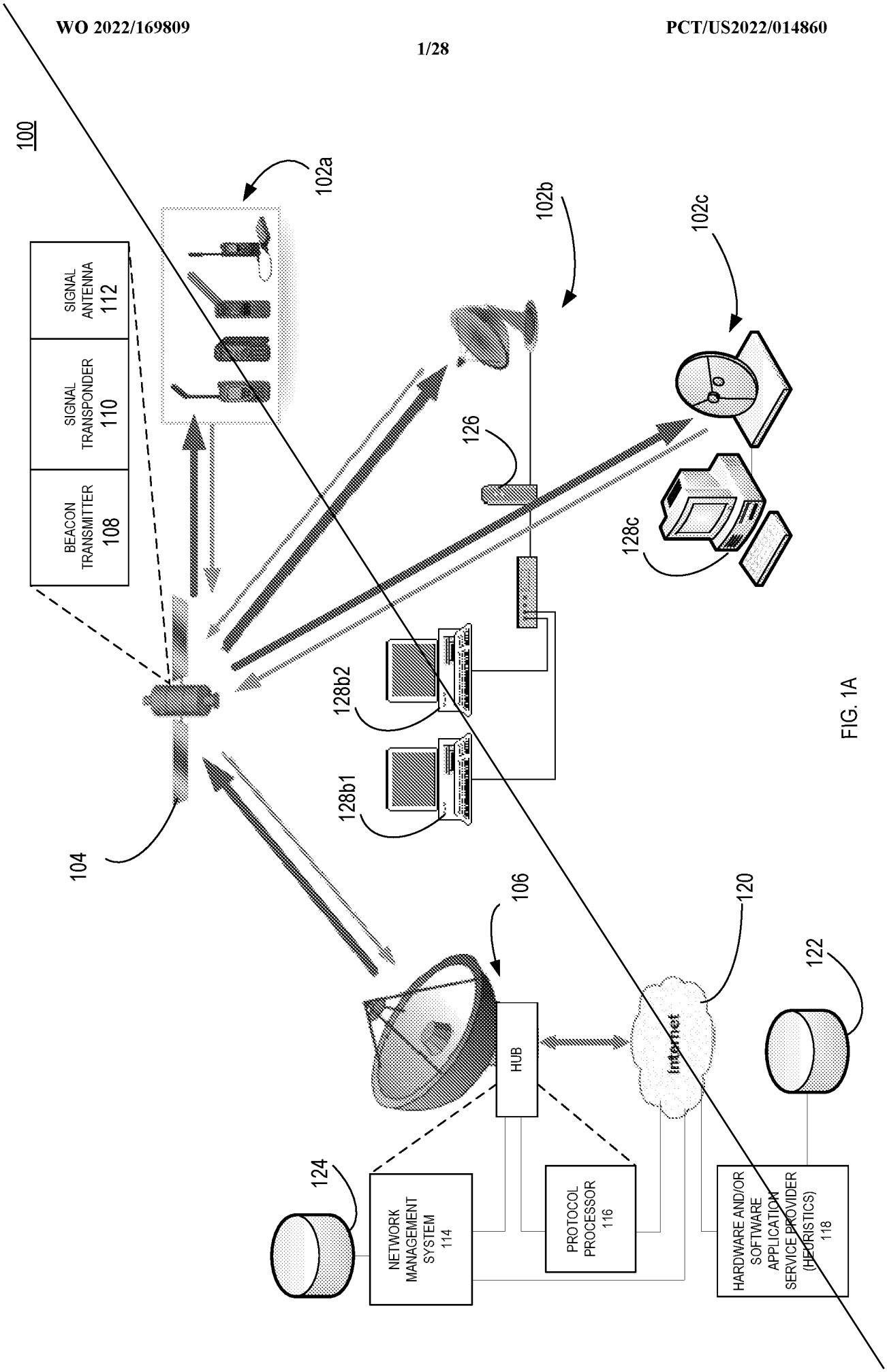

100
102a
102b
102c
SIGNAL ANTENNA 112
SIGNAL TRANSPONDER 110
BEACON TRANSMITTER 108
126
128c
128b2
128b1
104
106
120
122
HUB
Internet
124
NETWORK MANAGEMENT SYSTEM 114
PROTOCOL PROCESSOR 116
HARDWARE AND/OR SOFTWARE APPLICATION SERVICE PROVIDER (HEURISTICS) 118

FIG. 1A

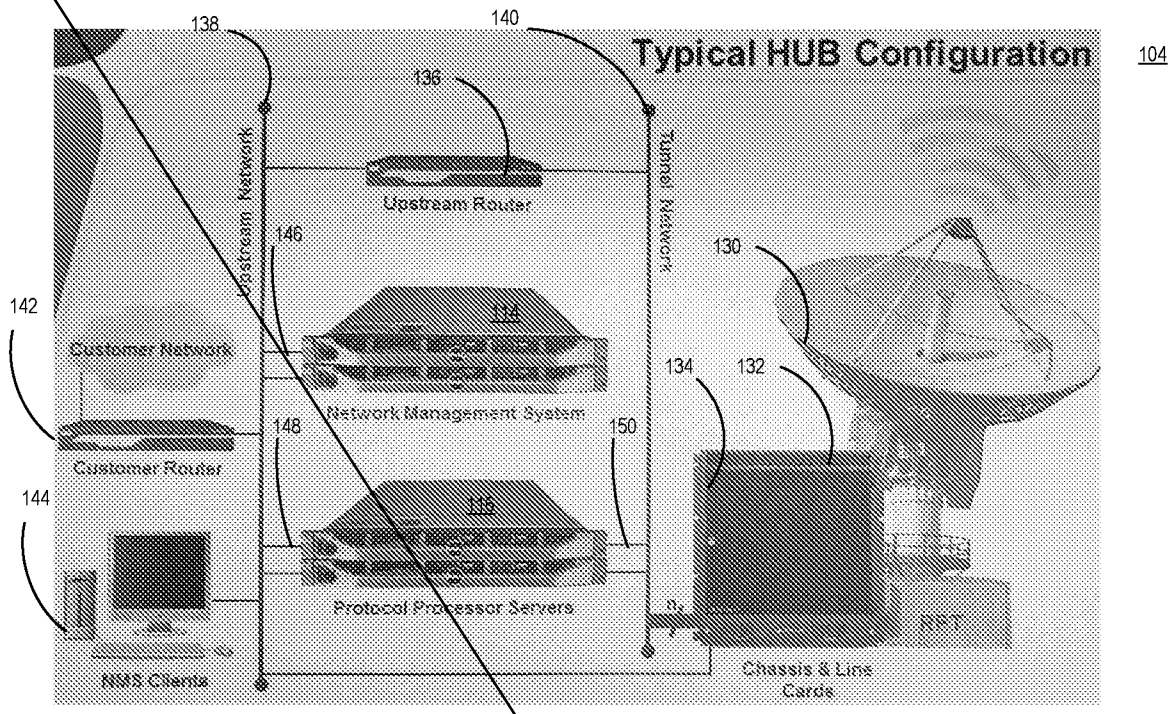


FIG. 1B

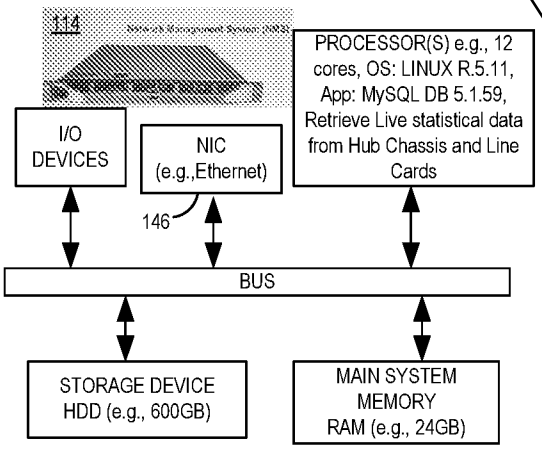


FIG. 1C

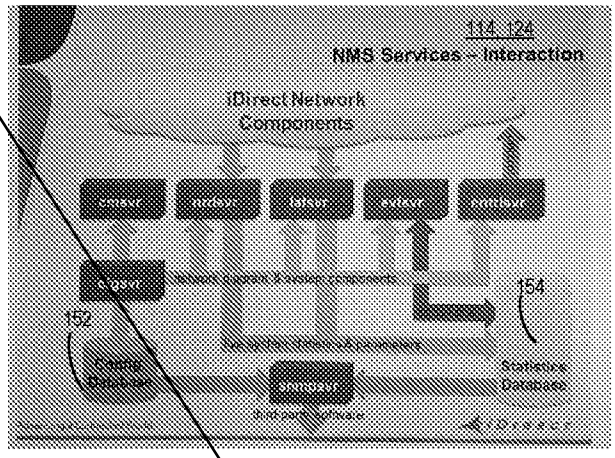


FIG. 1D

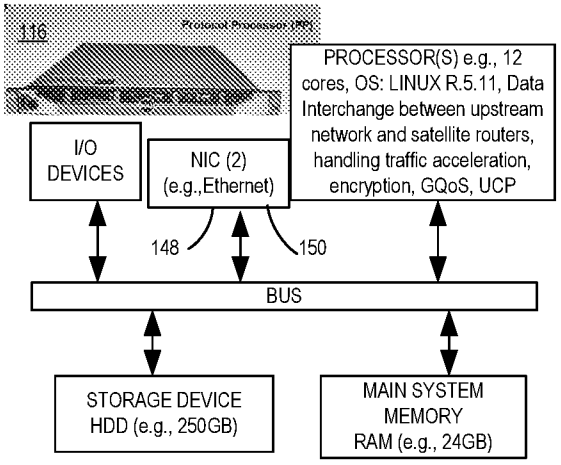


FIG. 1E

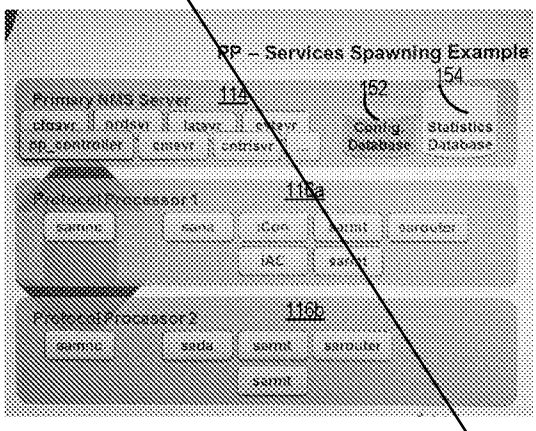


FIG. 1F

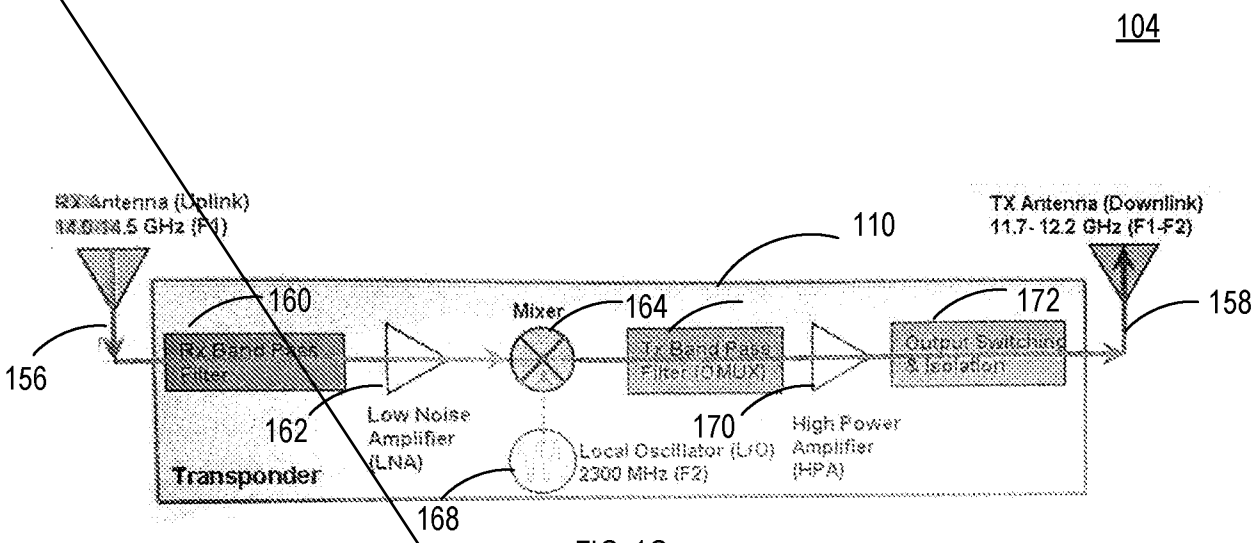


FIG. 1G

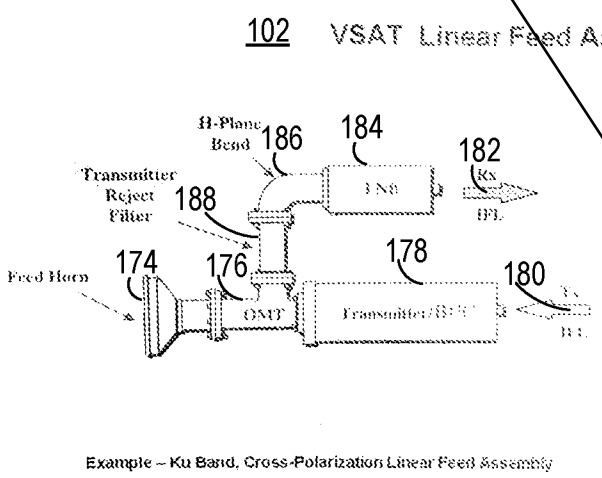


FIG. 1H

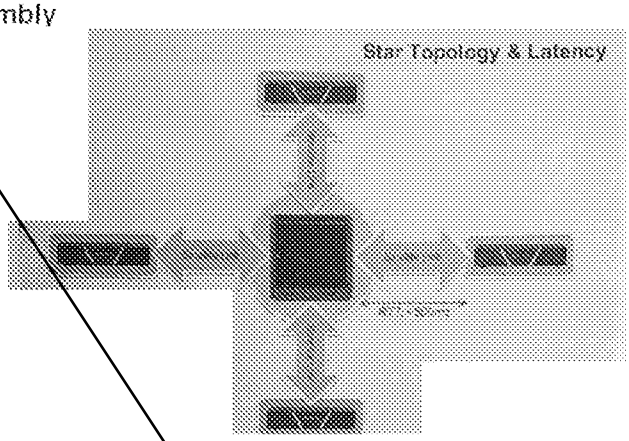


FIG. 1I

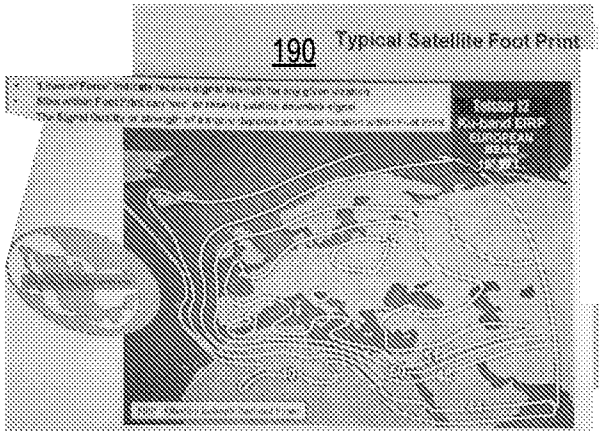


FIG. 1J

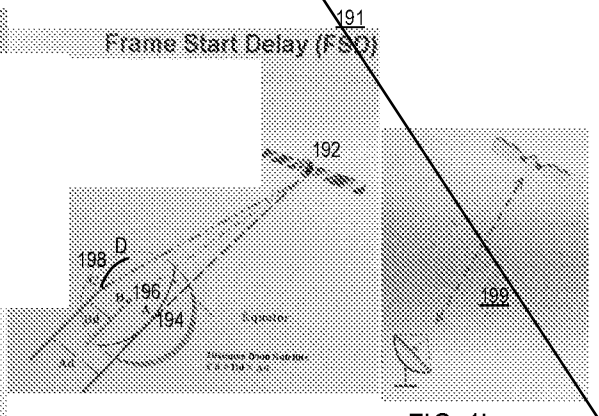


FIG. 1K

FIG. 1L

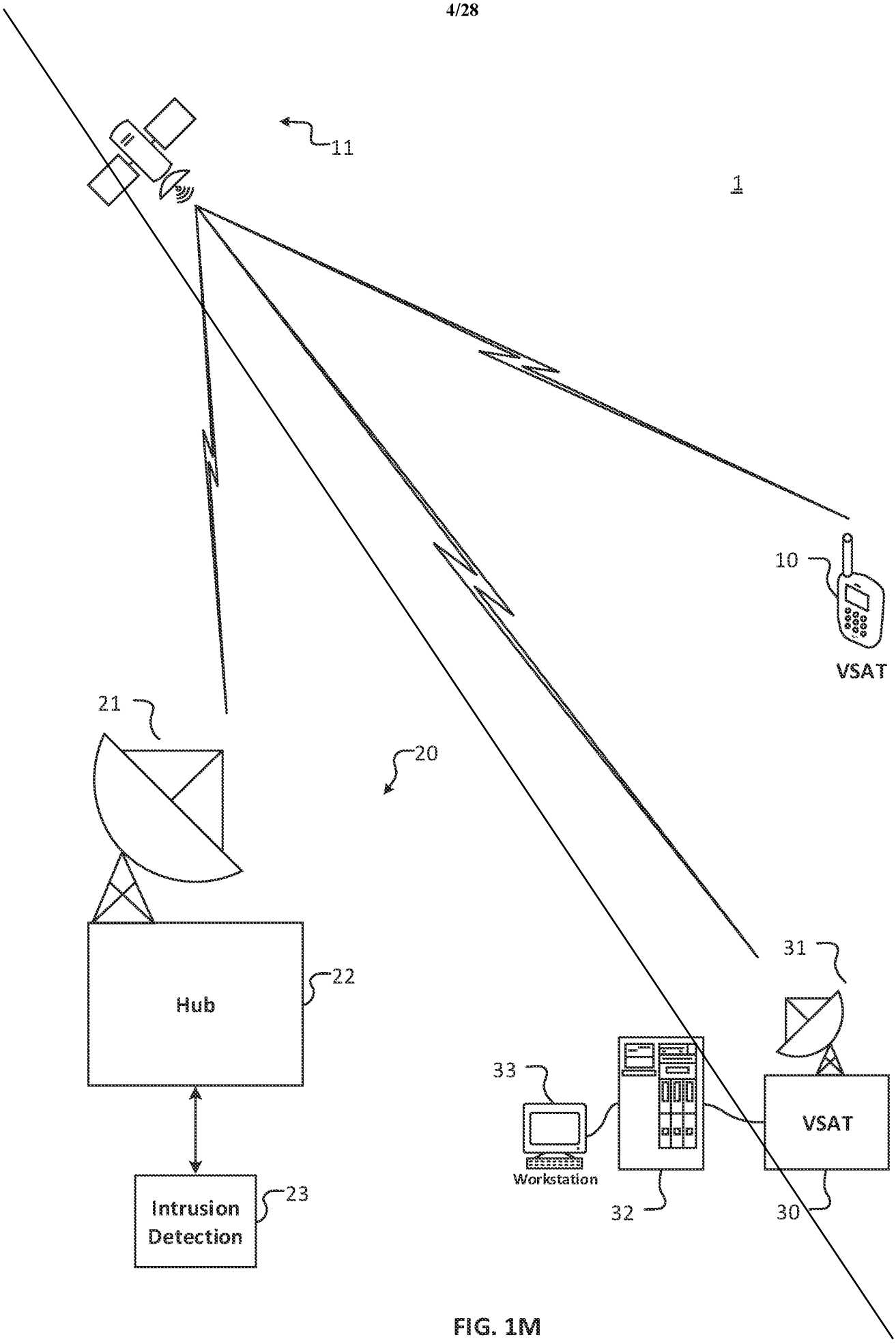

11
1
10
VSAT
21
20
Hub
22
31
33
Workstation
VSAT
32
30
Intrusion Detection
23

FIG. 1M

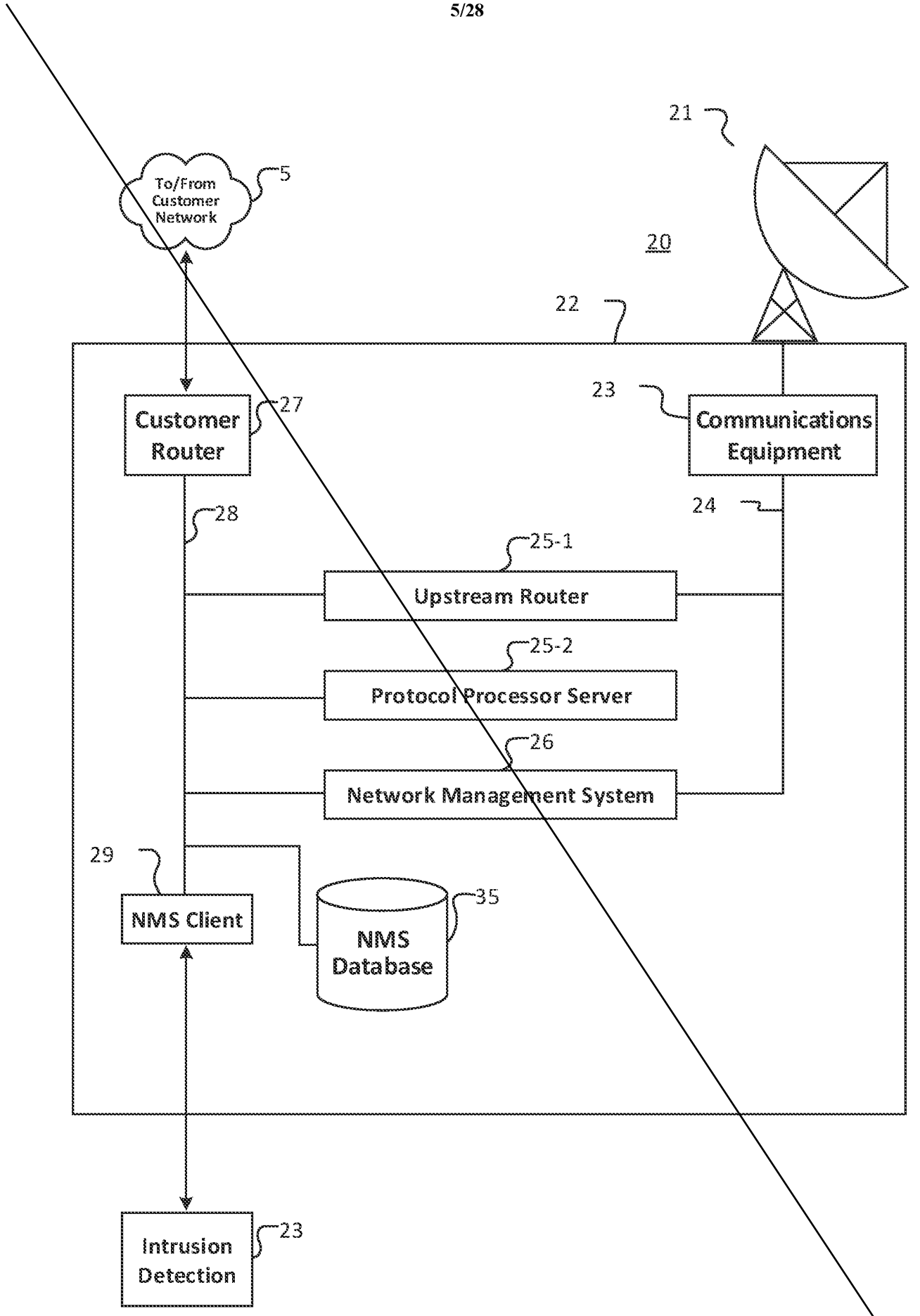
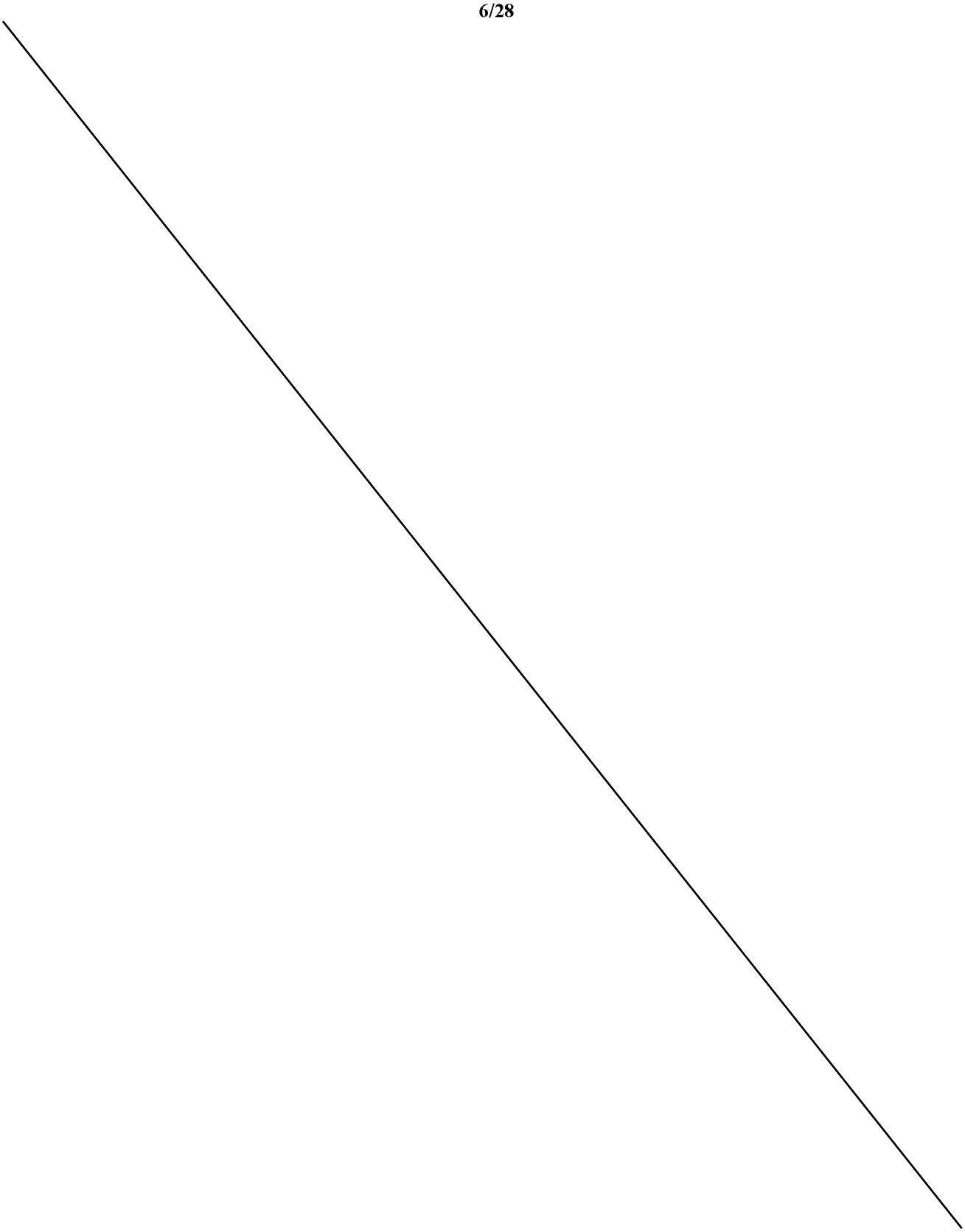

21
To/From Customer Network
5
20
22
23
Customer Router
27
Communications Equipment
24
28
25-1
Upstream Router
25-2
Protocol Processor Server
26
Network Management System
29
NMS Client
35
NMS Database
Intrusion Detection
23

FIG. 1N



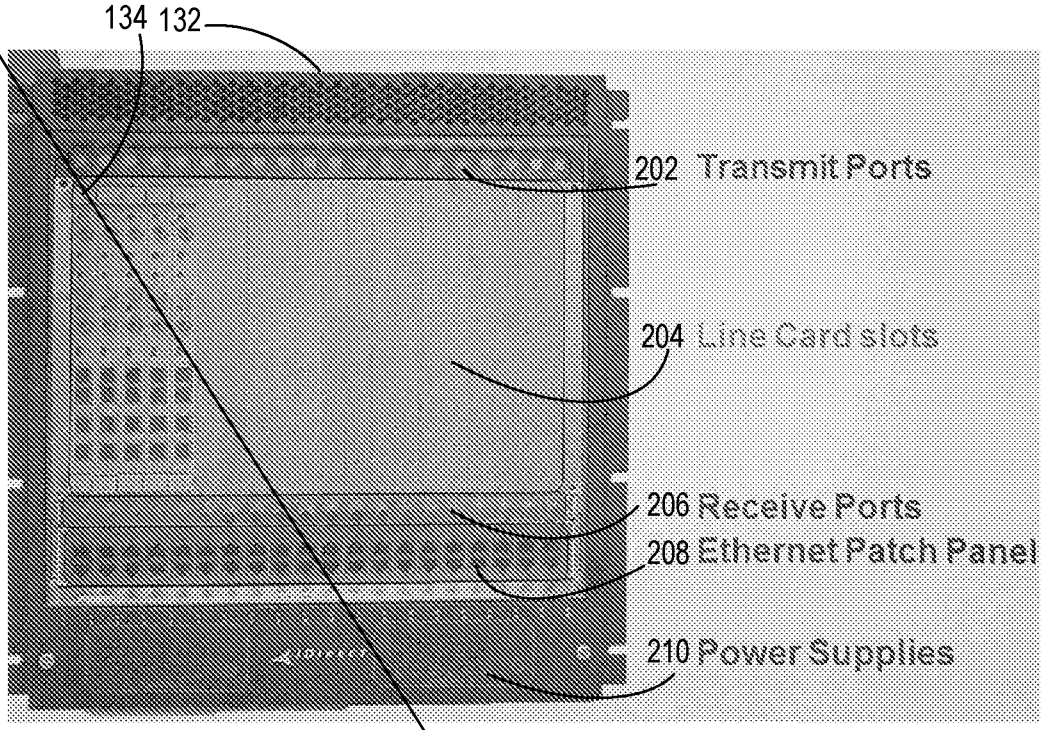

134
132
200
202 Transmit Ports
204 Line Card slots
206 Receive Ports
208 Ethernet Patch Panel
210 Power Supplies

FIG. 2

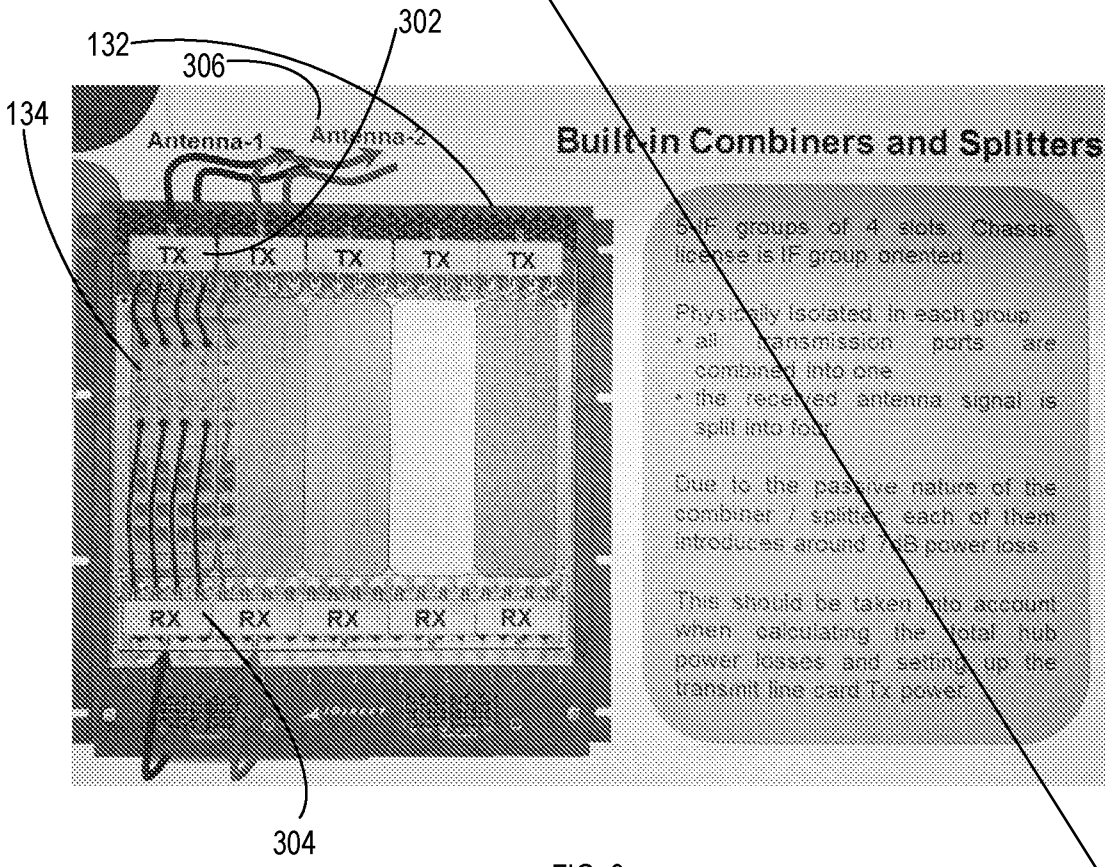

132
302
306
300
134
Antenna-1
Antenna-2
Built-in Combiners and Splitters
TX
TX
TX
TX
TX
RX
RX
RX
RX
RX
304

FIG. 3

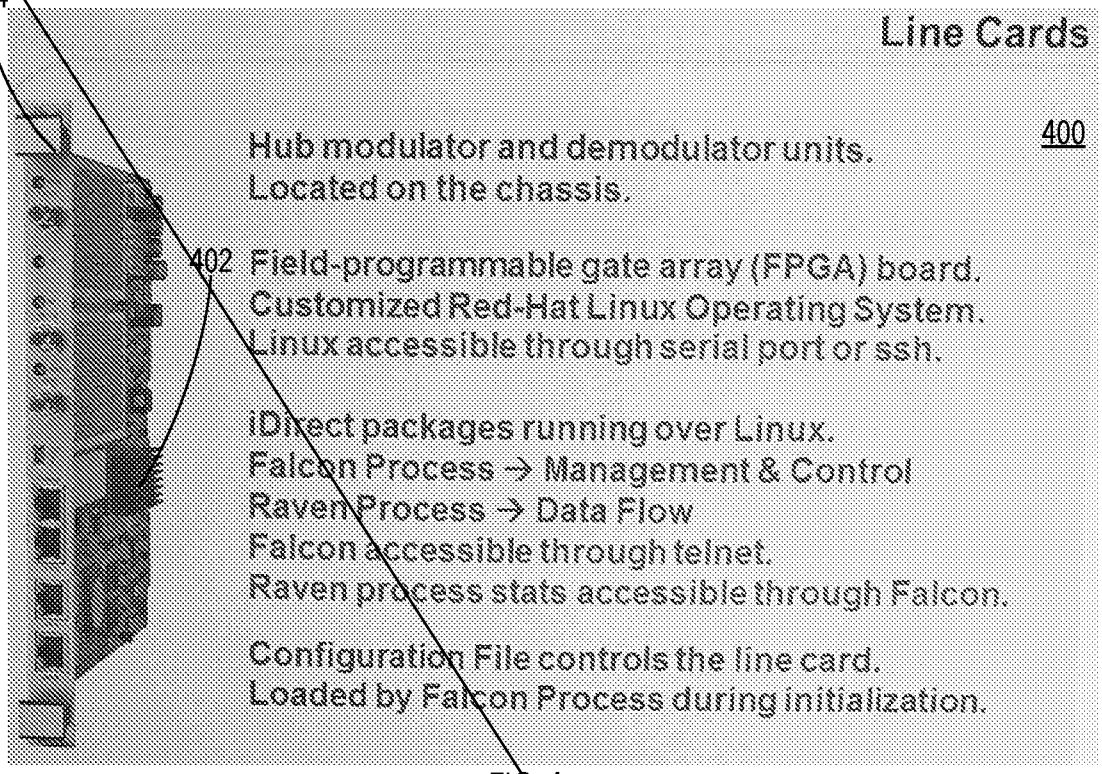


FIG. 4

500

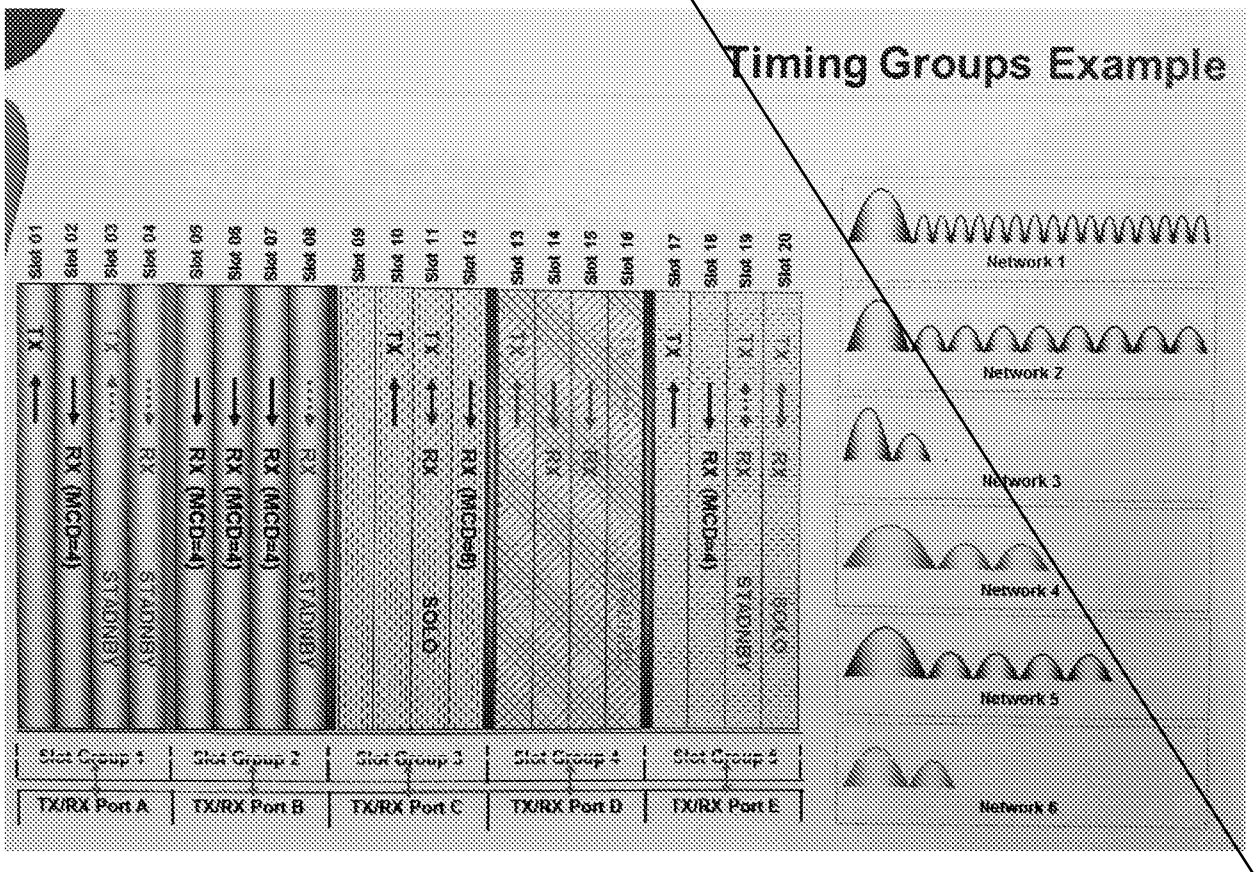


FIG. 5

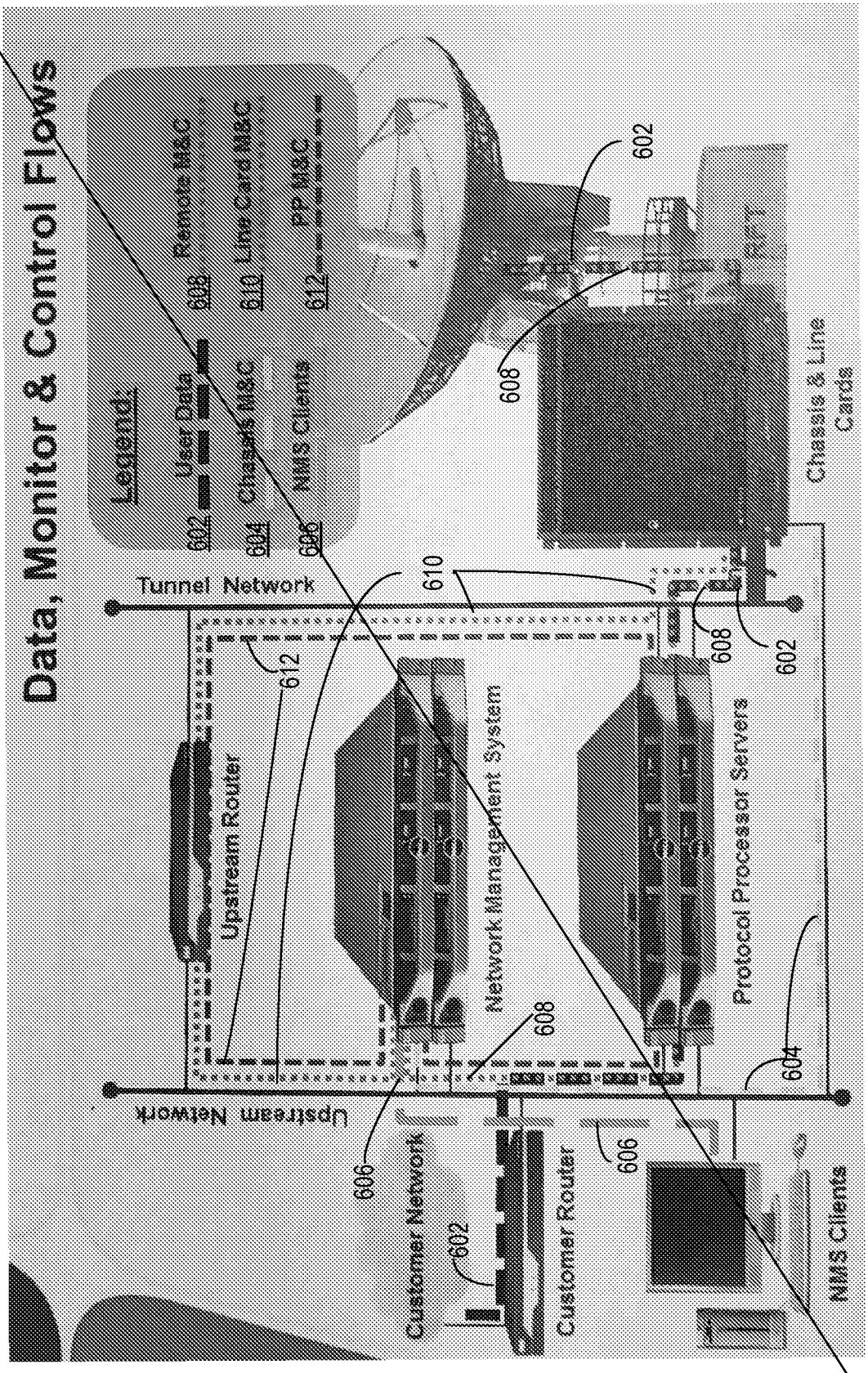

600
Data, Monitor & Control Flows
Legend:
User Data 602
Chassis M&C 604
NMS Clients 606
Remote M&C 608
Line Card M&C 610
PP M&C 612
Tunnel Network
Upstream Router
Network Management System
Protocol Processor Servers
Chassis & Line Cards
Upstream Network
Customer Network
Customer Router
NMS Clients

FIG. 6

700

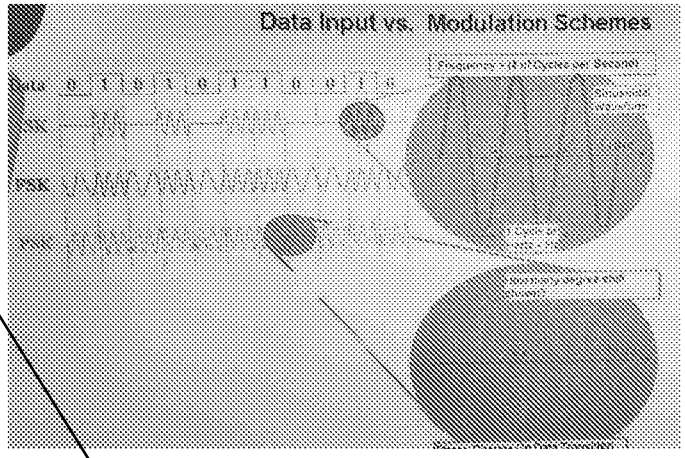


FIG. 7

800

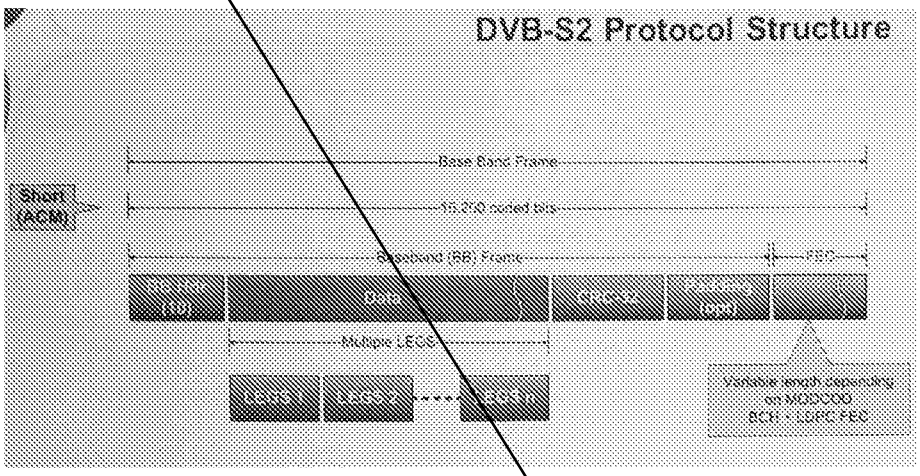


FIG. 8

900

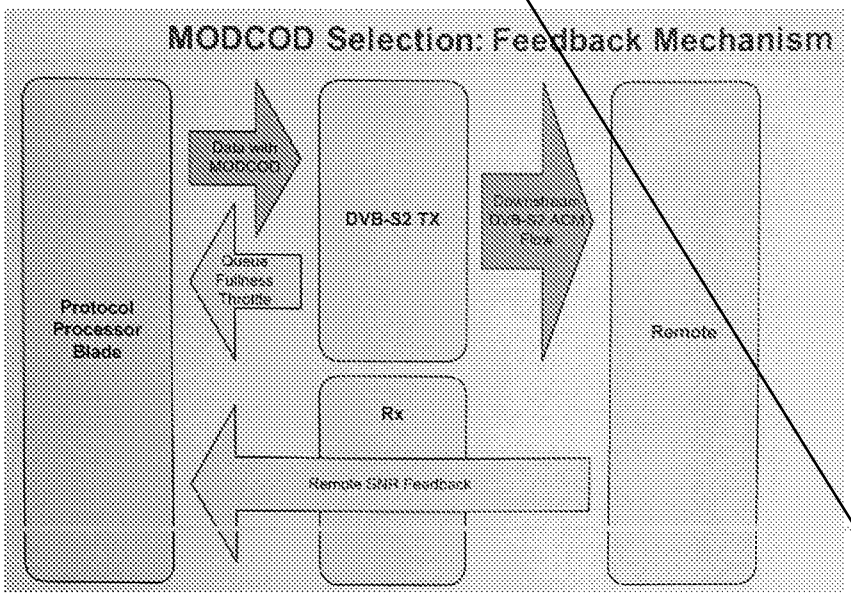


FIG. 9

1000

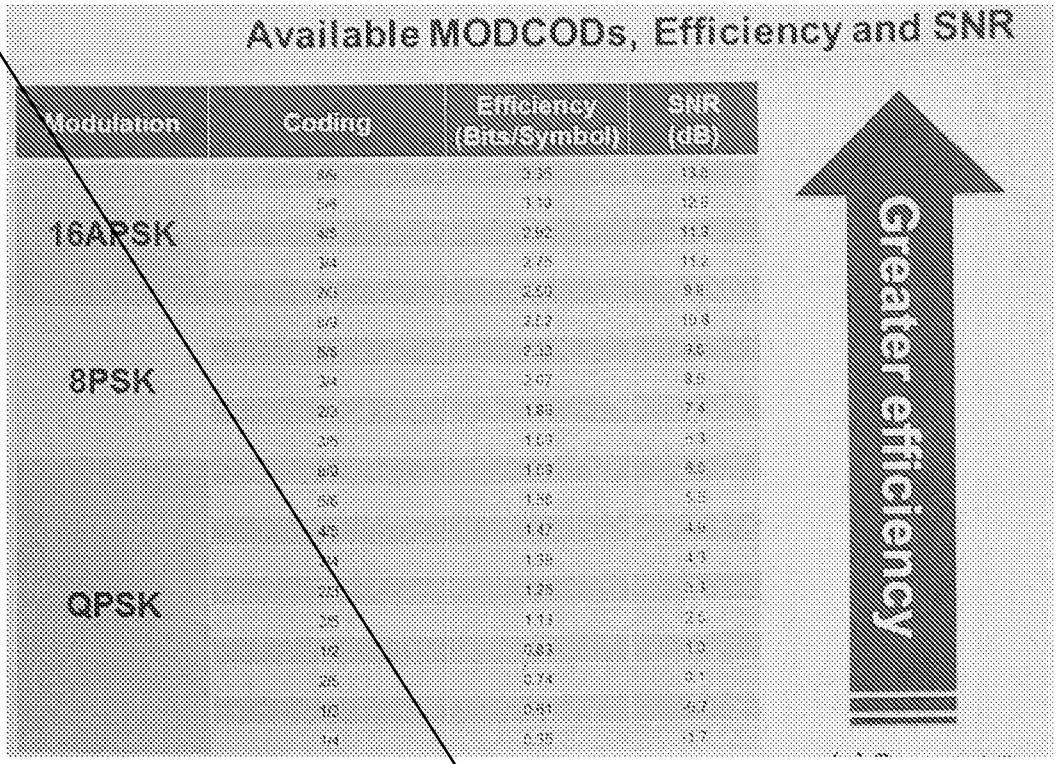


FIG. 10

1100

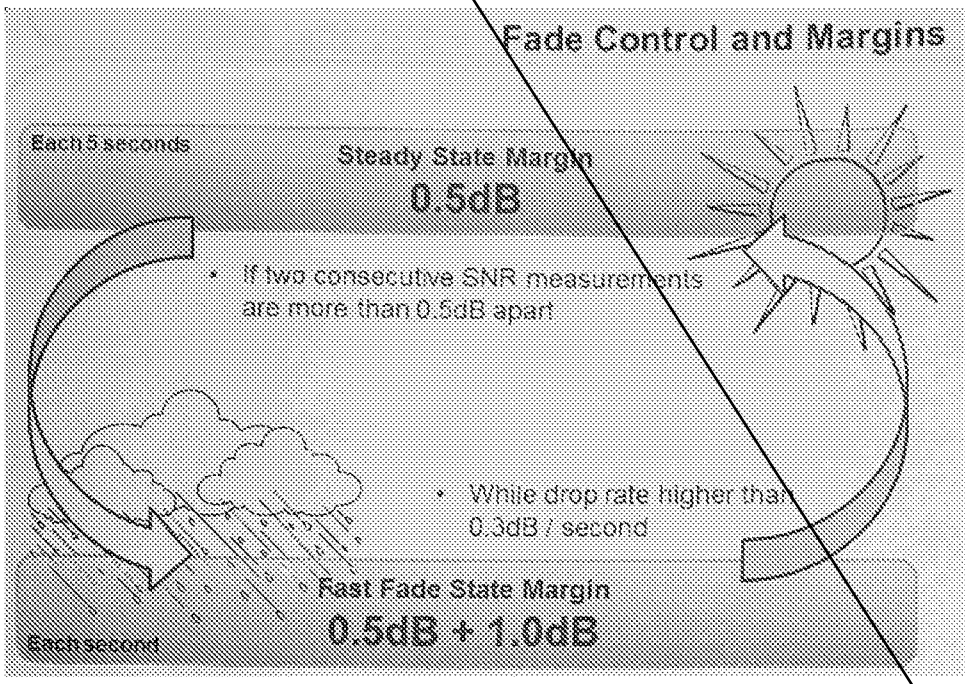


FIG. 11

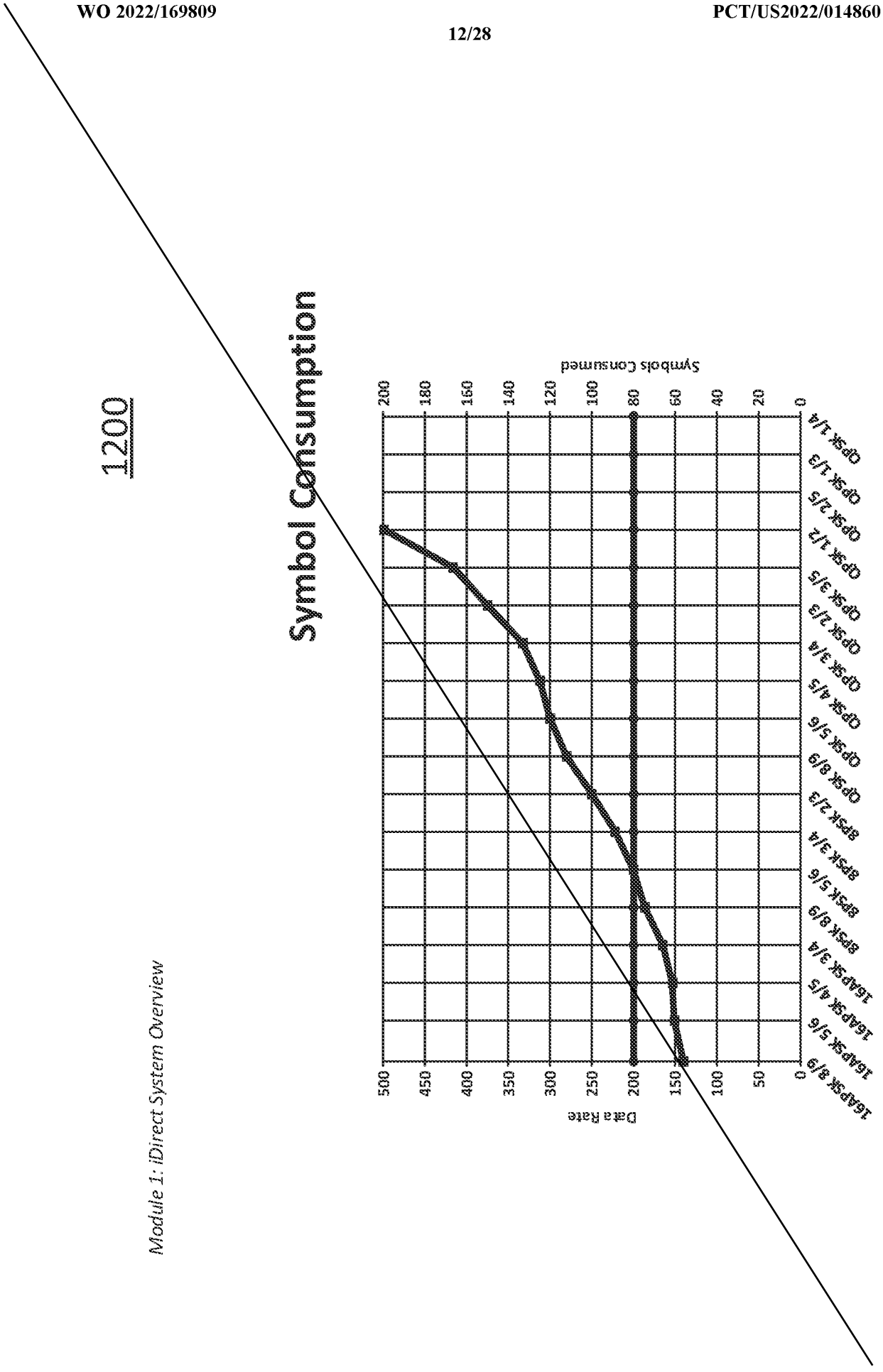

1200
Symbol Consumption
Module 1: iDirect System Overview
Data Rate
Symbols Consumed
500
450
400
350
300
250
200
150
100
50
0
200
180
160
140
120
100
80
60
40
20
0
16APSK 8/9
16APSK 5/6
16APSK 4/5
16APSK 3/4
8PSK 8/9
8PSK 5/6
8PSK 3/4
8PSK 2/3
QPSK 8/9
QPSK 5/6
QPSK 4/5
QPSK 3/4
QPSK 2/3
QPSK 3/5
QPSK 1/2
QPSK 2/5
QPSK 1/3
QPSK 1/4

FIG. 12A

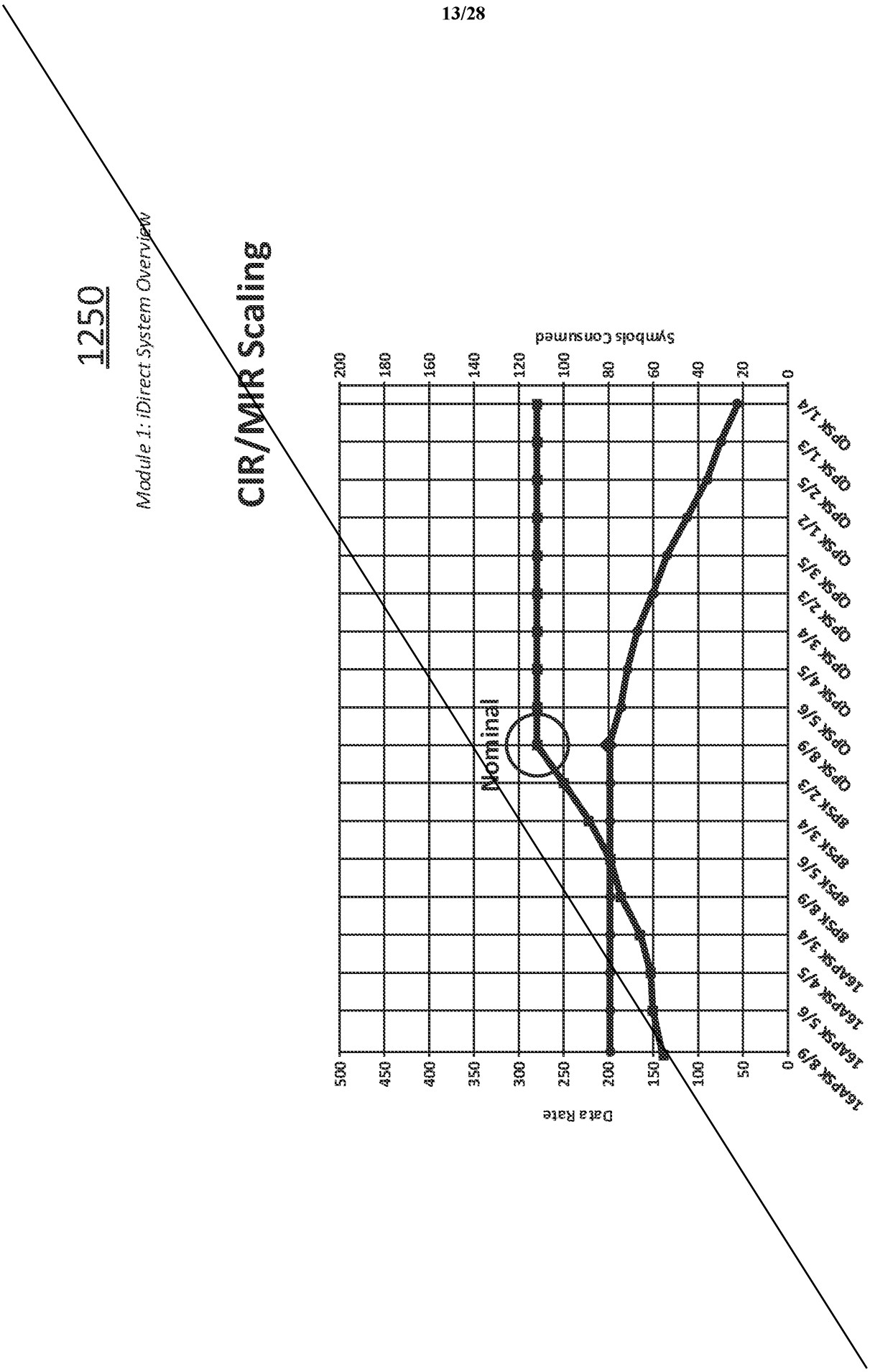

1250
Module 1: iDirect System Overview
CIR/MIR Scaling
Symbols Consumed
200
180
160
140
120
100
80
60
40
20
0
Nominal
QPSK 1/4
QPSK 1/3
QPSK 2/5
QPSK 1/2
QPSK 3/5
QPSK 2/3
QPSK 3/4
QPSK 4/5
QPSK 5/6
QPSK 8/9
8PSK 2/3
8PSK 3/4
8PSK 5/6
8PSK 8/9
16APSK 3/4
16APSK 4/5
16APSK 5/6
16APSK 8/9
500
450
400
350
300
250
200
150
100
50
0
Data Rate

FIG. 12B

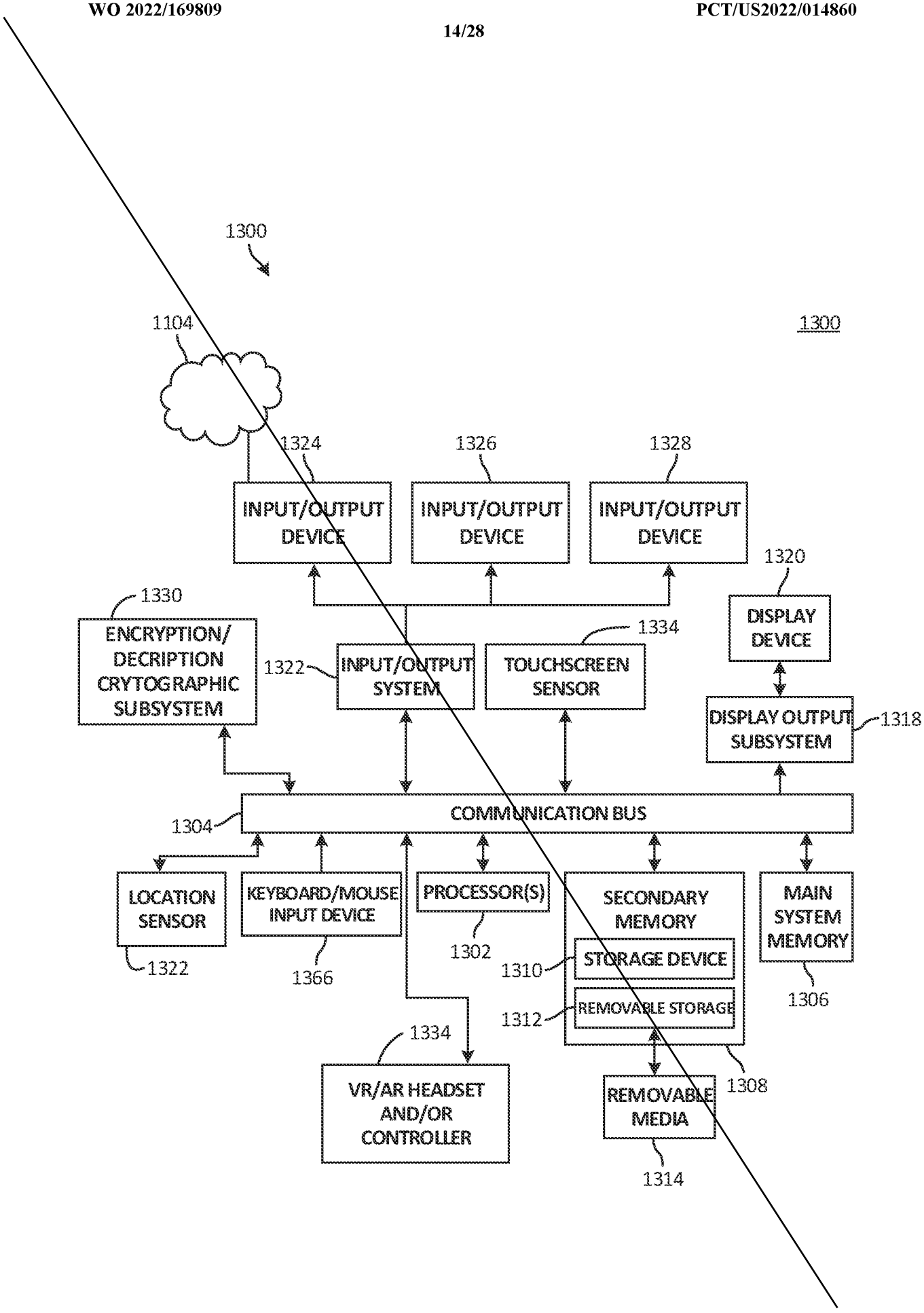

1300
1104
1300
1324
1326
1328
INPUT/OUTPUT DEVICE
INPUT/OUTPUT DEVICE
INPUT/OUTPUT DEVICE
1320
DISPLAY DEVICE
1330
ENCRYPTION/ DECRIPTION CRYTOGRAPHIC SUBSYSTEM
1322
INPUT/OUTPUT SYSTEM
1334
TOUCHSCREEN SENSOR
DISPLAY OUTPUT SUBSYSTEM
1318
COMMUNICATION BUS
1304
LOCATION SENSOR
1322
KEYBOARD/MOUSE INPUT DEVICE
1366
PROCESSOR(S)
1302
SECONDARY MEMORY
1310
STORAGE DEVICE
1312
REMOVABLE STORAGE
1308
MAIN SYSTEM MEMORY
1306
1334
VR/AR HEADSET AND/OR CONTROLLER
REMOVABLE MEDIA
1314

FIG. 13

1400

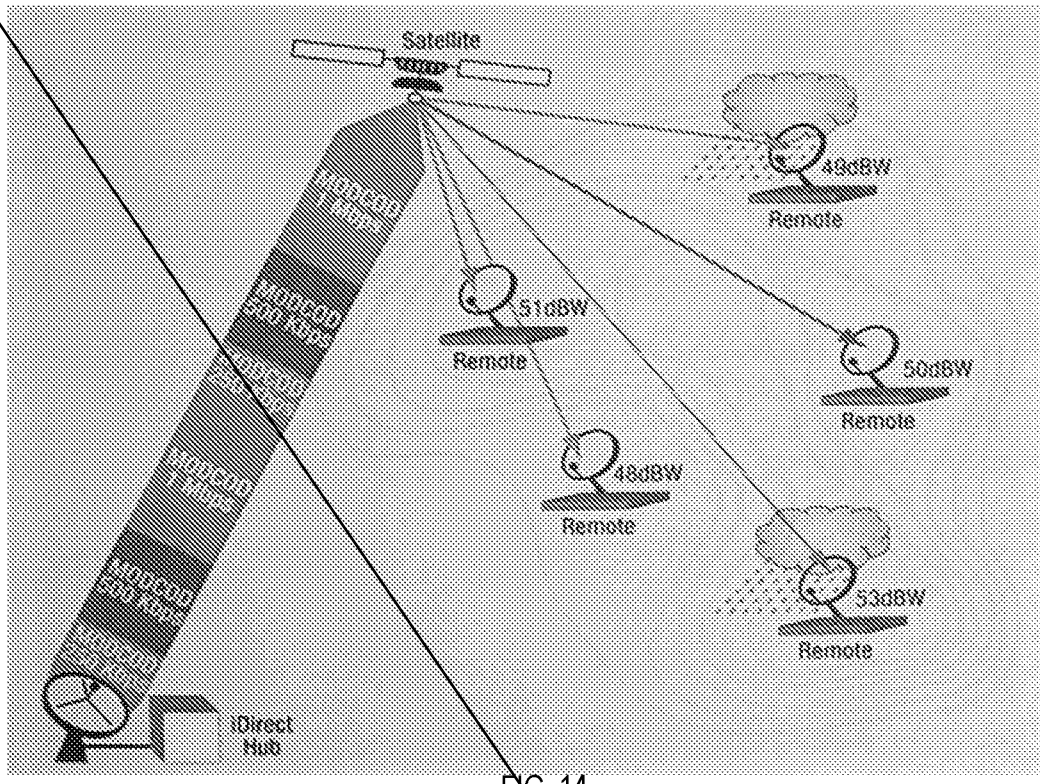


FIG. 14

1500

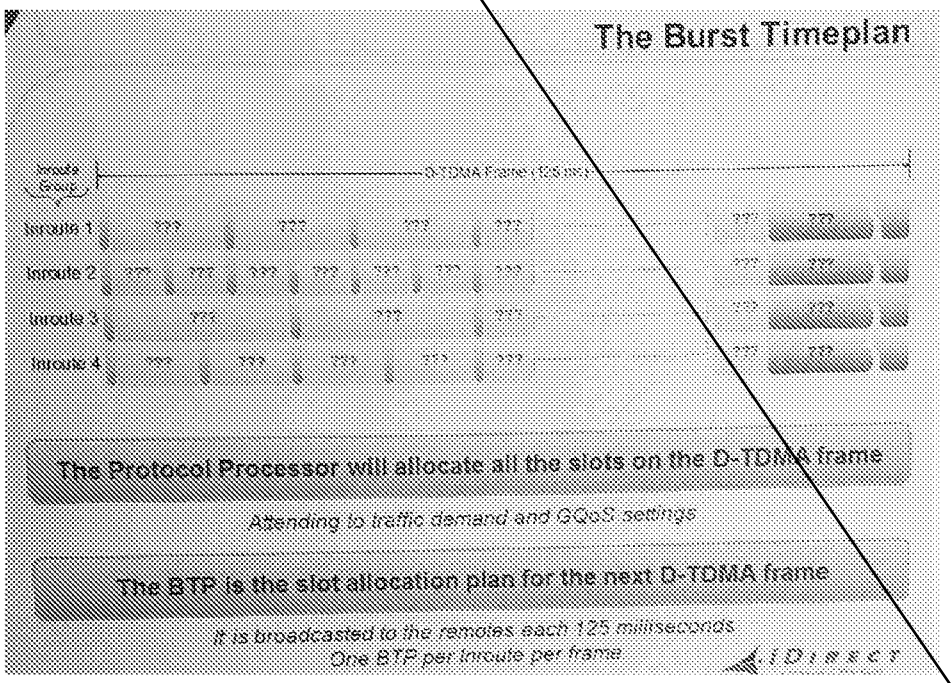


FIG. 15

1600

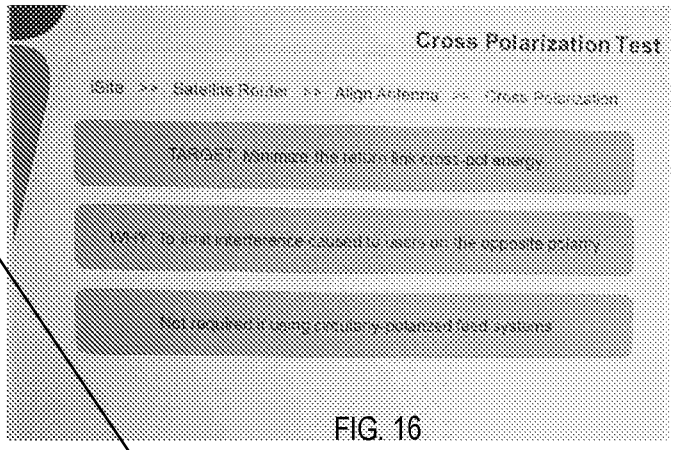
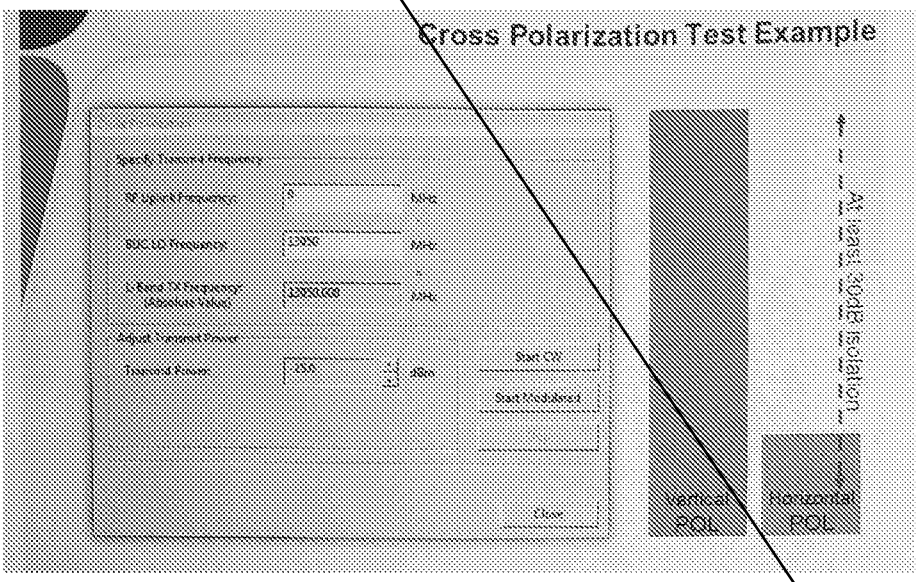


FIG. 16



1700

FIG. 17

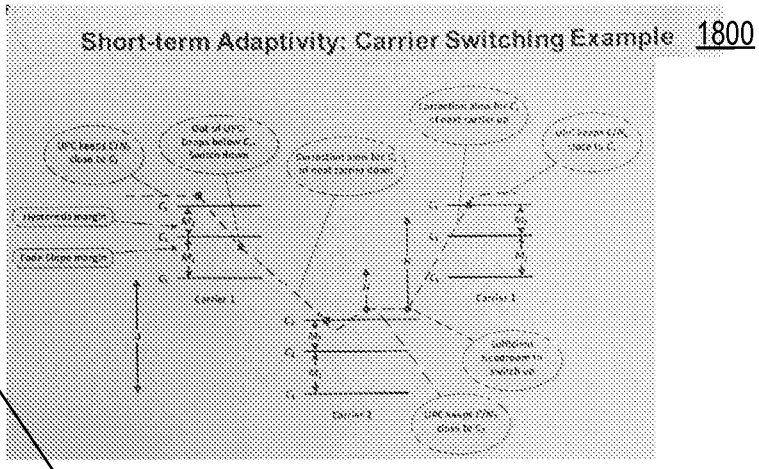

Short-term Adaptivity: Carrier Switching Example
1800

FIG. 18

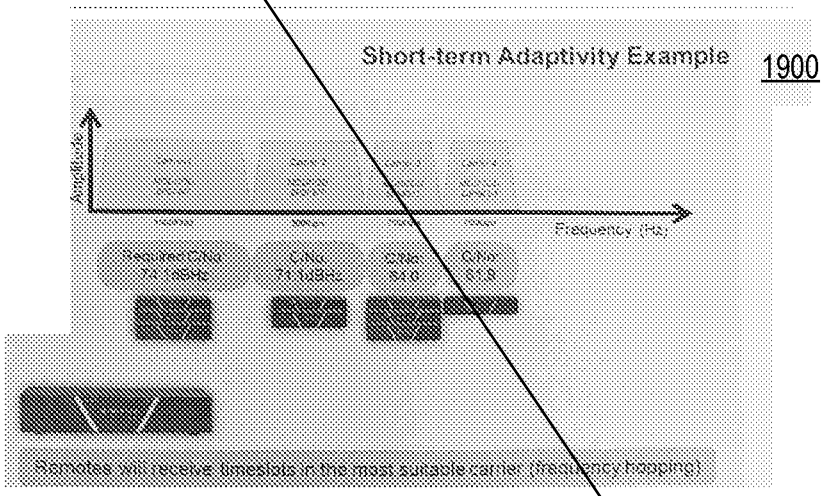
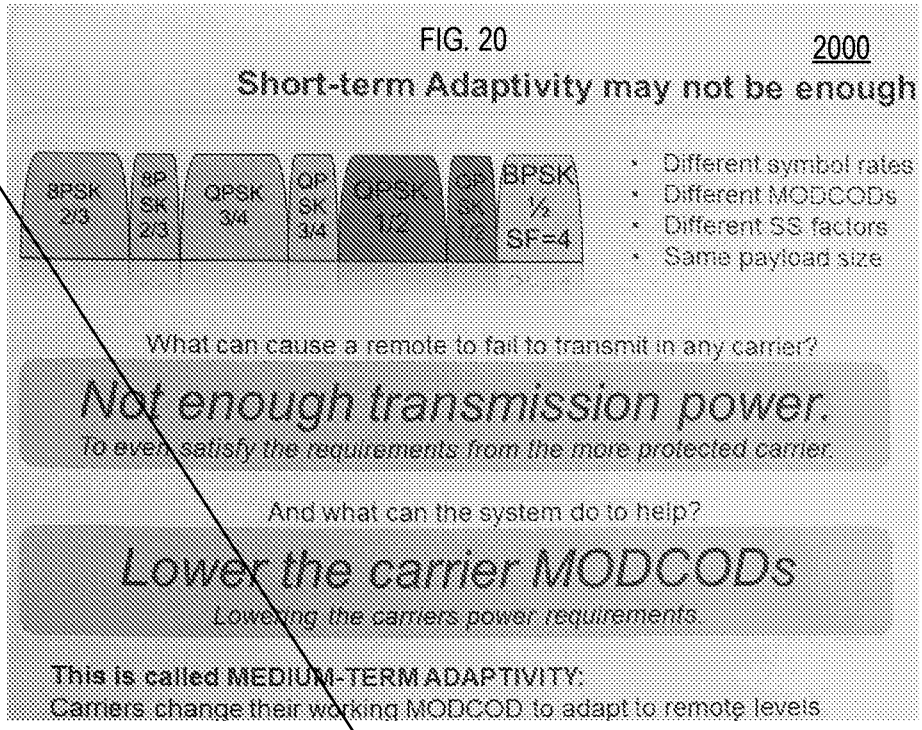

Short-term Adaptivity Example
1900
Frequency (Hz)

FIG. 19

FIG. 20


2000
Short-term Adaptivity may not be enough
BPSK
1/2
SF=4
Different symbol rates
Different MODCODs
Different SS factors
Same payload size
What can cause a remote to fail to transmit in any carrier?
Not enough transmission power.
To even satisfy the requirements from the more protected carrier.
And what can the system do to help?
Lower the carrier MODCODs
Lowering the carriers power requirements.
This is called MEDIUM-TERM ADAPTIVITY:
Carriers change their working MODCOD to adapt to remote levels

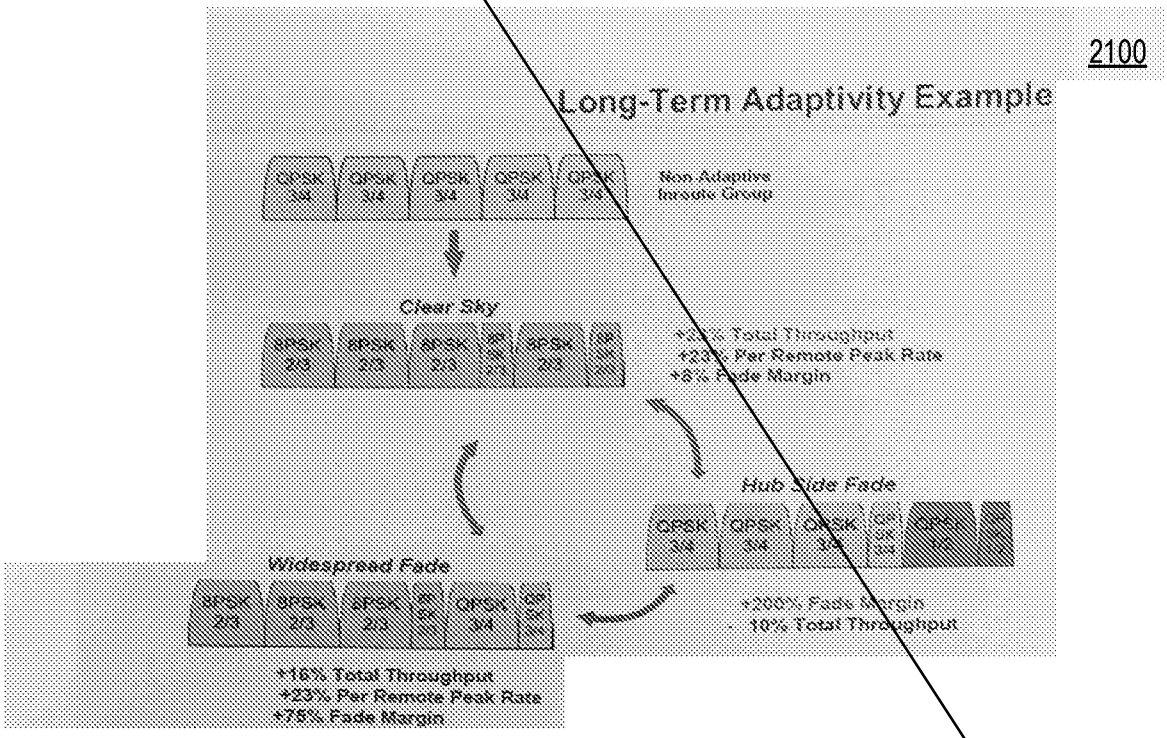

2100
Long-Term Adaptivity Example
Non Adaptive
Remote Group
Clear Sky
Hub Side Fade
Widespread Fade
+16% Total Throughput
+23% Per Remote Peak Rate
+75% Fade Margin
+200% Fade Margin
10% Total Throughput

FIG. 21

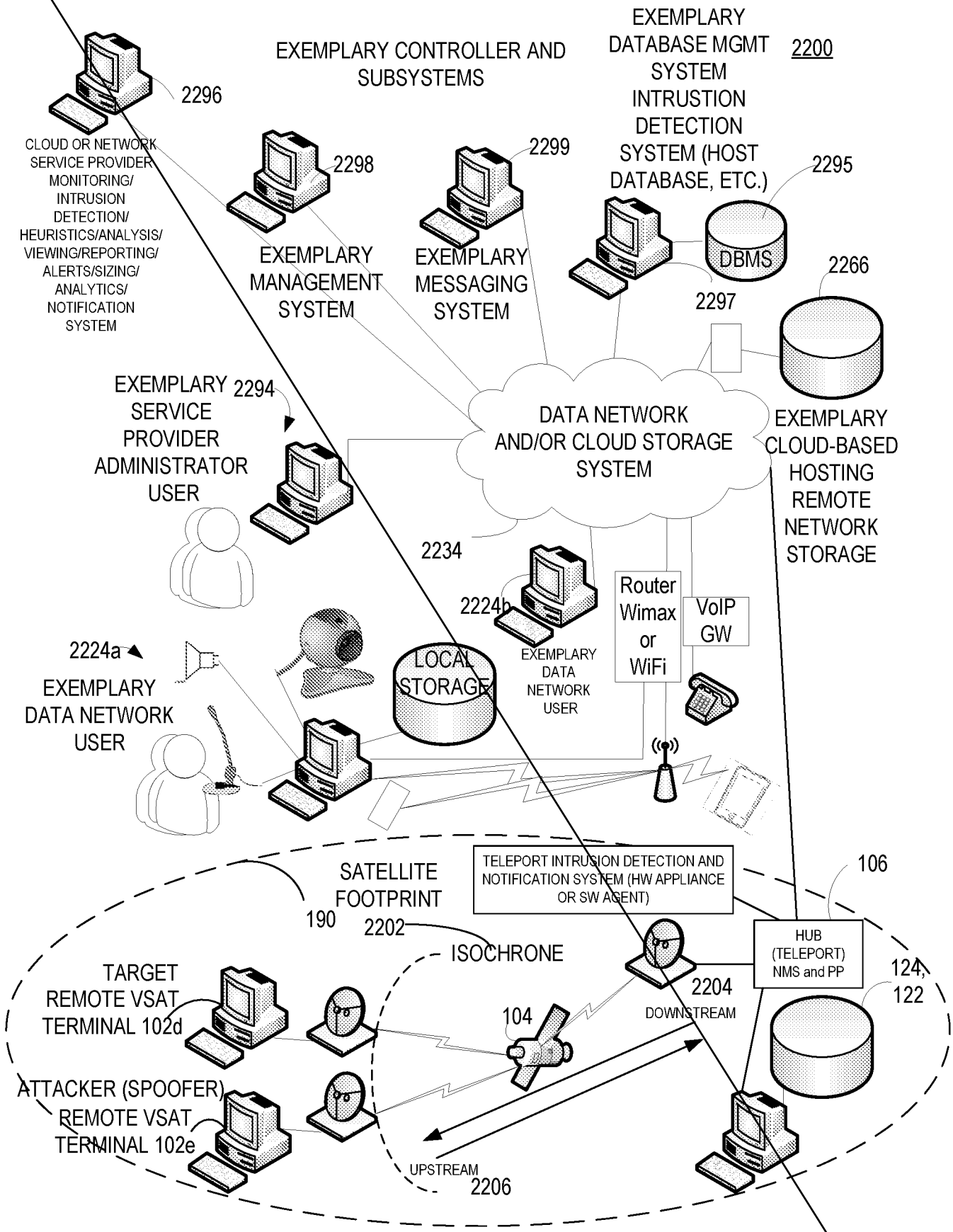

EXEMPLARY CONTROLLER AND SUBSYSTEMS
EXEMPLARY DATABASE MGMT SYSTEM INTRUSTION DETECTION SYSTEM (HOST DATABASE, ETC.) 2200
2296
CLOUD OR NETWORK SERVICE PROVIDER MONITORING/ INTRUSION DETECTION/ HEURISTICS/ANALYSIS/ VIEWING/REPORTING/ ALERTS/SIZING/ ANALYTICS/ NOTIFICATION SYSTEM
2298
EXEMPLARY MANAGEMENT SYSTEM
2299
EXEMPLARY MESSAGING SYSTEM
2295
DBMS
2297
2266
EXEMPLARY SERVICE PROVIDER ADMINISTRATOR USER
2294
DATA NETWORK AND/OR CLOUD STORAGE SYSTEM
EXEMPLARY CLOUD-BASED HOSTING REMOTE NETWORK STORAGE
2234
2224b
EXEMPLARY DATA NETWORK USER
Router Wimax or WiFi
VoIP GW
2224a
EXEMPLARY DATA NETWORK USER
LOCAL STORAGE
SATELLITE FOOTPRINT
190
TELEPORT INTRUSION DETECTION AND NOTIFICATION SYSTEM (HW APPLIANCE OR SW AGENT)
106
2202
ISOCHRONE
HUB (TELEPORT) NMS and PP
124, 122
TARGET REMOTE VSAT TERMINAL 102d
2204
DOWNSTREAM
104
ATTACKER (SPOOFER) REMOTE VSAT TERMINAL 102e
UPSTREAM
2206

FIG. 22

2300
ML activity
Ingest data
Prepare
Preprocess
Discover
Develop
Train
Test & Analyze
Deploy
GCP services
Transfer Service
Cloud Storage
Cloud Dataprep
Cloud Dataflow
Cloud Dataproc
BigQuery
Cloud Dataflow
Cloud Dataproc
BigQuery
AI Hub
Data labeling service
Deep Learning VM Image
AI Platform Notebooks
AI Platform Training
Kubeflow (on-premises)
TFX tools
AI Platform Prediction
Kubeflow (on-premises)
Workbench
AI Platform
On-premises: Kubeflow Pipelines
Repository (notebooks, modules, pipelines)
AI Hub

FIG. 23

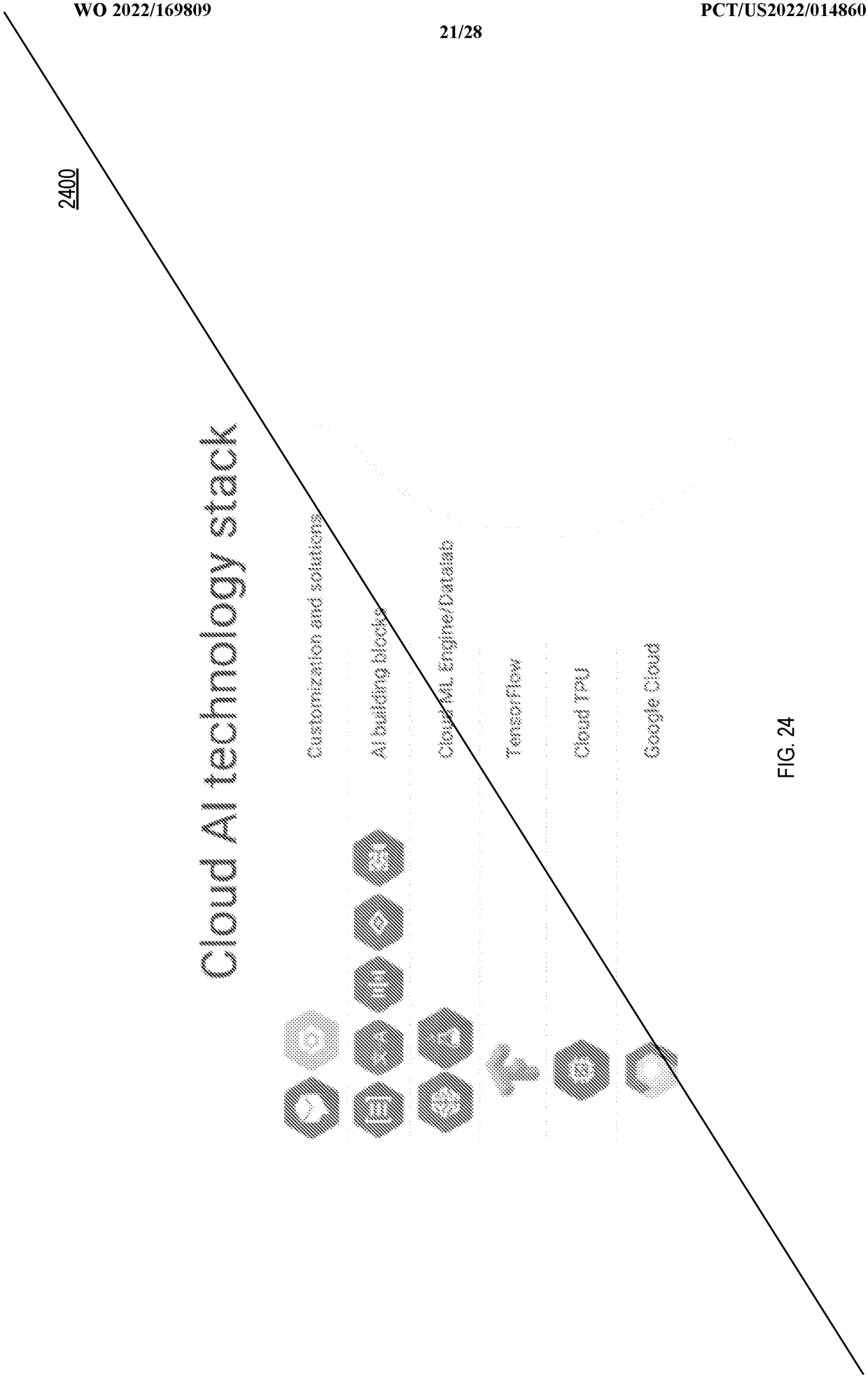

2400
Cloud AI technology stack
Customization and solutions
AI building blocks
Cloud ML Engine/Datalab
Tensorflow
Cloud TPU
Google Cloud

FIG. 24

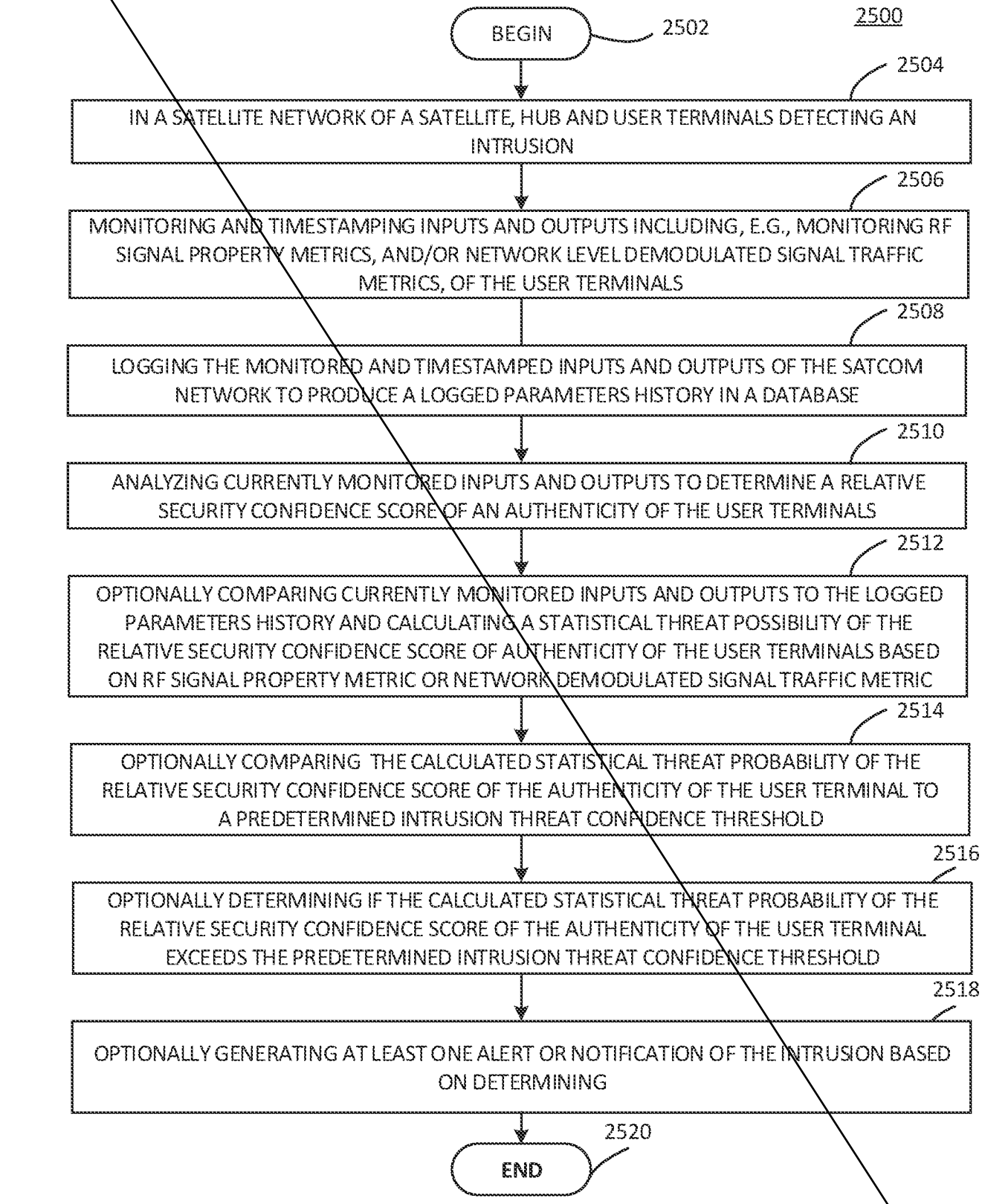

2500
BEGIN
2502
2504
IN A SATELLITE NETWORK OF A SATELLITE, HUB AND USER TERMINALS DETECTING AN INTRUSION
2506
MONITORING AND TIMESTAMPING INPUTS AND OUTPUTS INCLUDING, E.G., MONITORING RF SIGNAL PROPERTY METRICS, AND/OR NETWORK LEVEL DEMODULATED SIGNAL TRAFFIC METRICS, OF THE USER TERMINALS
2508
LOGGING THE MONITORED AND TIMESTAMPED INPUTS AND OUTPUTS OF THE SATCOM NETWORK TO PRODUCE A LOGGED PARAMETERS HISTORY IN A DATABASE
2510
ANALYZING CURRENTLY MONITORED INPUTS AND OUTPUTS TO DETERMINE A RELATIVE SECURITY CONFIDENCE SCORE OF AN AUTHENTICITY OF THE USER TERMINALS
2512
OPTIONALLY COMPARING CURRENTLY MONITORED INPUTS AND OUTPUTS TO THE LOGGED PARAMETERS HISTORY AND CALCULATING A STATISTICAL THREAT POSSIBILITY OF THE RELATIVE SECURITY CONFIDENCE SCORE OF AUTHENTICITY OF THE USER TERMINALS BASED ON RF SIGNAL PROPERTY METRIC OR NETWORK DEMODULATED SIGNAL TRAFFIC METRIC
2514
OPTIONALLY COMPARING THE CALCULATED STATISTICAL THREAT PROBABILITY OF THE RELATIVE SECURITY CONFIDENCE SCORE OF THE AUTHENTICITY OF THE USER TERMINAL TO A PREDETERMINED INTRUSION THREAT CONFIDENCE THRESHOLD
2516
OPTIONALLY DETERMINING IF THE CALCULATED STATISTICAL THREAT PROBABILITY OF THE RELATIVE SECURITY CONFIDENCE SCORE OF THE AUTHENTICITY OF THE USER TERMINAL EXCEEDS THE PREDETERMINED INTRUSION THREAT CONFIDENCE THRESHOLD
2518
OPTIONALLY GENERATING AT LEAST ONE ALERT OR NOTIFICATION OF THE INTRUSION BASED ON DETERMINING
2520
END

FIG. 25A

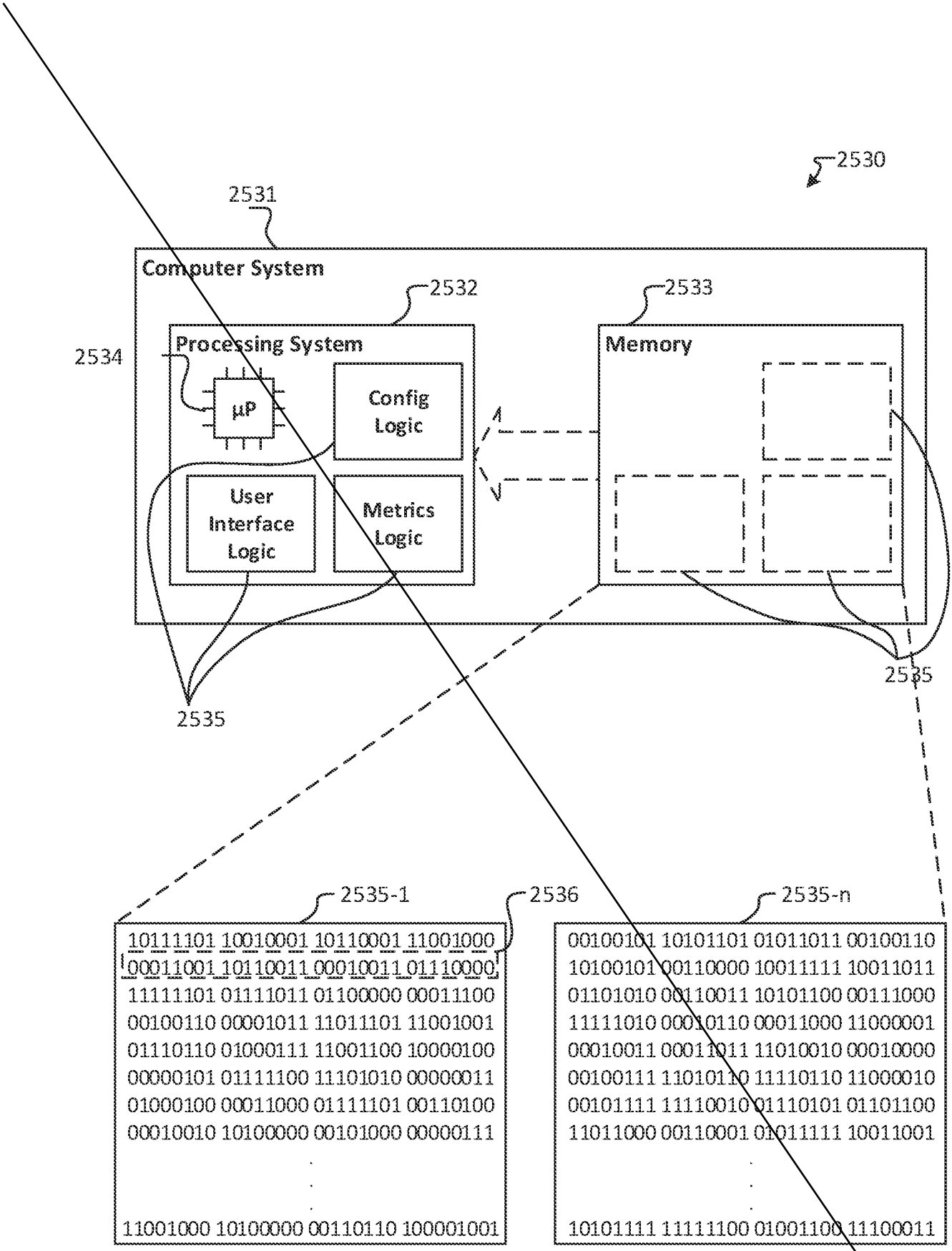

2530
2531
Computer System
2532
2533
2534
Processing System
Memory
µP
Config Logic
User Interface Logic
Metrics Logic
2535
2535
2535-1
2536
2535-n
10111101 10010001 10110001 11001000
00011001 10110011 00010011 01110000
11111101 01111011 01100000 00011100
00100110 00001011 11011101 11001001
01110110 01000111 11001100 10000100
00000101 01111100 11101010 00000011
01000100 00011000 01111101 00110100
00010010 10100000 00101000 00000111
11001000 10100000 00110110 100001001
00100101 10101101 01011011 00100110
10100101 00110000 10011111 10011011
01101010 00110011 10101100 00111000
11111010 00010110 00011000 11000001
00010011 00011011 11010010 00010000
00100111 11010110 11110110 11000010
00101111 11110010 01110101 01101100
11011000 00110001 01011111 10011001
10101111 11111100 01001100 11100011

FIG. 25B

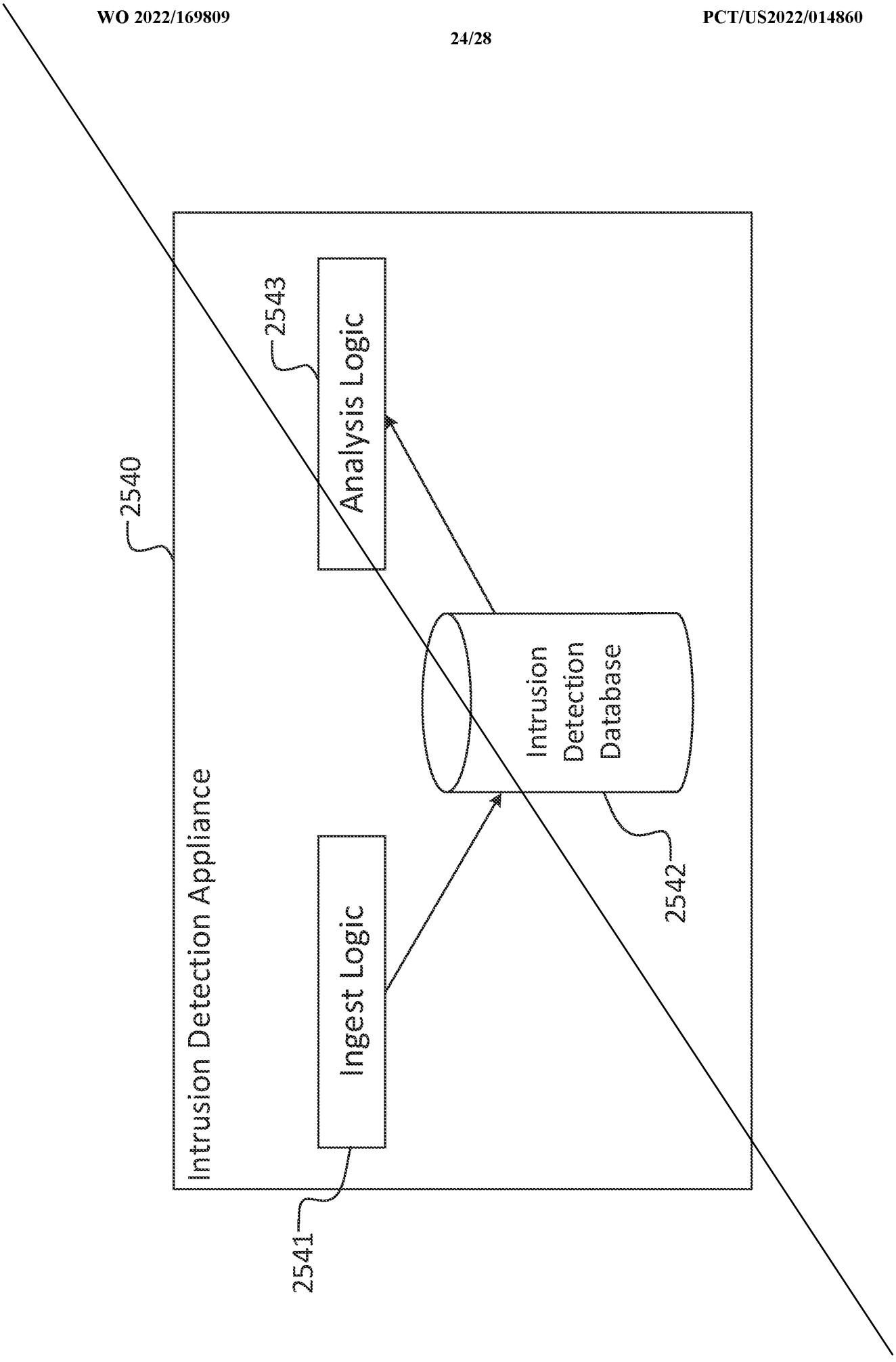

2540
Intrusion Detection Appliance
2543
Analysis Logic
Intrusion Detection Database
2542
Ingest Logic
2541

FIG. 25C

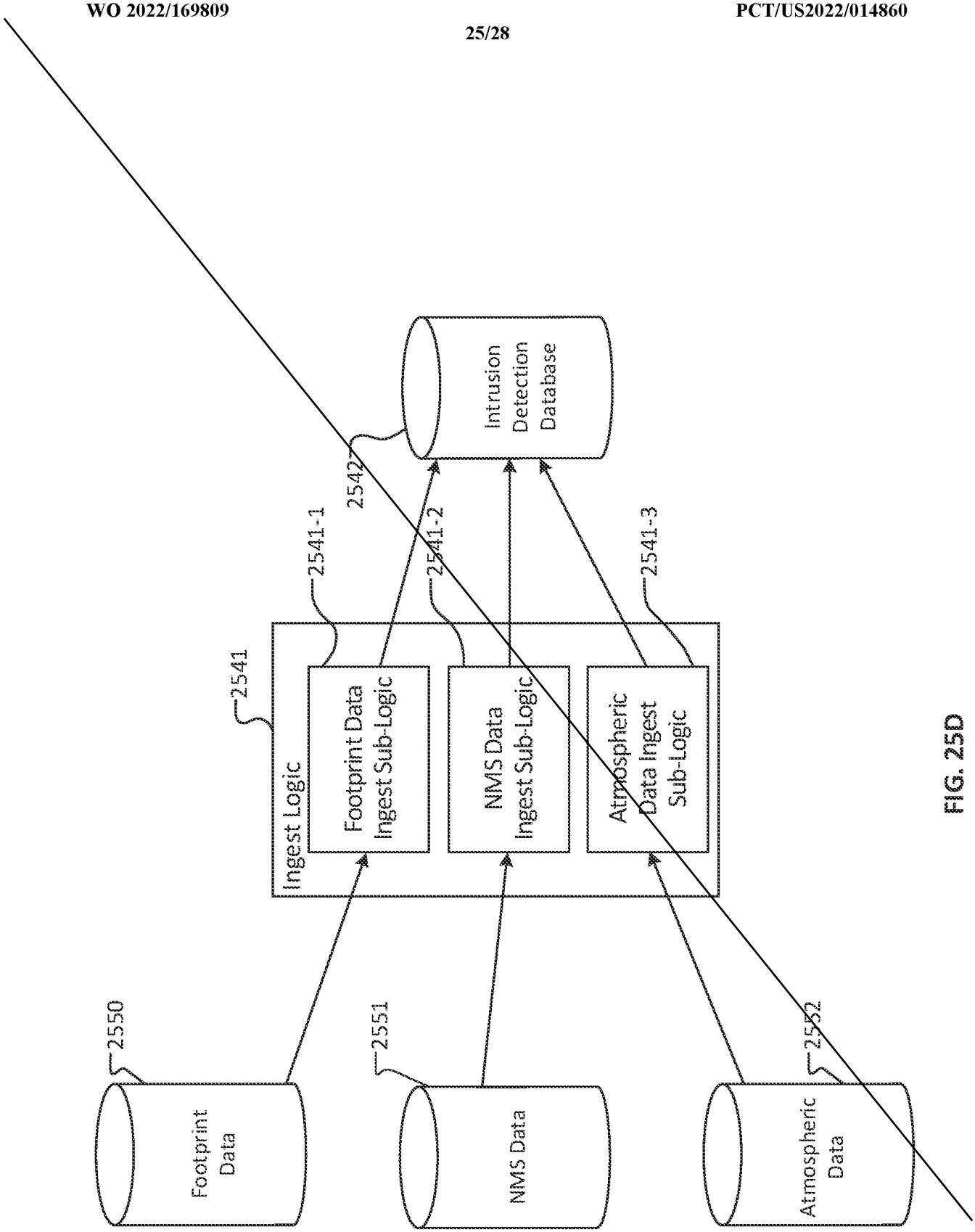

Intrusion Detection Database
2542
2541-1
2541-2
2541-3
2541
Ingest Logic
Footprint Data Ingest Sub-Logic
NMS Data Ingest Sub-Logic
Atmospheric Data Ingest Sub-Logic
2550
2551
2552
Footprint Data
NMS Data
Atmospheric Data

FIG. 25D

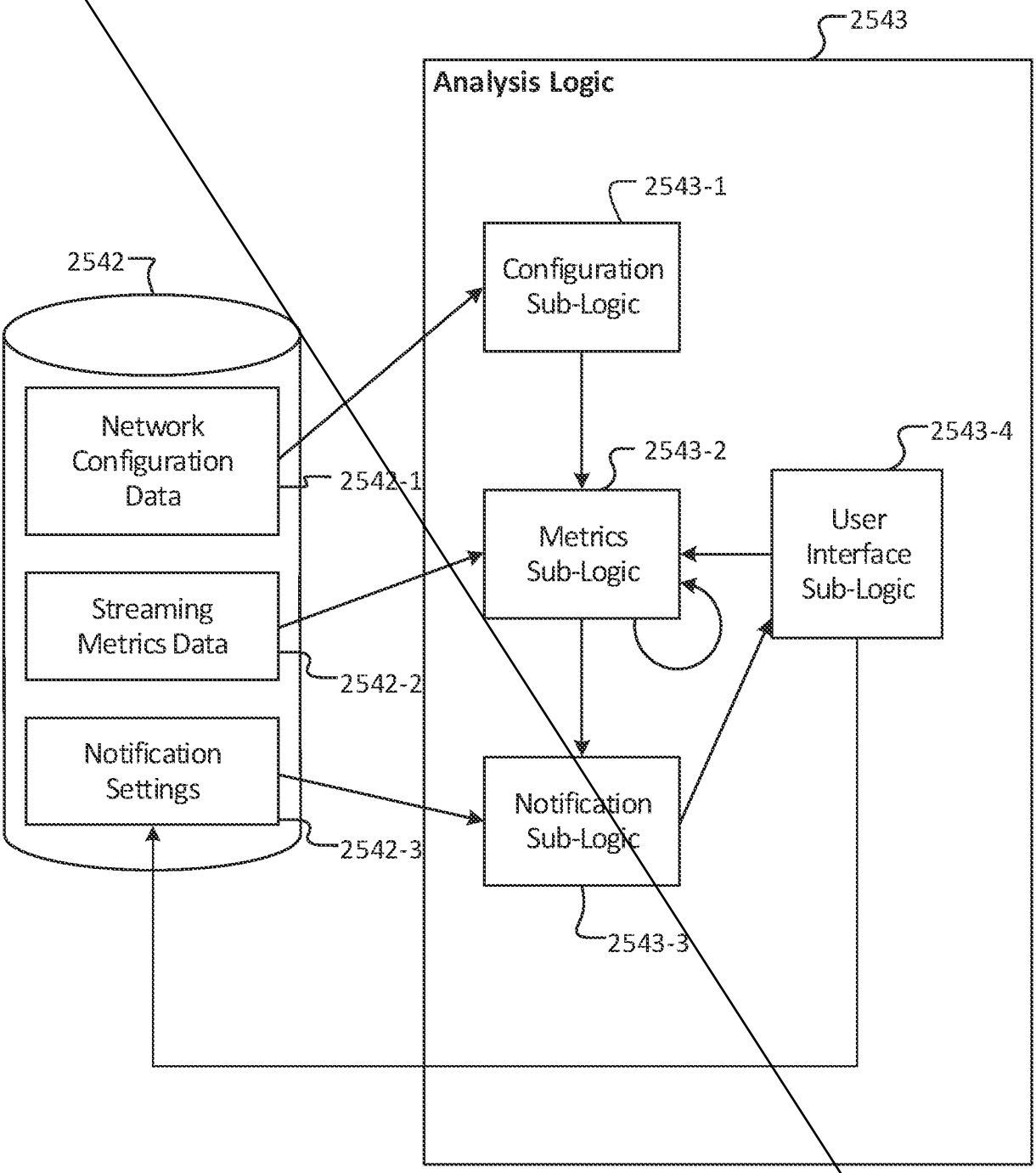

2543
Analysis Logic
2543-1
Configuration Sub-Logic
2542
Network Configuration Data
2542-1
2543-2
Metrics Sub-Logic
2543-4
User Interface Sub-Logic
Streaming Metrics Data
2542-2
Notification Settings
2542-3
Notification Sub-Logic
2543-3

FIG. 25E

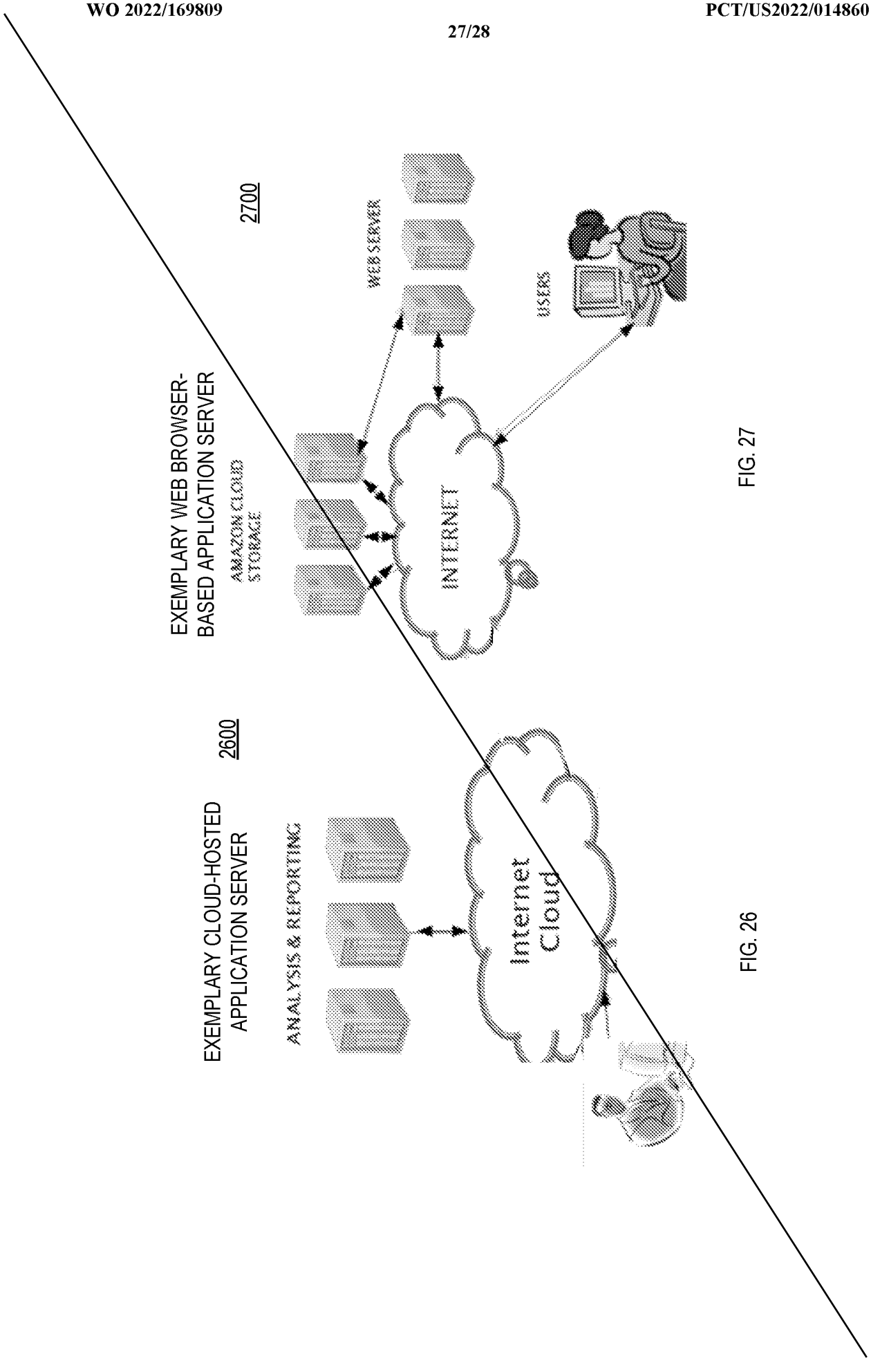

EXEMPLARY CLOUD-HOSTED APPLICATION SERVER
2600
ANALYSIS & REPORTING
Internet Cloud
EXEMPLARY WEB BROWSER-BASED APPLICATION SERVER
2700
AMAZON CLOUD STORAGE
INTERNET
WEB SERVER
USERS

FIG. 26

FIG. 27

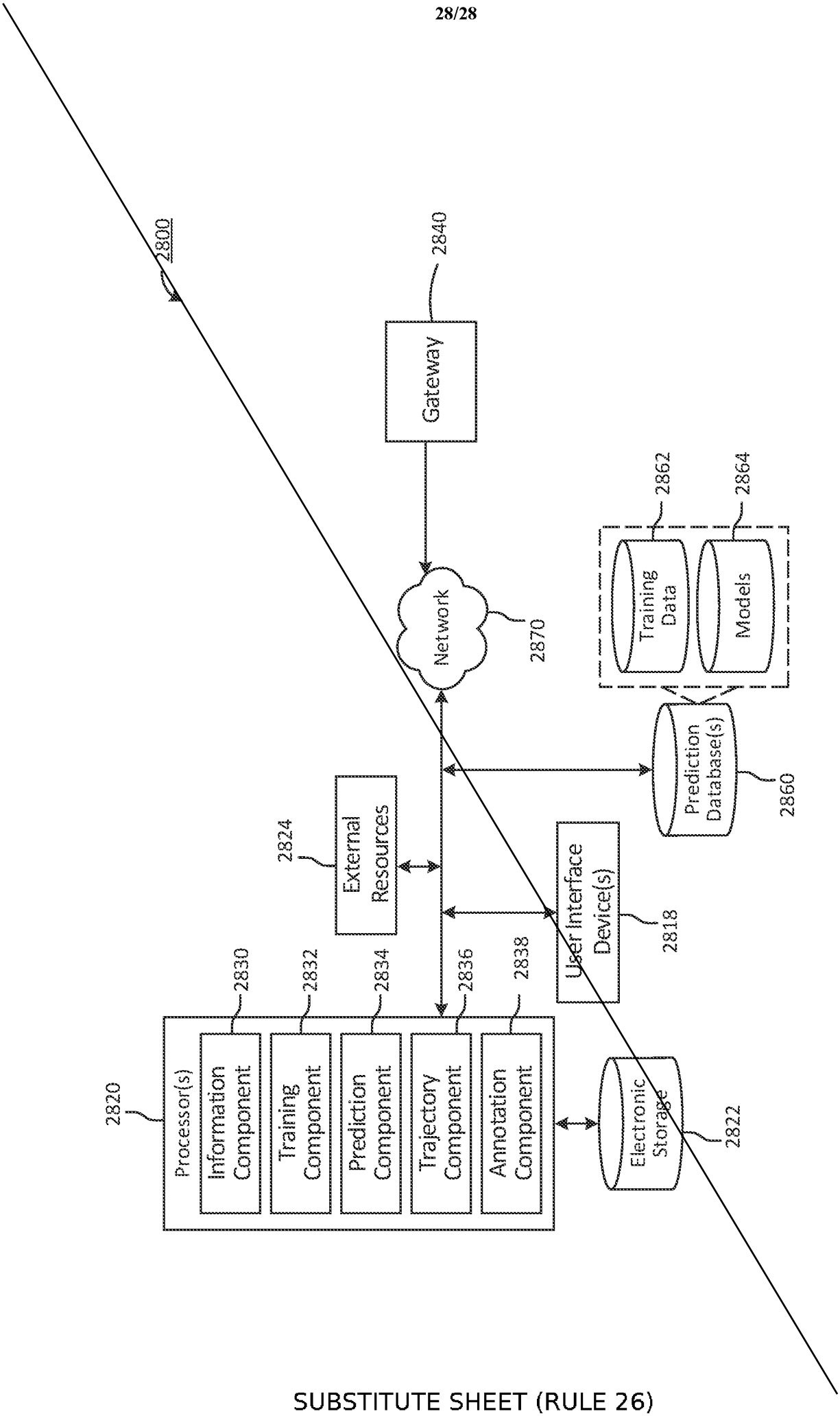

2800
2840
Gateway
2862
2864
Training Data
Models
Network
2870
Prediction Database(s)
2860
2824
External Resources
User Interface Device(s)
2818
2820
Processor(s)
2830
Information Component
2832
Training Component
2834
Prediction Component
2836
Trajectory Component
2838
Annotation Component
Electronic Storage
2822

FIG. 28

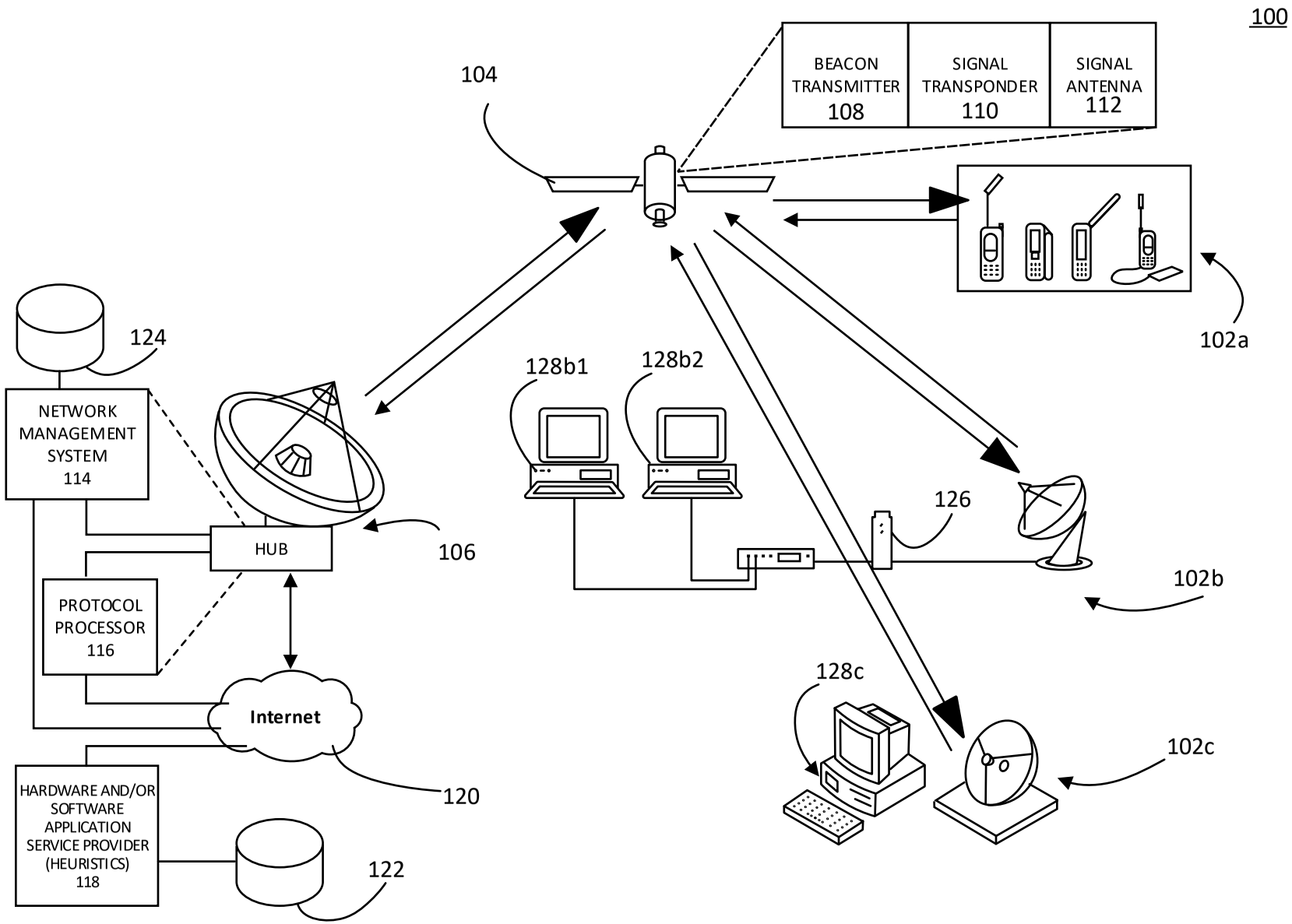

100
104
BEACON TRANSMITTER 108
SIGNAL TRANSPONDER 110
SIGNAL ANTENNA 112
102a
124
NETWORK MANAGEMENT SYSTEM 114
HUB
106
PROTOCOL PROCESSOR 116
Internet
120
HARDWARE AND/OR SOFTWARE APPLICATION SERVICE PROVIDER (HEURISTICS) 118
122
128b1
128b2
126
102b
128c
102c

FIG. 1

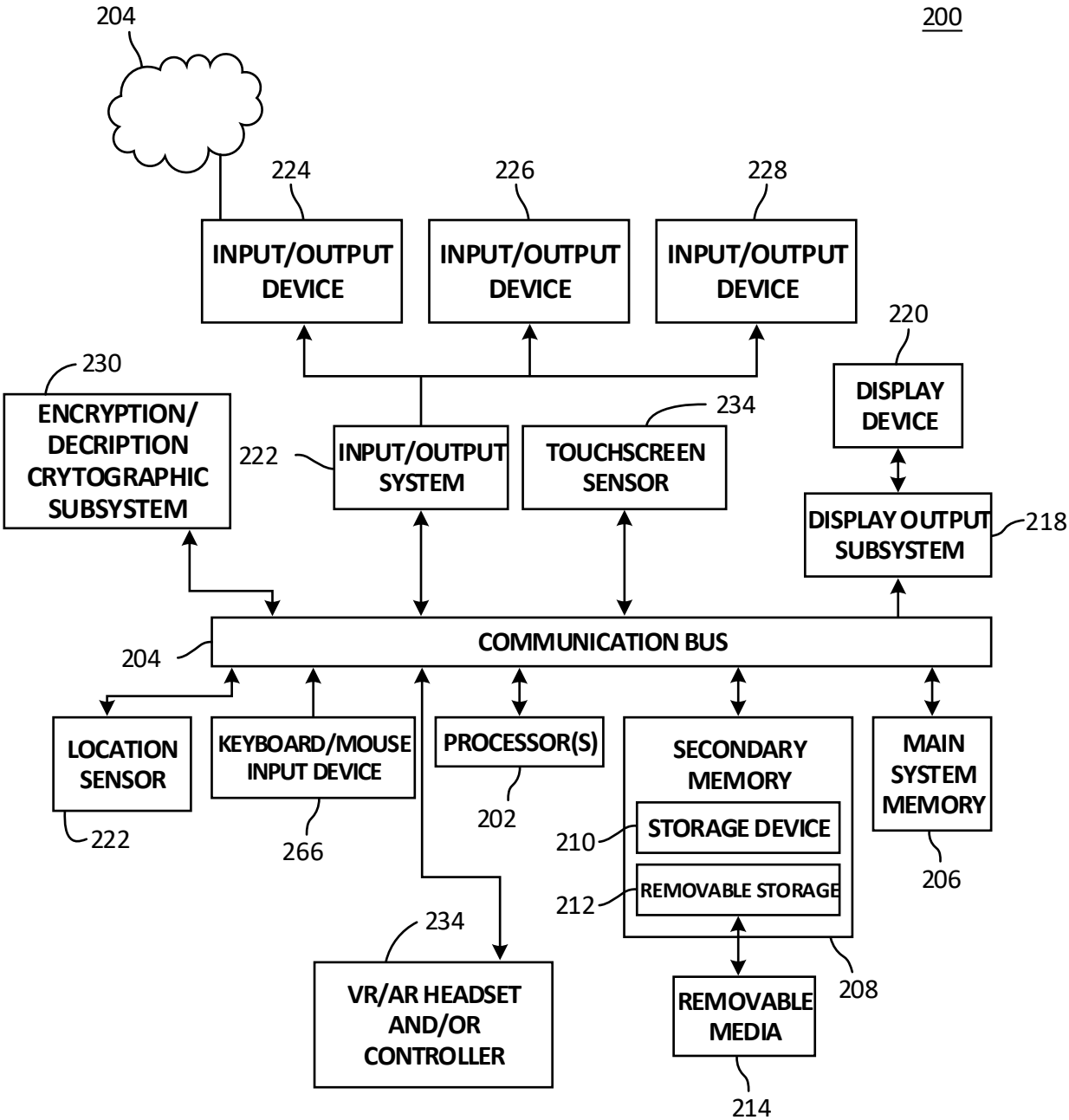

204
200
224
226
228
INPUT/OUTPUT DEVICE
INPUT/OUTPUT DEVICE
INPUT/OUTPUT DEVICE
220
230
DISPLAY DEVICE
ENCRYPTION/ DECRIPTION CRYTOGRAPHIC SUBSYSTEM
222
INPUT/OUTPUT SYSTEM
234
TOUCHSCREEN SENSOR
DISPLAY OUTPUT SUBSYSTEM
218
204
COMMUNICATION BUS
LOCATION SENSOR
222
KEYBOARD/MOUSE INPUT DEVICE
266
PROCESSOR(S)
202
SECONDARY MEMORY
STORAGE DEVICE
210
REMOVABLE STORAGE
212
MAIN SYSTEM MEMORY
206
234
VR/AR HEADSET AND/OR CONTROLLER
REMOVABLE MEDIA
214
208

FIG. 2

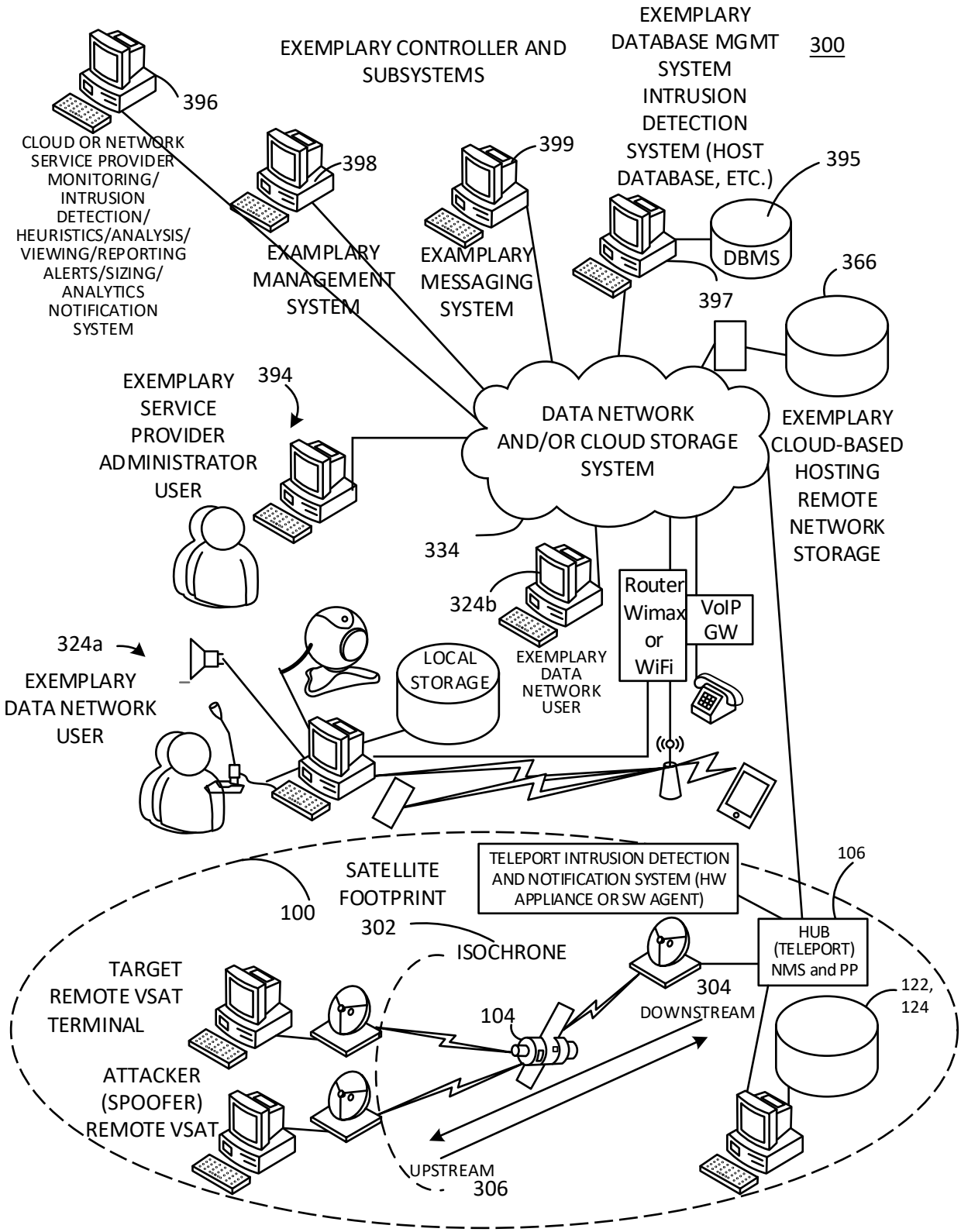

EXEMPLARY CONTROLLER AND SUBSYSTEMS
EXEMPLARY DATABASE MGMT SYSTEM INTRUSION DETECTION SYSTEM (HOST DATABASE, ETC.)
300
396
CLOUD OR NETWORK SERVICE PROVIDER MONITORING/ INTRUSION DETECTION/ HEURISTICS/ANALYSIS/ VIEWING/REPORTING ALERTS/SIZING/ ANALYTICS NOTIFICATION SYSTEM
398
EXAMPLARY MANAGEMENT SYSTEM
399
EXAMPLARY MESSAGING SYSTEM
395
DBMS
366
397
394
EXEMPLARY SERVICE PROVIDER ADMINISTRATOR USER
DATA NETWORK AND/OR CLOUD STORAGE SYSTEM
EXEMPLARY CLOUD-BASED HOSTING REMOTE NETWORK STORAGE
334
324b
Router Wimax or WiFi
VoIP GW
324a
EXEMPLARY DATA NETWORK USER
LOCAL STORAGE
EXEMPLARY DATA NETWORK USER
TELEPORT INTRUSION DETECTION AND NOTIFICATION SYSTEM (HW APPLIANCE OR SW AGENT)
106
SATELLITE FOOTPRINT
100
302
ISOCHRONE
HUB (TELEPORT) NMS and PP
TARGET REMOTE VSAT TERMINAL
304
DOWNSTREAM
122, 124
104
ATTACKER (SPOOFER) REMOTE VSAT
UPSTREAM
306

FIG. 3

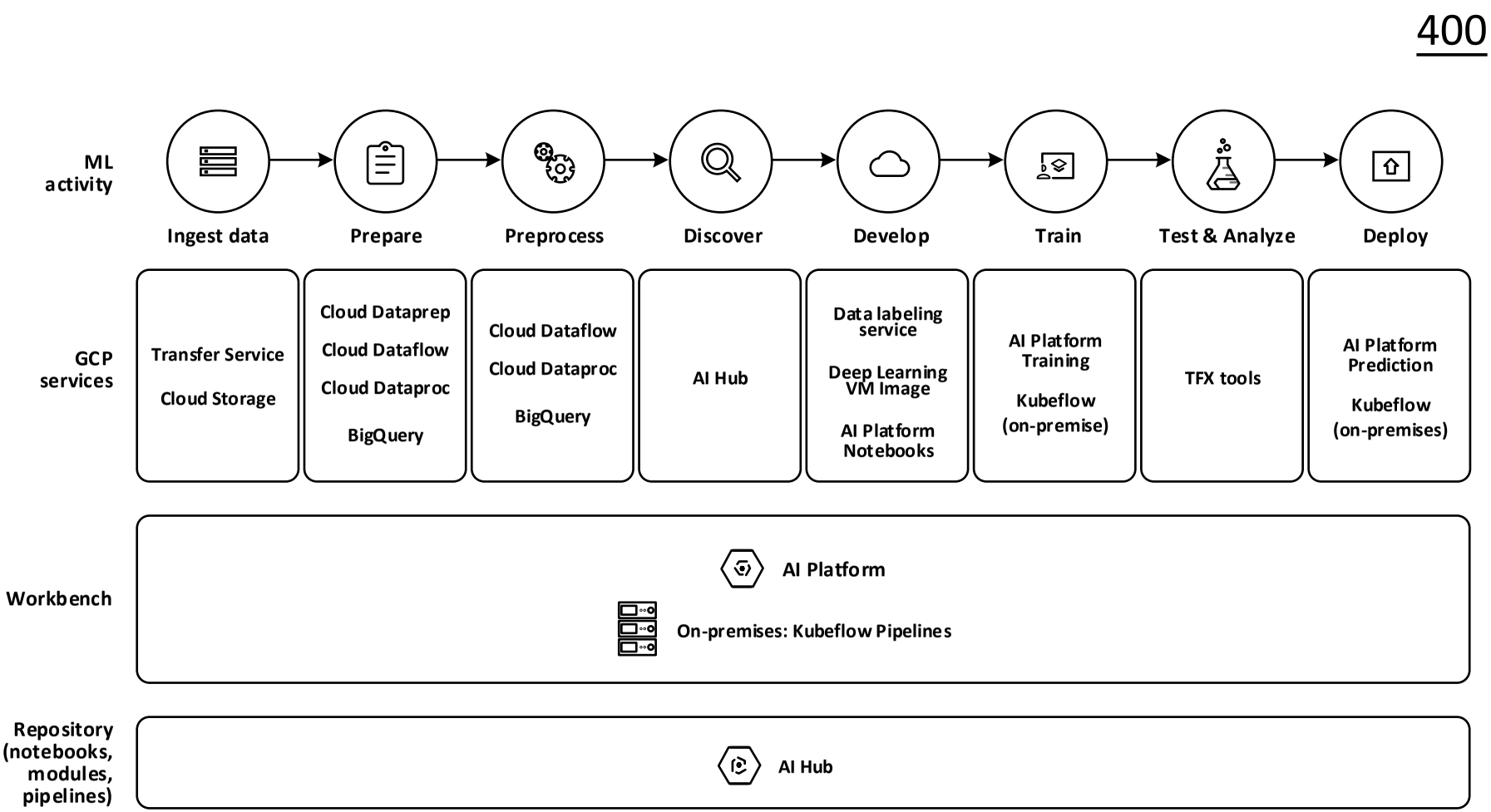

400
ML activity
Ingest data
Prepare
Preprocess
Discover
Develop
Train
Test & Analyze
Deploy
GCP services
Transfer Service
Cloud Storage
Cloud Dataprep
Cloud Dataflow
Cloud Dataproc
BigQuery
Cloud Dataflow
Cloud Dataproc
BigQuery
AI Hub
Data labeling service
Deep Learning VM Image
AI Platform Notebooks
AI Platform Training
Kubeflow (on-premise)
TFX tools
AI Platform Prediction
Kubeflow (on-premises)
Workbench
AI Platform
On-premises: Kubeflow Pipelines
Repository (notebooks, modules, pipelines)
AI Hub

FIG. 4

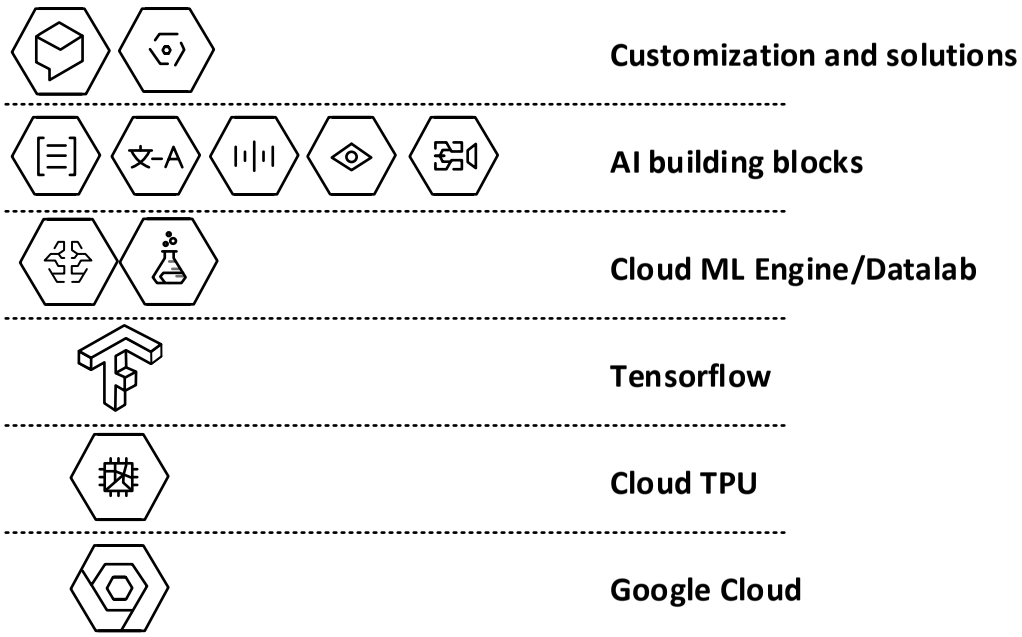

Cloud AI technology stack
Customization and solutions
AI building blocks
Cloud ML Engine/Datalab
Tensorflow
Cloud TPU
Google Cloud

FIG. 5

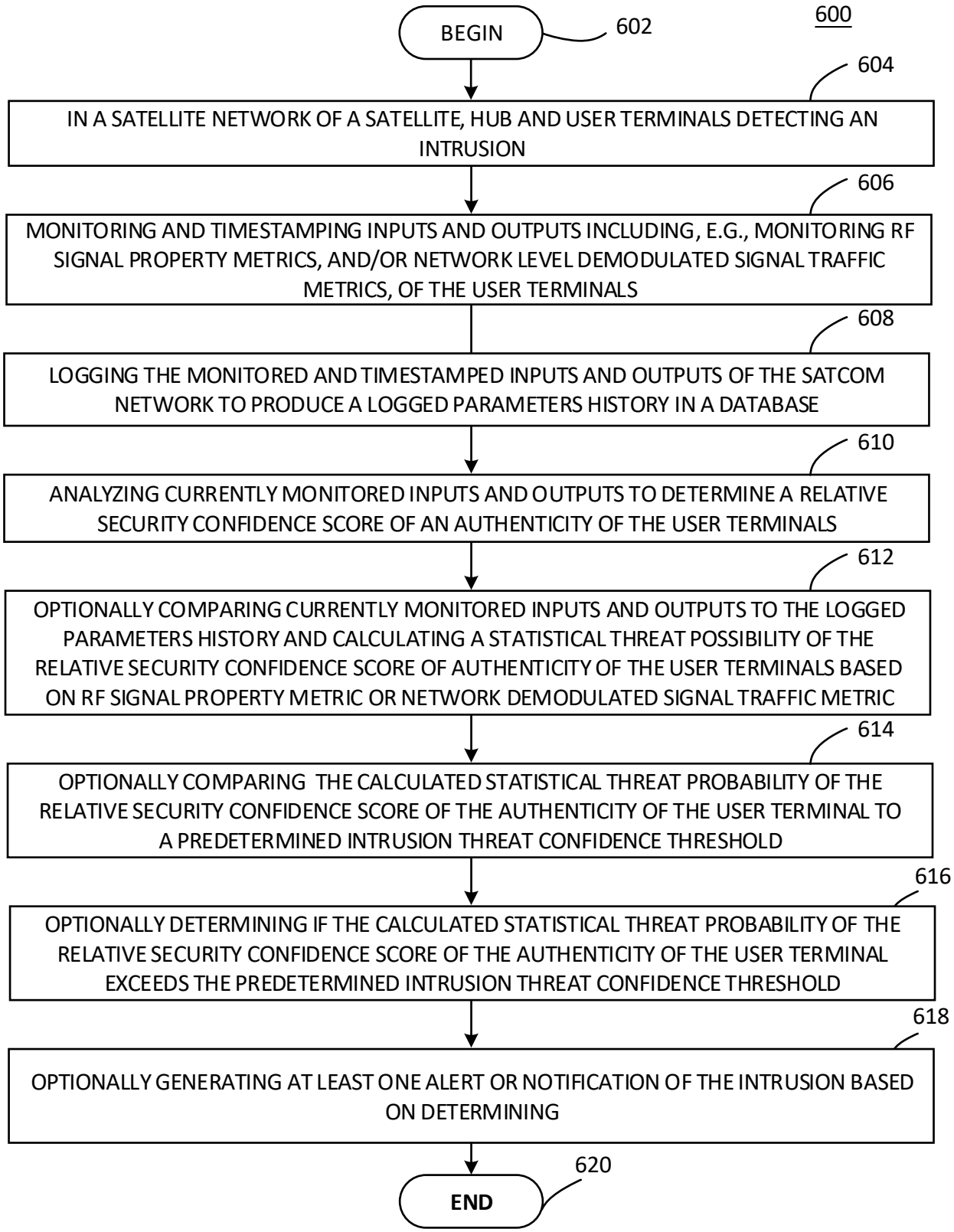

600
BEGIN
602
604
IN A SATELLITE NETWORK OF A SATELLITE, HUB AND USER TERMINALS DETECTING AN INTRUSION
606
MONITORING AND TIMESTAMPING INPUTS AND OUTPUTS INCLUDING, E.G., MONITORING RF SIGNAL PROPERTY METRICS, AND/OR NETWORK LEVEL DEMODULATED SIGNAL TRAFFIC METRICS, OF THE USER TERMINALS
608
LOGGING THE MONITORED AND TIMESTAMPED INPUTS AND OUTPUTS OF THE SATCOM NETWORK TO PRODUCE A LOGGED PARAMETERS HISTORY IN A DATABASE
610
ANALYZING CURRENTLY MONITORED INPUTS AND OUTPUTS TO DETERMINE A RELATIVE SECURITY CONFIDENCE SCORE OF AN AUTHENTICITY OF THE USER TERMINALS
612
OPTIONALLY COMPARING CURRENTLY MONITORED INPUTS AND OUTPUTS TO THE LOGGED PARAMETERS HISTORY AND CALCULATING A STATISTICAL THREAT POSSIBILITY OF THE RELATIVE SECURITY CONFIDENCE SCORE OF AUTHENTICITY OF THE USER TERMINALS BASED ON RF SIGNAL PROPERTY METRIC OR NETWORK DEMODULATED SIGNAL TRAFFIC METRIC
614
OPTIONALLY COMPARING THE CALCULATED STATISTICAL THREAT PROBABILITY OF THE RELATIVE SECURITY CONFIDENCE SCORE OF THE AUTHENTICITY OF THE USER TERMINAL TO A PREDETERMINED INTRUSION THREAT CONFIDENCE THRESHOLD
616
OPTIONALLY DETERMINING IF THE CALCULATED STATISTICAL THREAT PROBABILITY OF THE RELATIVE SECURITY CONFIDENCE SCORE OF THE AUTHENTICITY OF THE USER TERMINAL EXCEEDS THE PREDETERMINED INTRUSION THREAT CONFIDENCE THRESHOLD
618
OPTIONALLY GENERATING AT LEAST ONE ALERT OR NOTIFICATION OF THE INTRUSION BASED ON DETERMINING
620
END

FIG. 6A

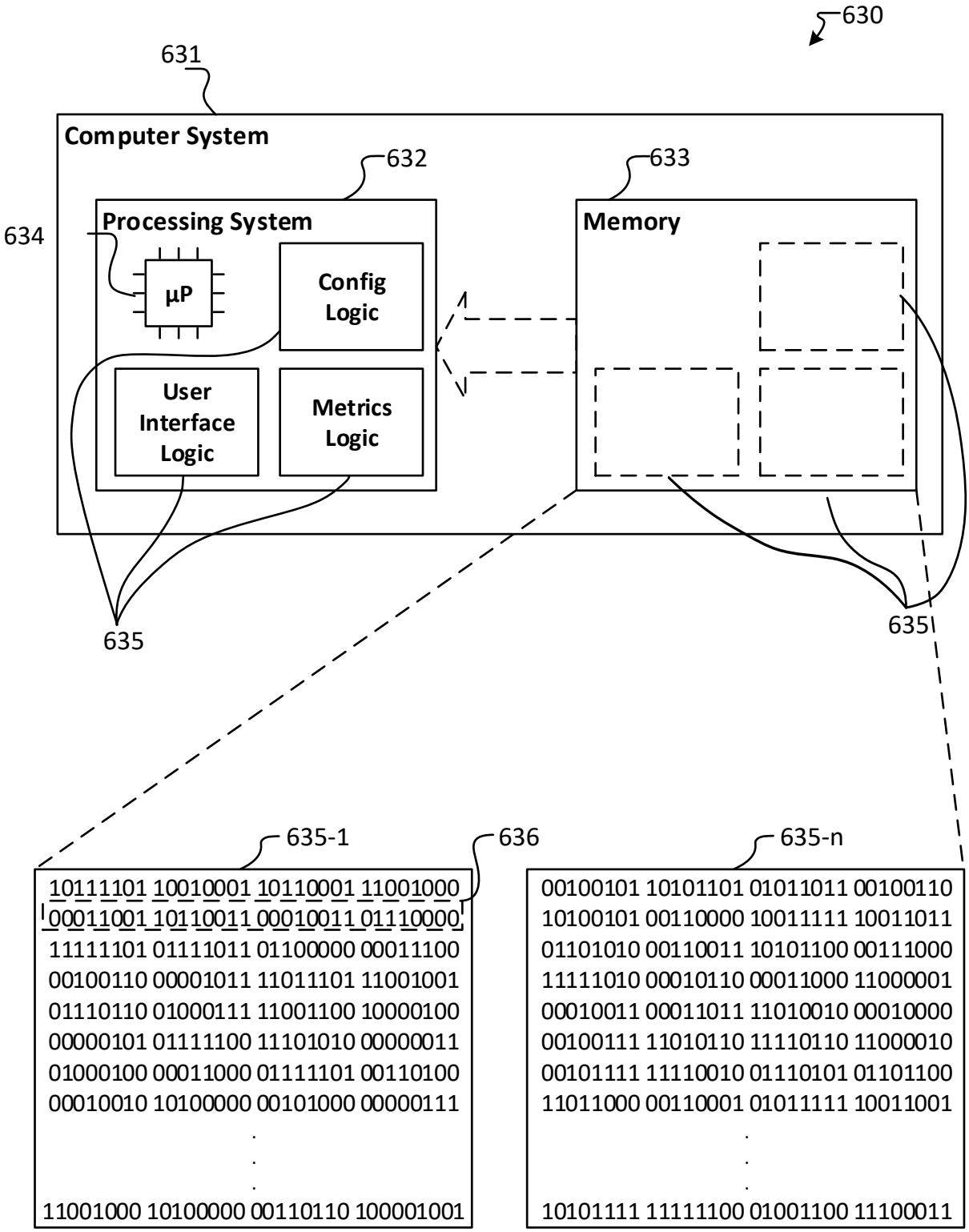

630
631
Computer System
632
633
634
Processing System
Memory
µP
Config Logic
User Interface Logic
Metrics Logic
635
635
635-1
636
635-n
10111101 10010001 10110001 11001000
00011001 10110011 00010011 01110000
11111101 01111011 01100000 00011100
00100110 00001011 11011101 11001001
01110110 01000111 11001100 10000100
00000101 01111100 11101010 00000011
01000100 00011000 01111101 00110100
00010010 10100000 00101000 00000111
11001000 10100000 00110110 100001001
00100101 10101101 01011011 00100110
10100101 00110000 10011111 10011011
01101010 00110011 10101100 00111000
11111010 00010110 00011000 11000001
00010011 00011011 11010010 00010000
00100111 11010110 11110110 11000010
00101111 11110010 01110101 01101100
11011000 00110001 01011111 10011001
10101111 11111100 01001100 11100011

FIG. 6B

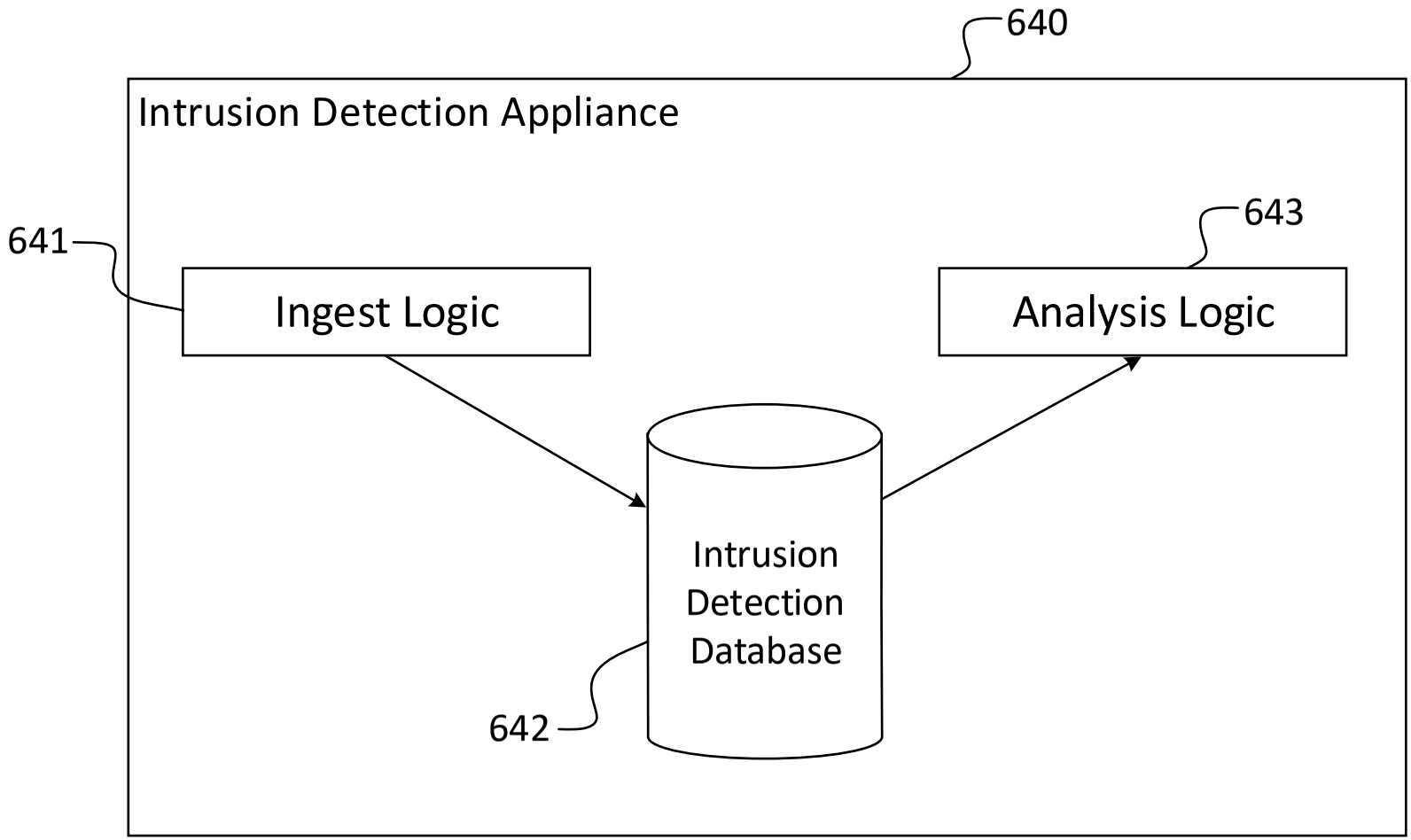

640
Intrusion Detection Appliance
641
643
Ingest Logic
Analysis Logic
Intrusion
Detection
Database
642

FIG. 6C

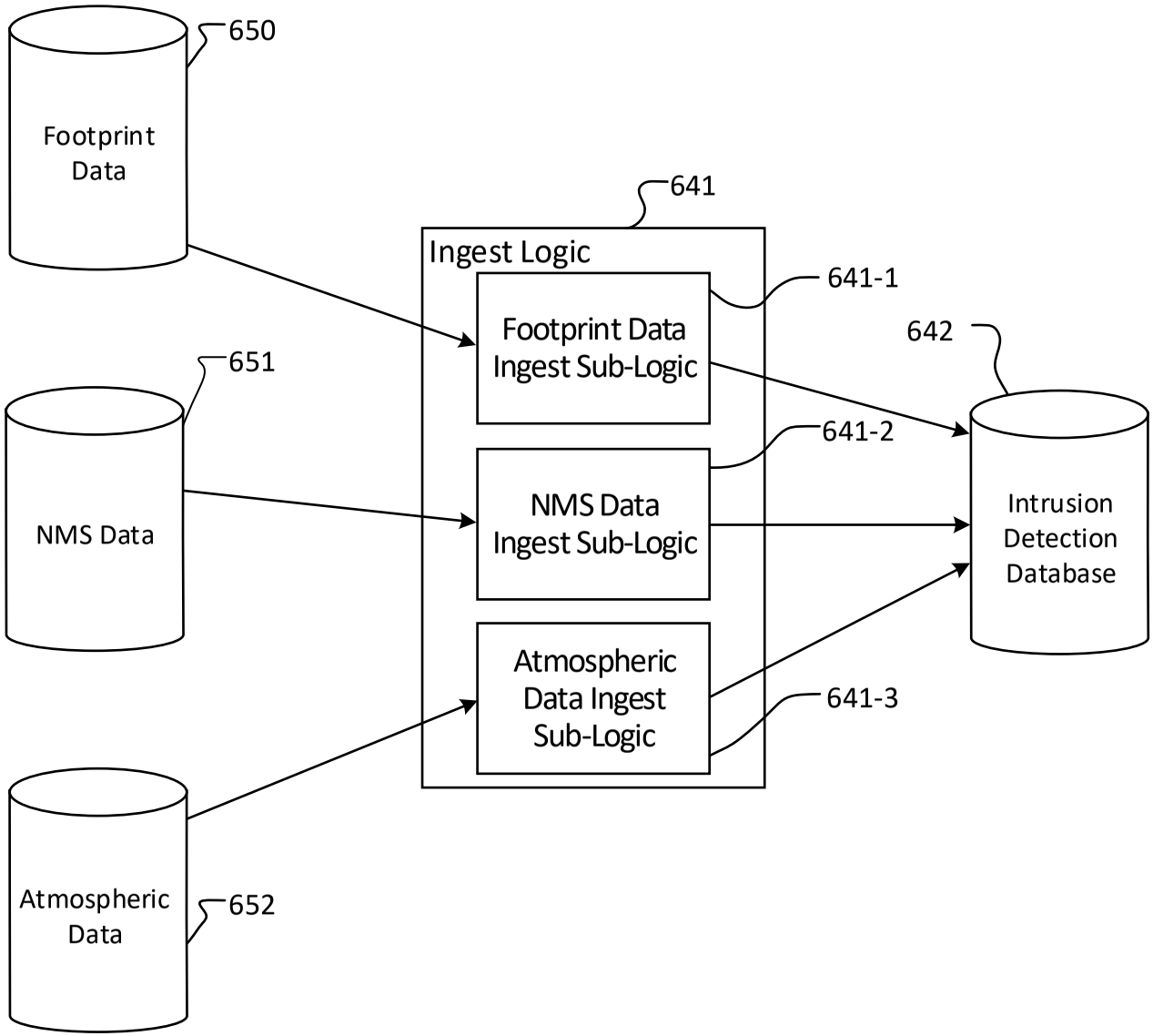

650
Footprint Data
641
Ingest Logic
641-1
Footprint Data Ingest Sub-Logic
642
651
NMS Data
641-2
NMS Data Ingest Sub-Logic
Intrusion Detection Database
Atmospheric Data Ingest Sub-Logic
641-3
Atmospheric Data
652

FIG. 6D

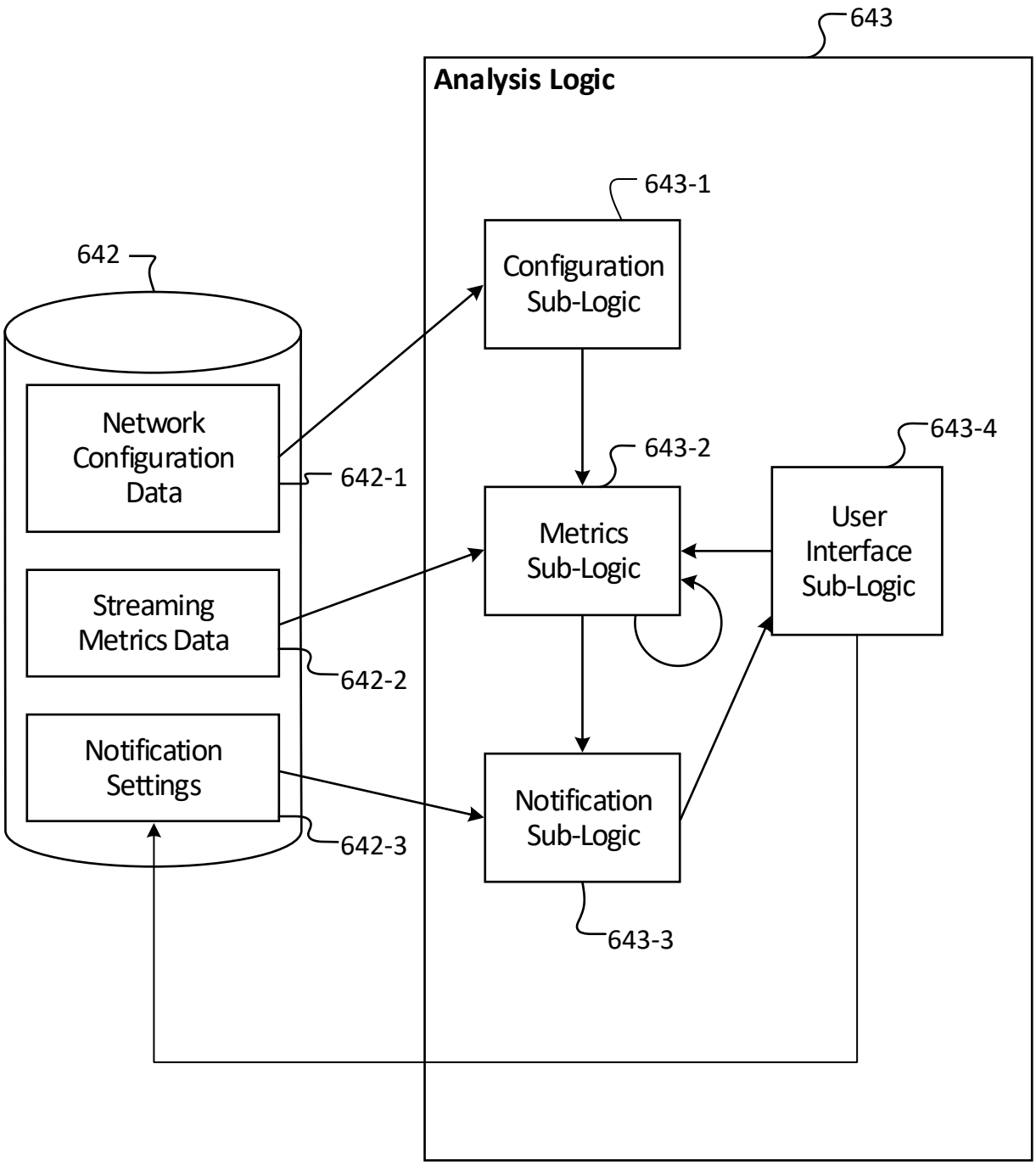

643
Analysis Logic
643-1
Configuration Sub-Logic
642
Network Configuration Data
642-1
643-2
Metrics Sub-Logic
643-4
User Interface Sub-Logic
Streaming Metrics Data
642-2
Notification Settings
642-3
Notification Sub-Logic
643-3

FIG. 6E

700

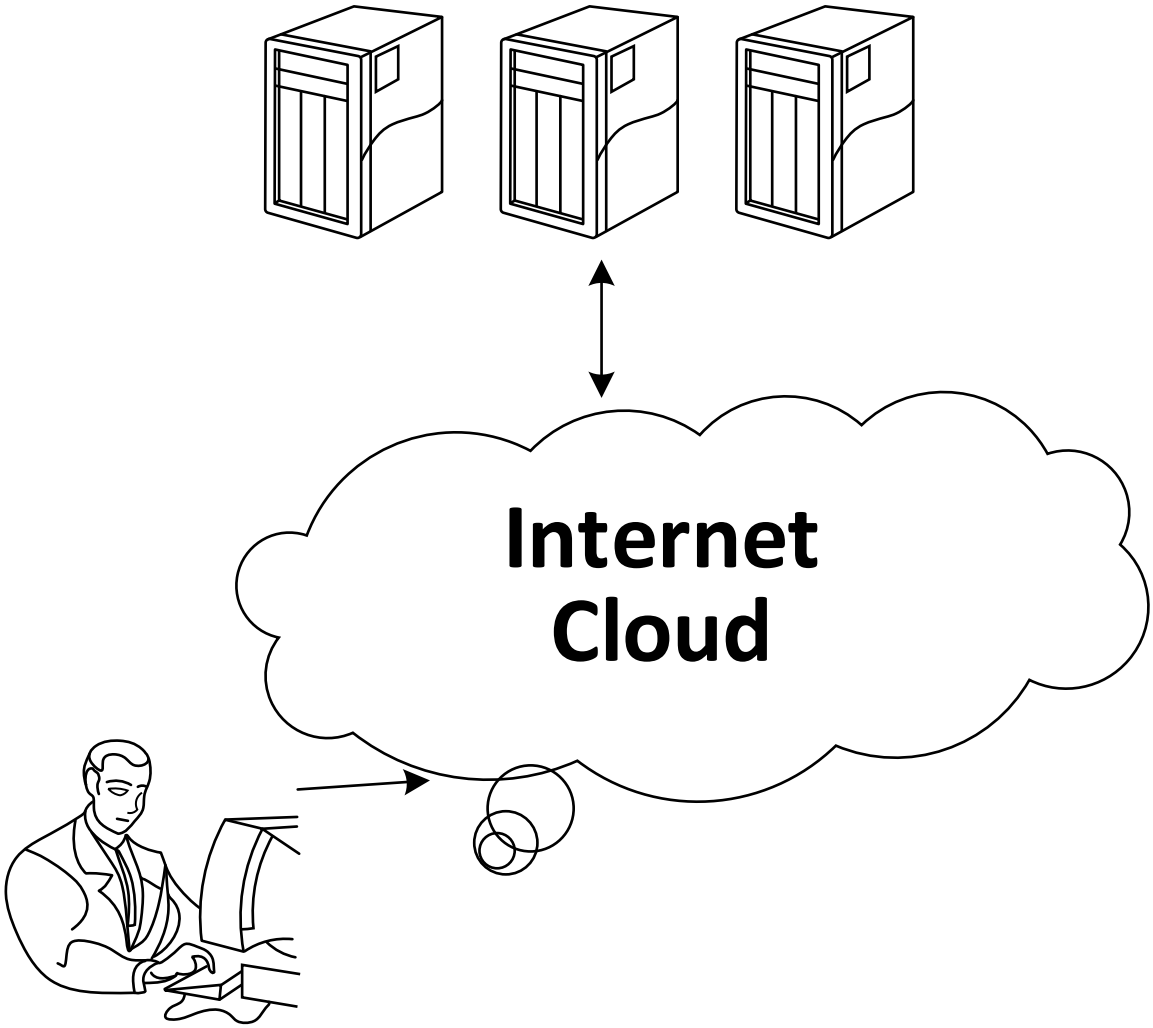


FIG. 7

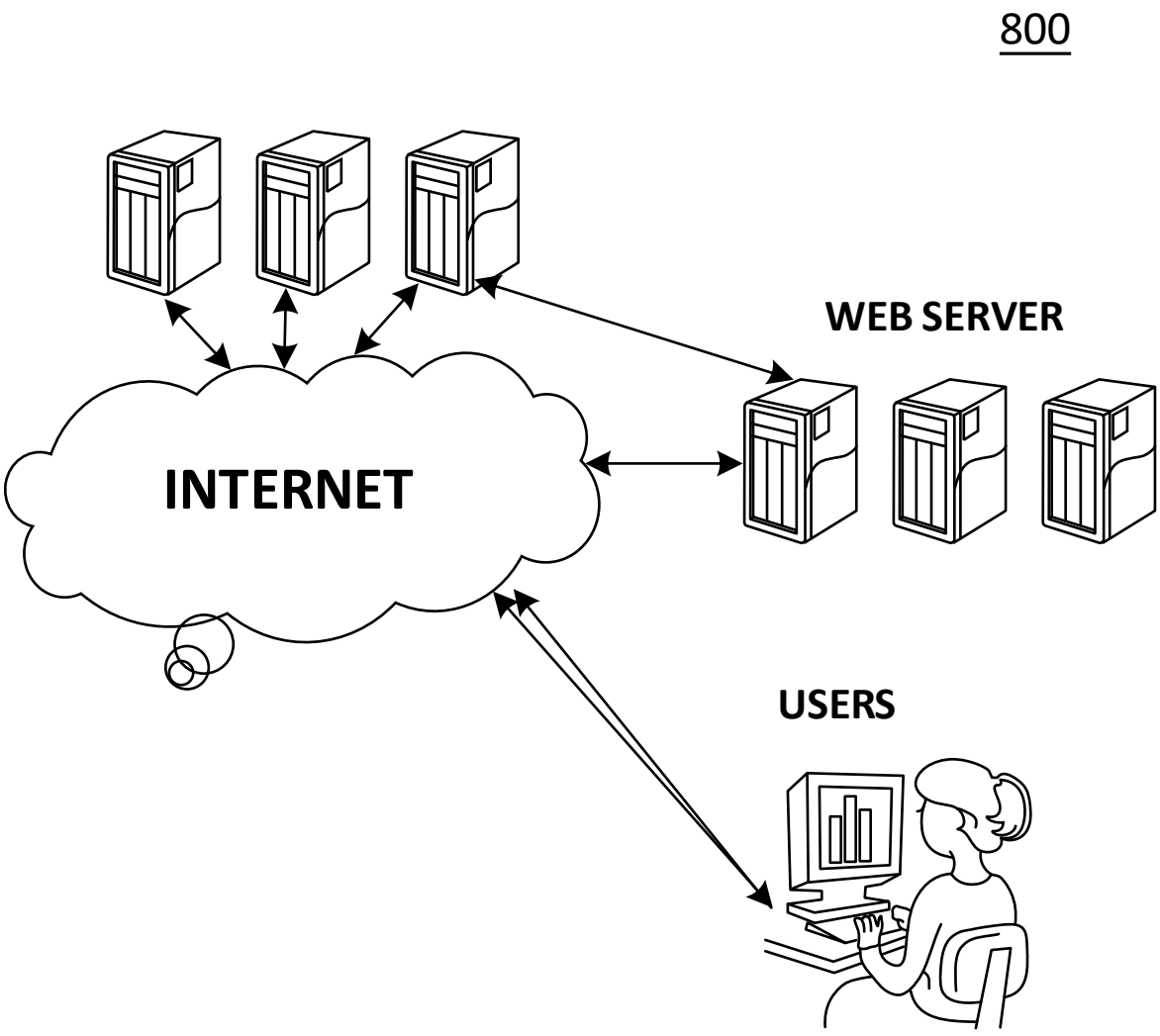


FIG. 8

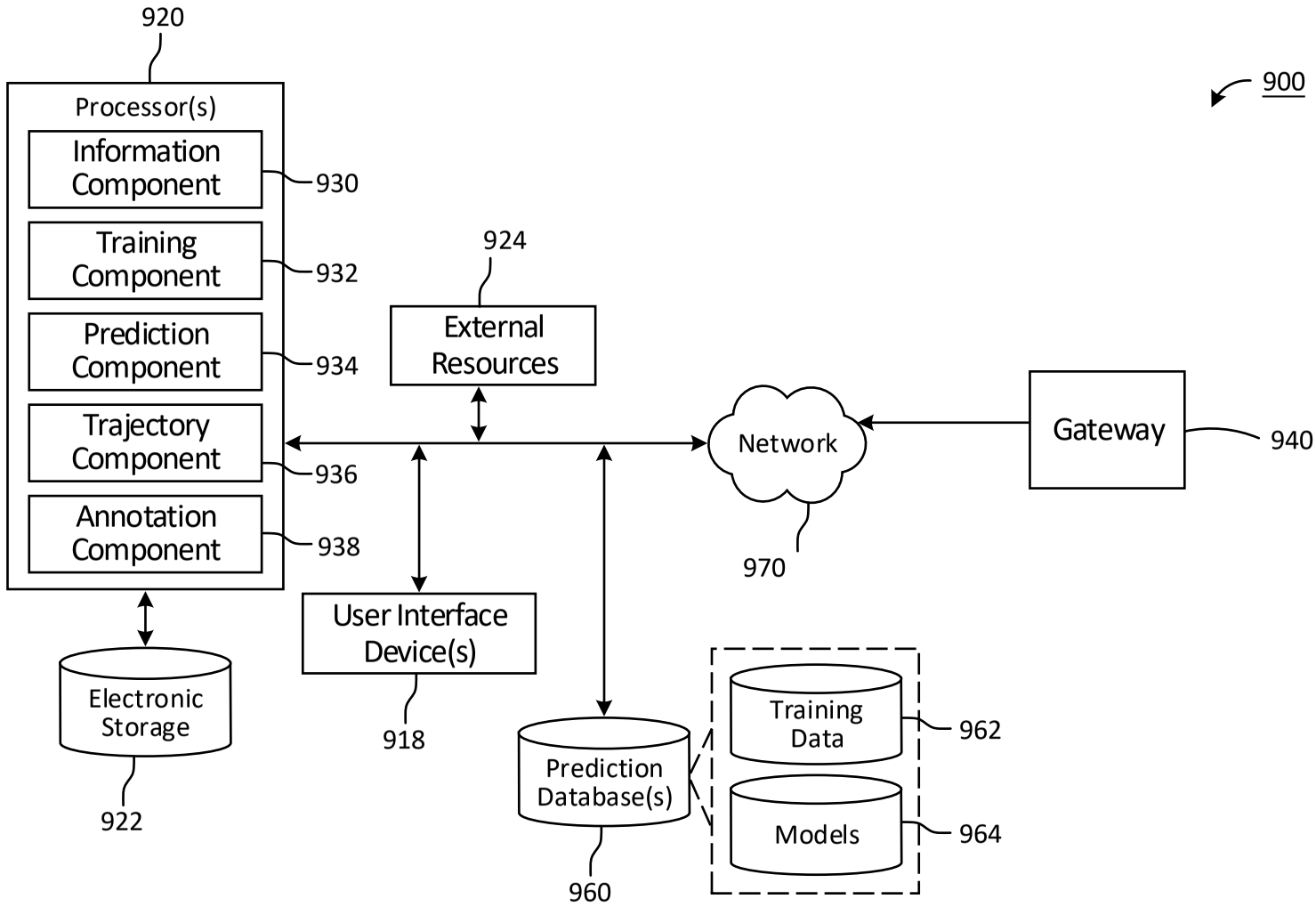

920
Processor(s)
Information Component
930
Training Component
932
Prediction Component
934
Trajectory Component
936
Annotation Component
938
924
External Resources
Network
970
Gateway
940
900
User Interface Device(s)
918
Electronic Storage
922
Prediction Database(s)
960
Training Data
962
Models
964

FIG. 9