514
Enhanced Client Discovery Module
3518
Information of associated non-AP STAs
3520
PHY 3516
Power Source 3502
Memory 3504
CPU 3506
Secondary Storage 3508
3522
3500

Figure 35