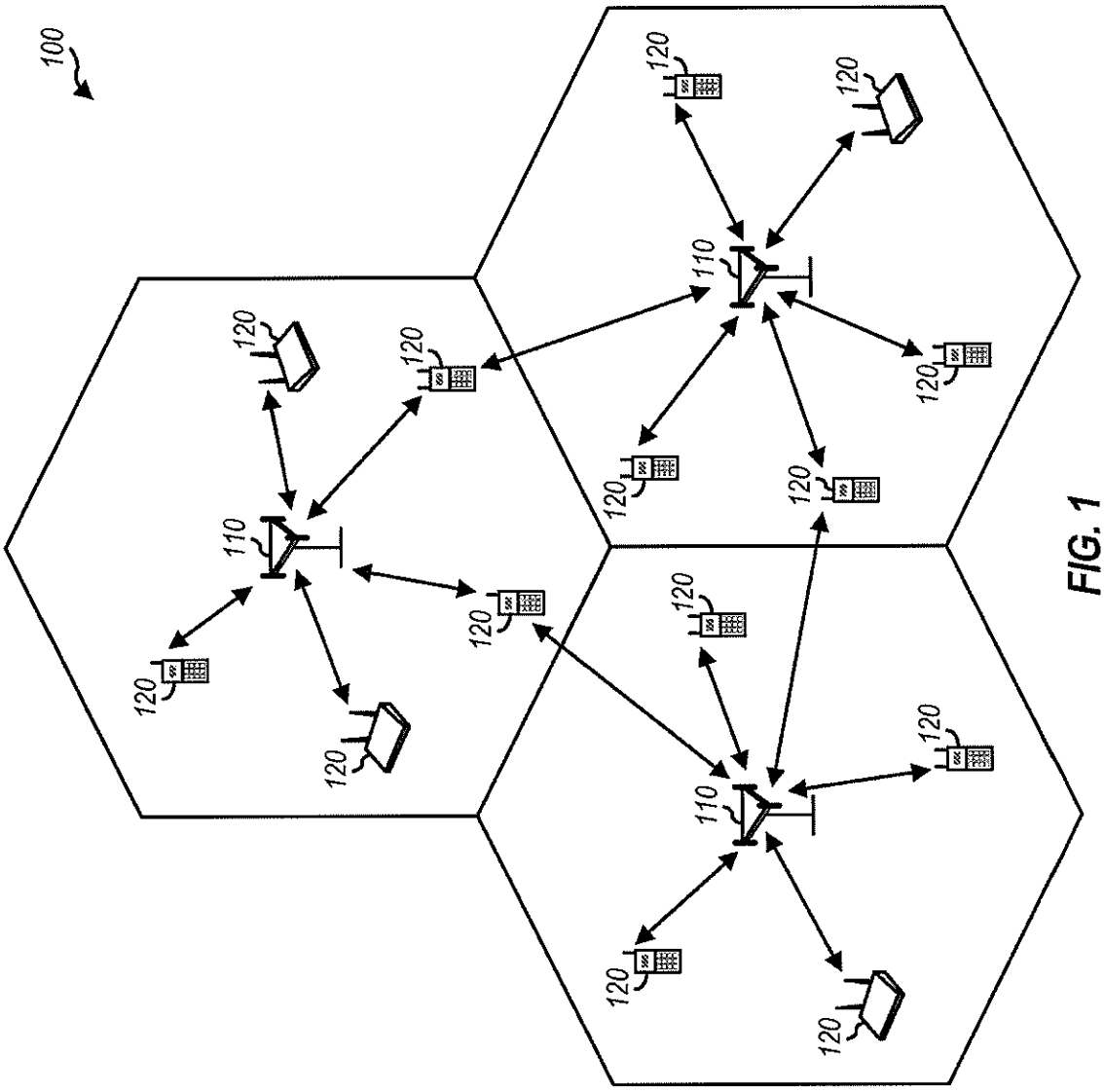


FIG. 1

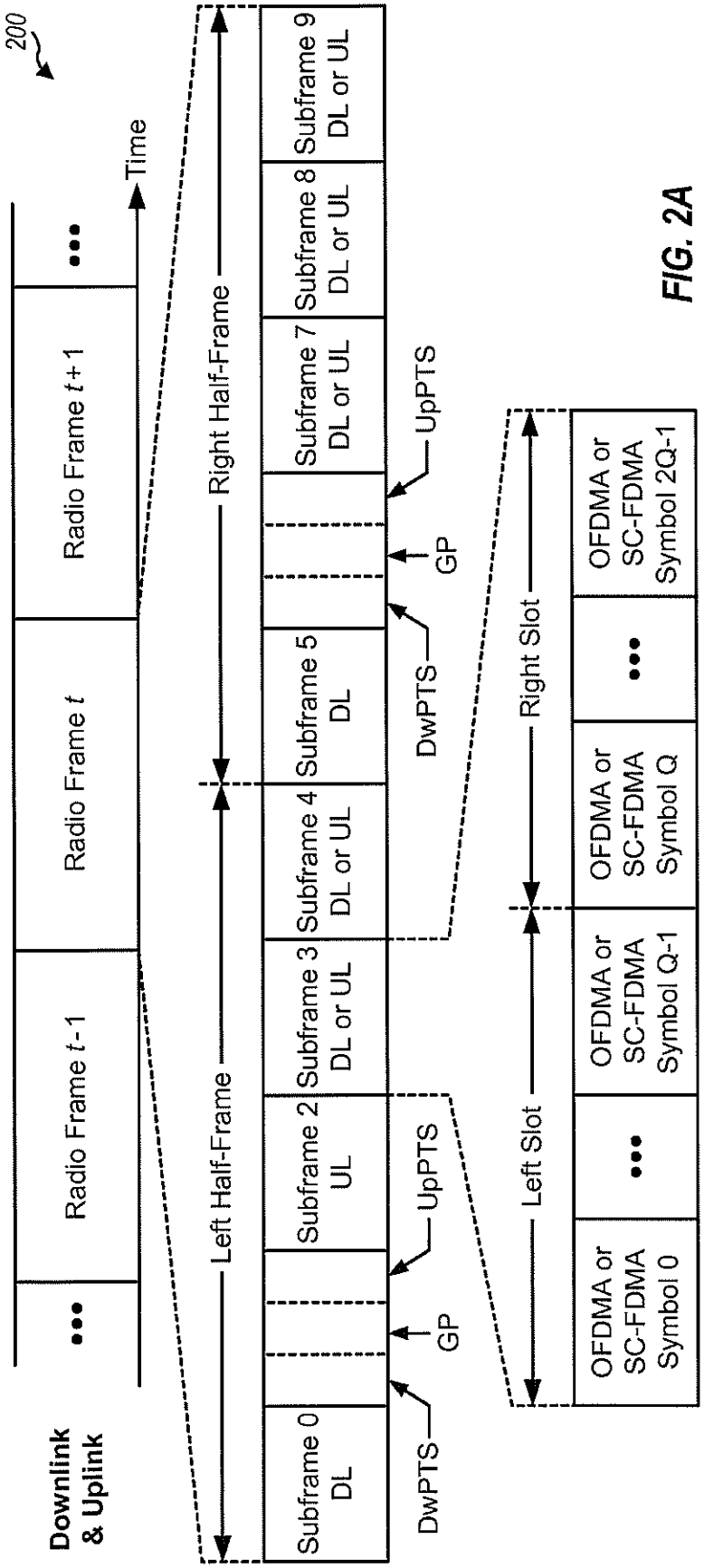

200
Downlink & Uplink
Time
Radio Frame t - 1
Radio Frame t
Radio Frame t + 1
Left Half-Frame
Right Half-Frame
Subframe 0 DL
DwPTS
GP
Subframe 2 UL
UpPTS
Subframe 3 DL or UL
Subframe 4 DL or UL
Subframe 5 DL
DwPTS
GP
UpPTS
Subframe 7 DL or UL
Subframe 8 DL or UL
Subframe 9 DL or UL
Left Slot
Right Slot
OFDMA or SC-FDMA Symbol 0
OFDMA or SC-FDMA Symbol Q-1
OFDMA or SC-FDMA Symbol Q
OFDMA or SC-FDMA Symbol 2Q-1

FIG. 2A

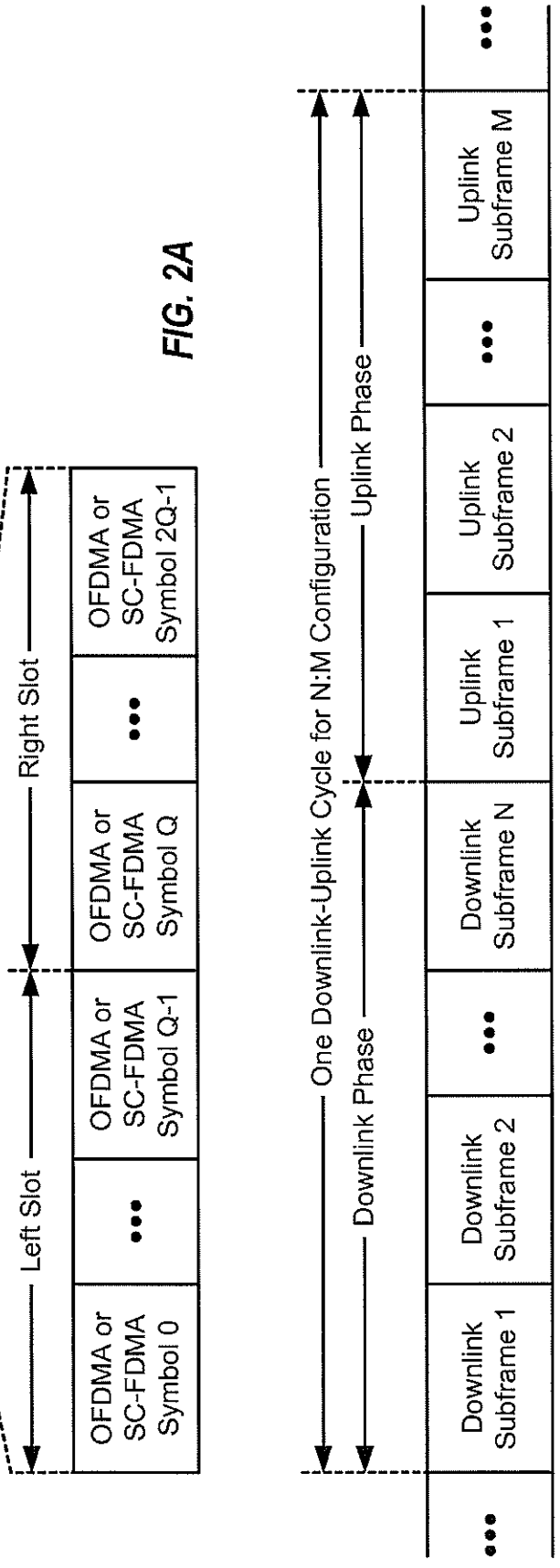

One Downlink-Uplink Cycle for N:M Configuration
Downlink Phase
Uplink Phase
Downlink Subframe 1
Downlink Subframe 2
Downlink Subframe N
Uplink Subframe 1
Uplink Subframe 2
Uplink Subframe M

FIG. 2B

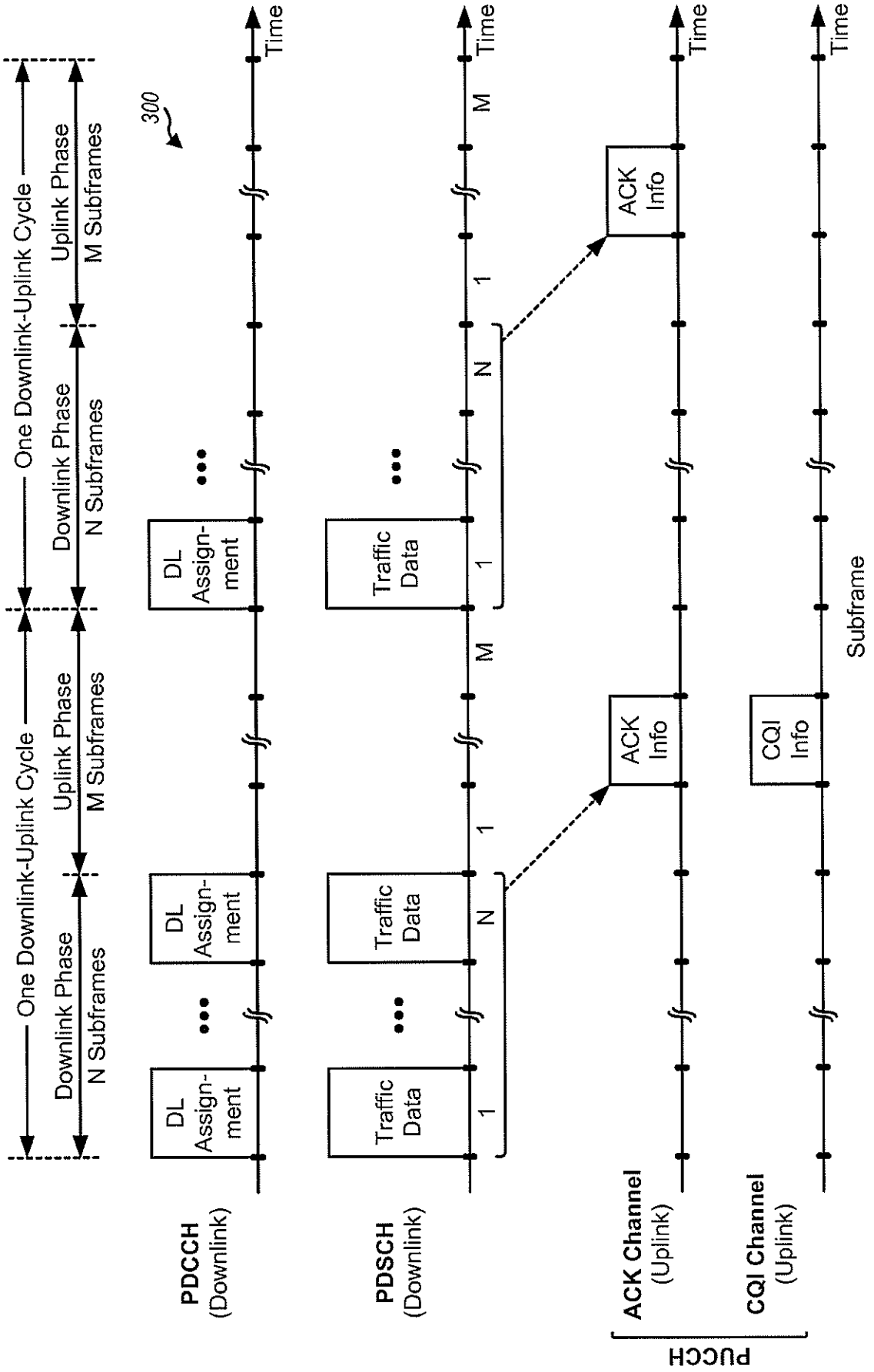

One Downlink-Uplink Cycle
Downlink Phase
N Subframes
Uplink Phase
M Subframes
300
PDCCH
(Downlink)
DL
Assign-
ment
PDSCH
(Downlink)
Traffic
Data
N
1
M
ACK Channel
(Uplink)
CQI Channel
(Uplink)
PUCCH
ACK
Info
CQI
Info
Time
Subframe

FIG. 3

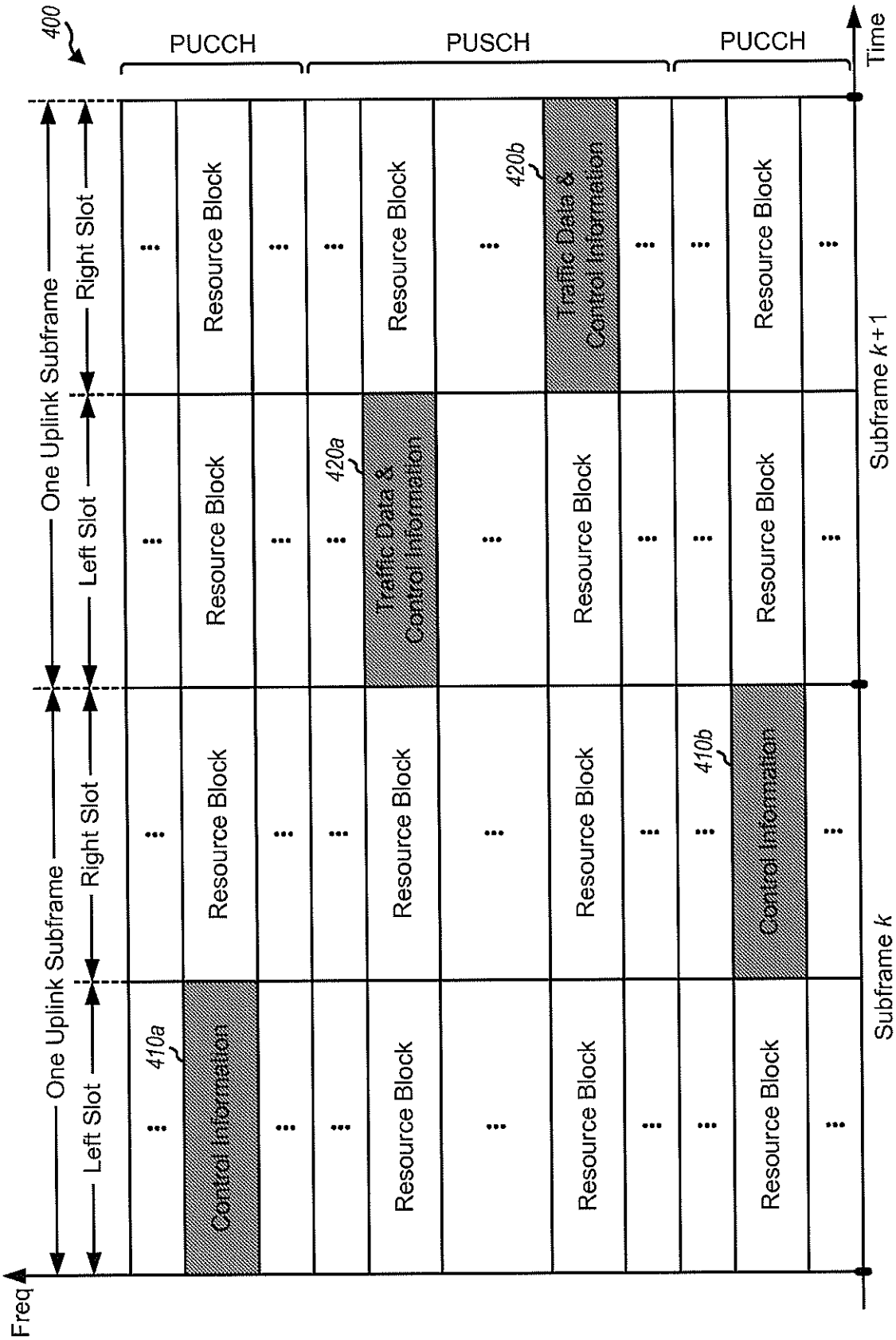

400
PUCCH
PUSCH
PUCCH
Time
Freq
One Uplink Subframe
Left Slot
Right Slot
Resource Block
Control Information
Traffic Data & Control Information
410a
410b
420a
420b
Subframe k
Subframe k+1

FIG. 4

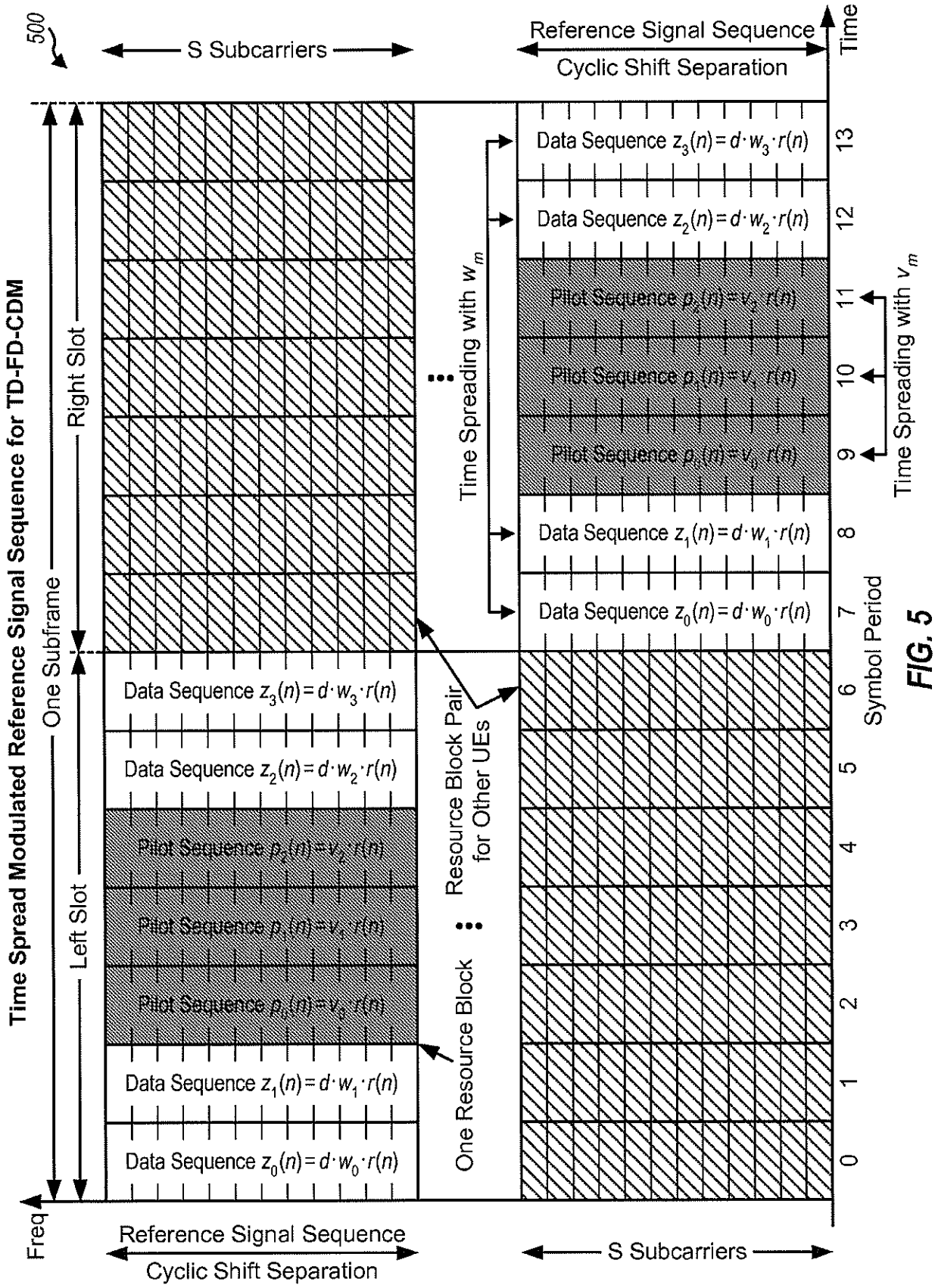

500
S Subcarriers
Reference Signal Sequence
Cyclic Shift Separation
Time
Time Spread Modulated Reference Signal Sequence for TD-FD-CDM
One Subframe
Right Slot
Left Slot
Data Sequence $z_3(n) = d \cdot w_3 \cdot r(n)$
Data Sequence $z_2(n) = d \cdot w_2 \cdot r(n)$
Pilot Sequence $p_2(n) = v_2 \cdot r(n)$
Pilot Sequence $p_1(n) = v_1 \cdot r(n)$
Pilot Sequence $p_0(n) = v_0 \cdot r(n)$
Data Sequence $z_1(n) = d \cdot w_1 \cdot r(n)$
Data Sequence $z_0(n) = d \cdot w_0 \cdot r(n)$
Time Spreading with w_m
Time Spreading with v_m
Resource Block Pair for Other UEs
One Resource Block
Symbol Period
0 1 2 3 4 5 6 7 8 9 10 11 12 13
Freq
Reference Signal Sequence
Cyclic Shift Separation
S Subcarriers

FIG. 5

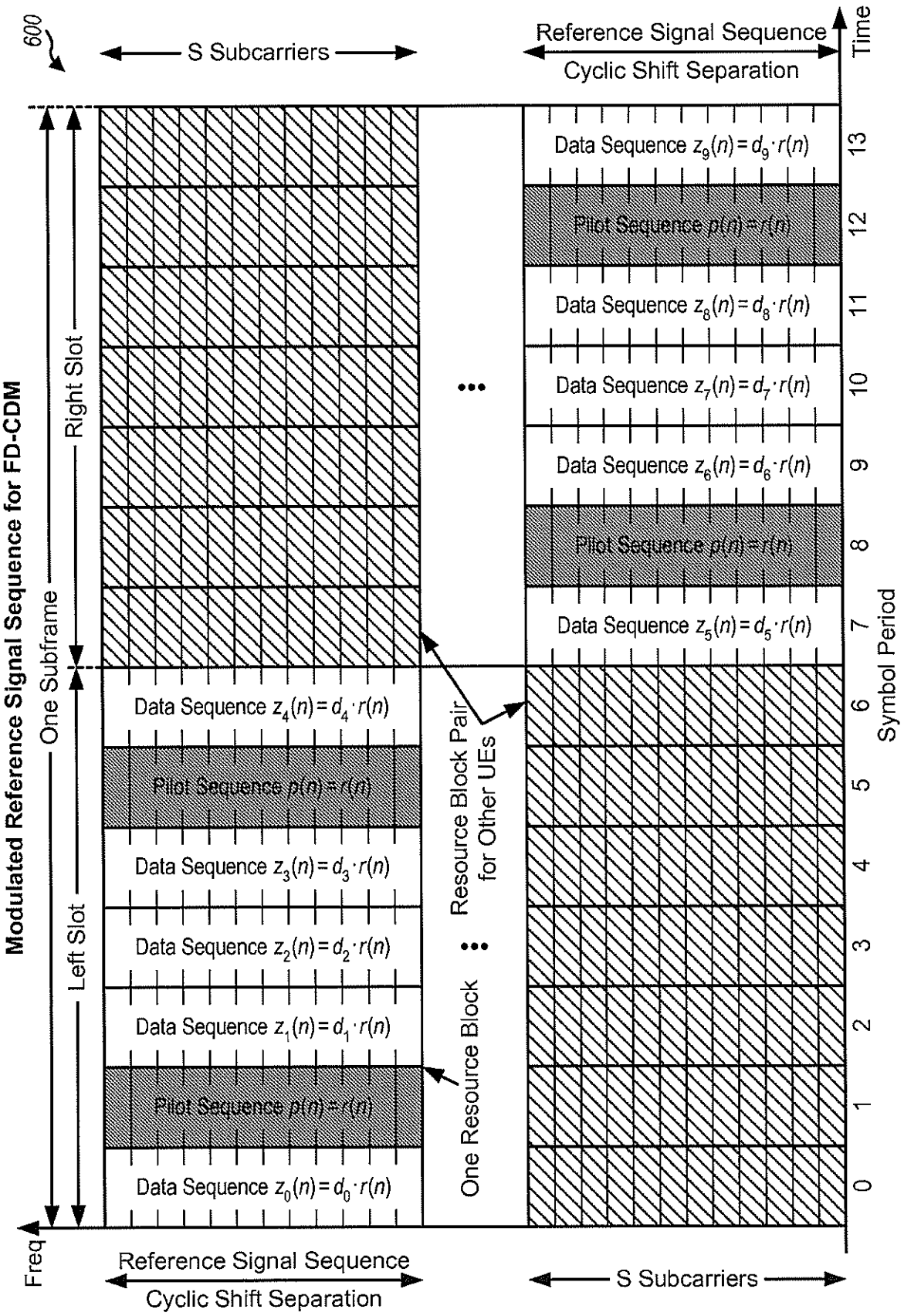

600
S Subcarriers
Reference Signal Sequence
Cyclic Shift Separation
Time
Modulated Reference Signal Sequence for FD-CDM
One Subframe
Right Slot
Left Slot
Data Sequence $z_9(n) = d_9 \cdot r(n)$
Pilot Sequence $p(n) = r(n)$
Data Sequence $z_8(n) = d_8 \cdot r(n)$
Data Sequence $z_7(n) = d_7 \cdot r(n)$
Data Sequence $z_6(n) = d_6 \cdot r(n)$
Pilot Sequence $p(n) = r(n)$
Data Sequence $z_5(n) = d_5 \cdot r(n)$
Data Sequence $z_4(n) = d_4 \cdot r(n)$
Pilot Sequence $p(n) = r(n)$
Data Sequence $z_3(n) = d_3 \cdot r(n)$
Data Sequence $z_2(n) = d_2 \cdot r(n)$
Data Sequence $z_1(n) = d_1 \cdot r(n)$
Pilot Sequence $p(n) = r(n)$
Data Sequence $z_0(n) = d_0 \cdot r(n)$
Resource Block Pair for Other UEs
One Resource Block
Symbol Period
0 1 2 3 4 5 6 7 8 9 10 11 12 13
Freq
Reference Signal Sequence
Cyclic Shift Separation
S Subcarriers

FIG. 6

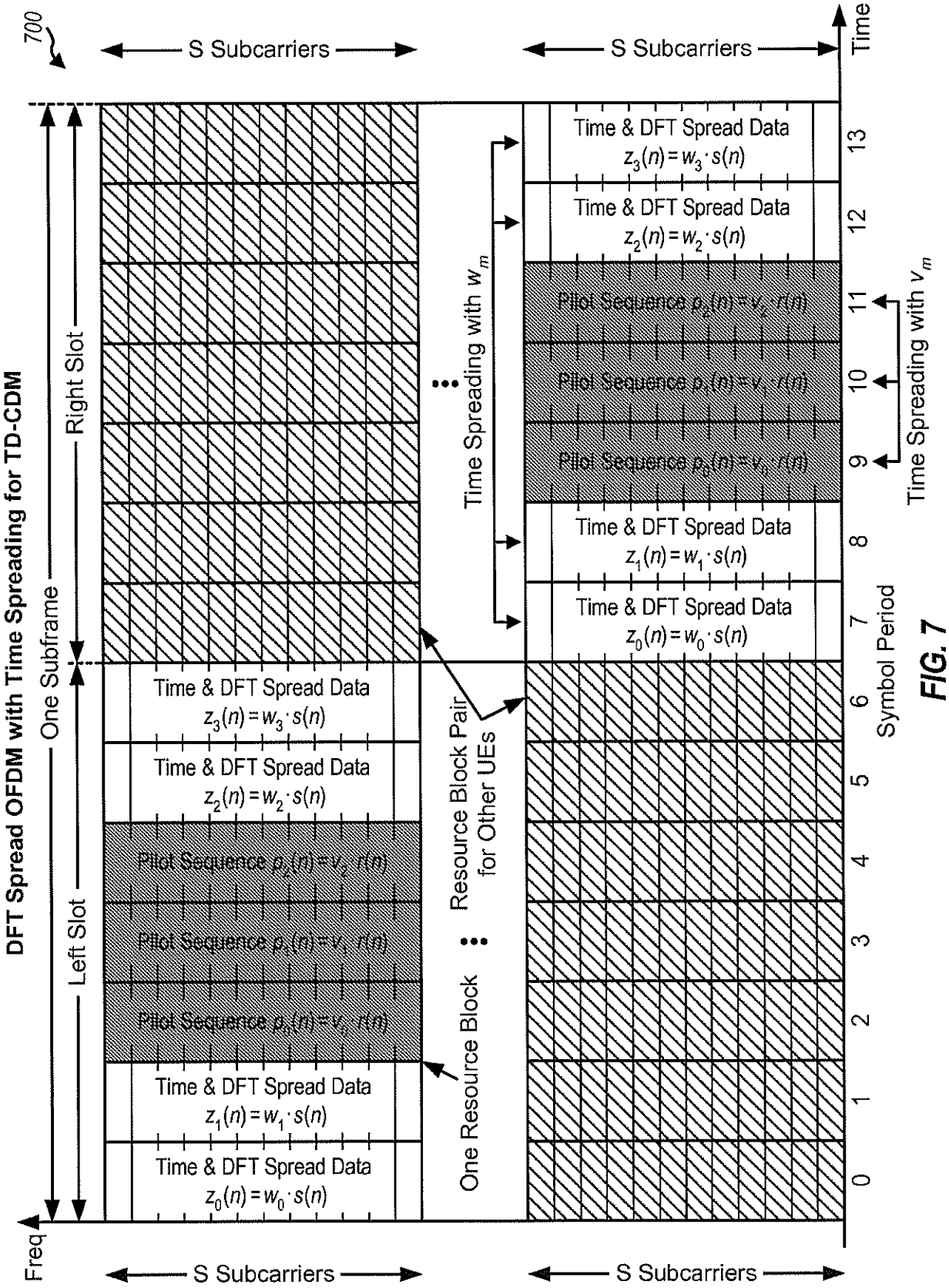

700
S Subcarriers
S Subcarriers
Time
DFT Spread OFDM with Time Spreading for TD-CDM
One Subframe
Right Slot
Left Slot
Time & DFT Spread Data $z_3(n) = w_3 \cdot s(n)$
Time & DFT Spread Data $z_2(n) = w_2 \cdot s(n)$
Pilot Sequence $p_2(n) = v_2 \cdot r(n)$
Pilot Sequence $p_1(n) = v_1 \cdot r(n)$
Pilot Sequence $p_0(n) = v_0 \cdot r(n)$
Time & DFT Spread Data $z_1(n) = w_1 \cdot s(n)$
Time & DFT Spread Data $z_0(n) = w_0 \cdot s(n)$
Time Spreading with w_m
Time Spreading with v_m
Resource Block Pair for Other UEs
One Resource Block
Symbol Period
0 1 2 3 4 5 6 7 8 9 10 11 12 13
Freq
S Subcarriers
S Subcarriers

FIG. 7

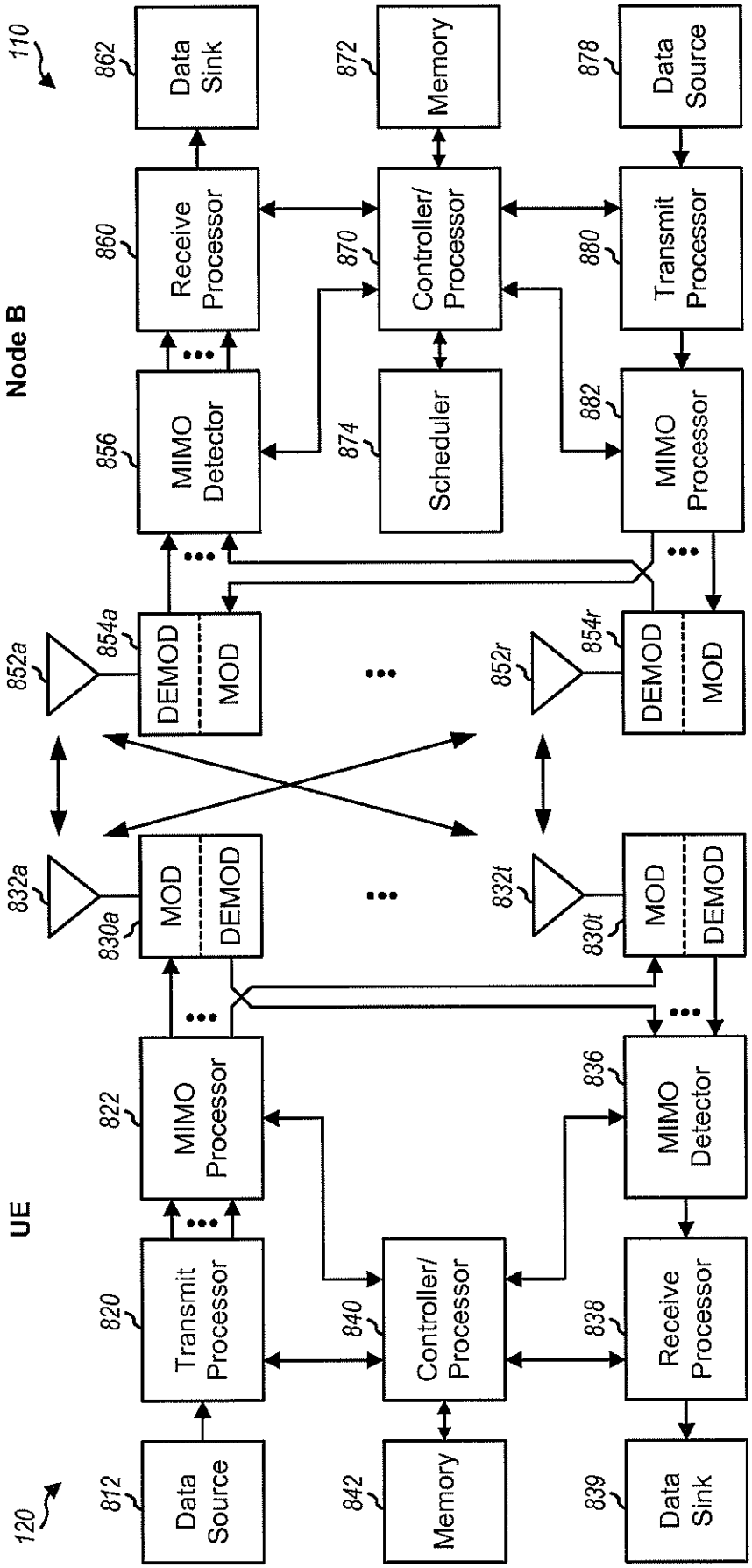

110
Node B
862
Data Sink
872
Memory
878
Data Source
860
Receive Processor
870
Controller/ Processor
880
Transmit Processor
856
MIMO Detector
874
Scheduler
882
MIMO Processor
852a
854a
DEMOD
MOD
852r
854r
DEMOD
MOD
832a
830a
MOD
DEMOD
832t
830t
MOD
DEMOD
UE
822
MIMO Processor
836
MIMO Detector
820
Transmit Processor
840
Controller/ Processor
838
Receive Processor
120
812
Data Source
842
Memory
839
Data Sink

FIG. 8

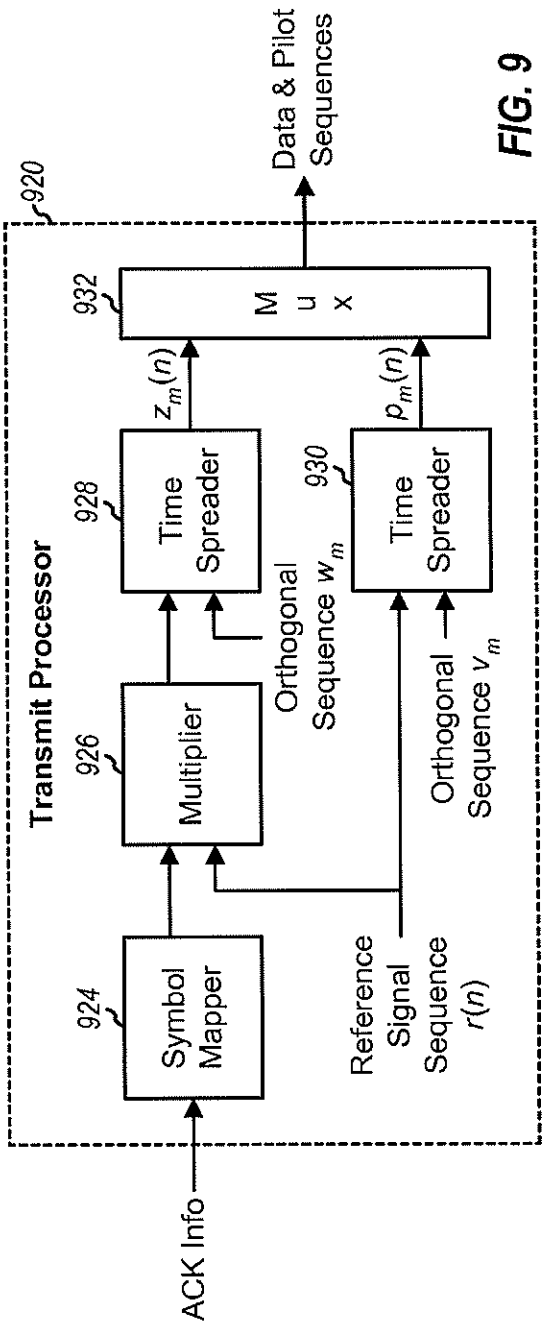

Transmit Processor
920
ACK Info
924
Symbol Mapper
926
Multiplier
928
Time Spreader
930
Time Spreader
932
M u x
Orthogonal Sequence w_m
Reference Signal Sequence $r(n)$
Orthogonal Sequence v_m
$z_m(n)$
$p_m(n)$
Data & Pilot Sequences

FIG. 9

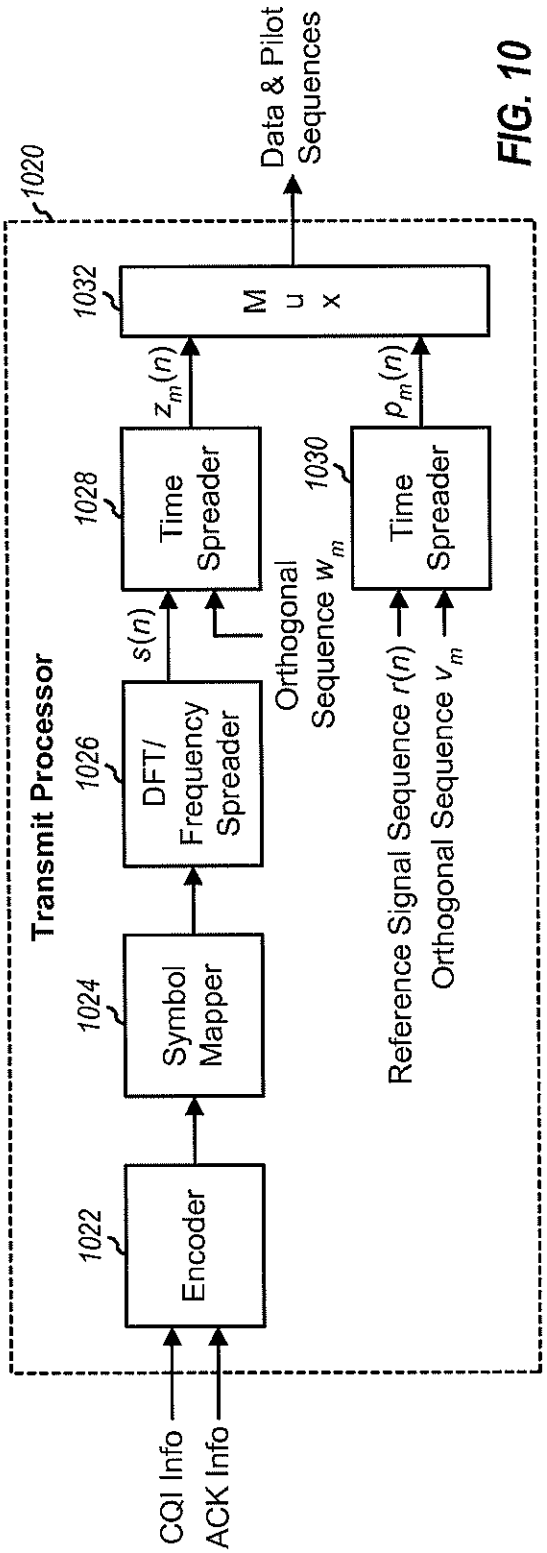

Transmit Processor
1020
CQI Info
ACK Info
1022
Encoder
1024
Symbol Mapper
1026
DFT/ Frequency Spreader
1028
Time Spreader
1030
Time Spreader
1032
M u x
$s(n)$
Orthogonal Sequence w_m
Reference Signal Sequence $r(n)$
Orthogonal Sequence v_m
$z_m(n)$
$p_m(n)$
Data & Pilot Sequences

FIG. 10

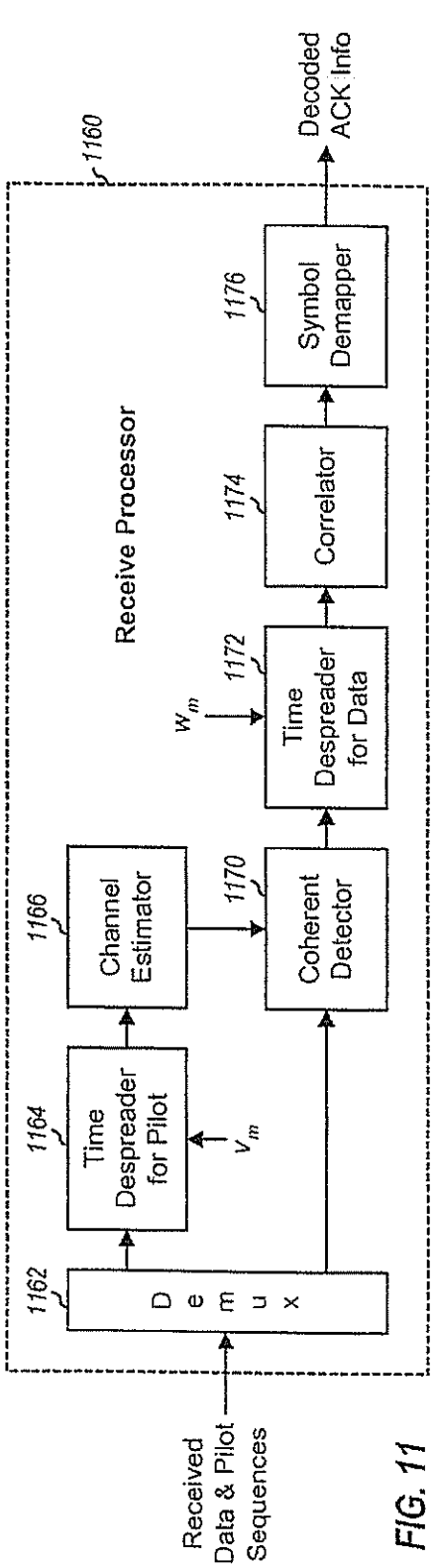

Received Data & Pilot Sequences
Receive Processor
1160
1162
Demux
1164
Time Despreader for Pilot
v_m
1166
Channel Estimator
1170
Coherent Detector
w_m
1172
Time Despreader for Data
1174
Correlator
1176
Symbol Demapper
Decoded ACK Info

FIG. 11

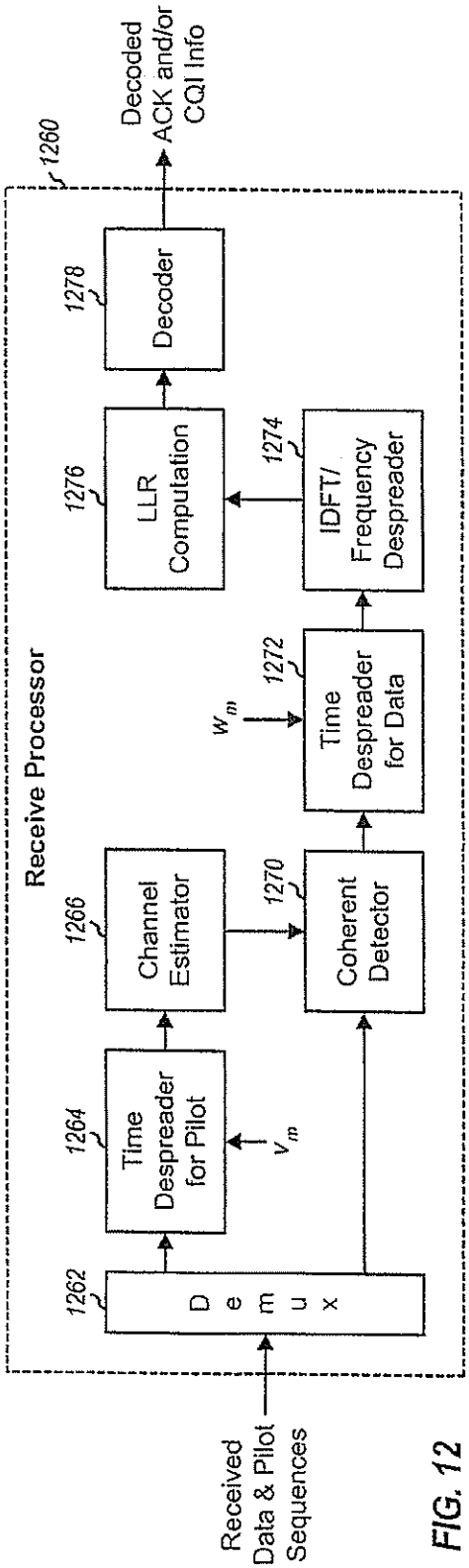

Received Data & Pilot Sequences
Receive Processor
1260
1262
Demux
1264
Time Despreader for Pilot
v_m
1266
Channel Estimator
1270
Coherent Detector
w_m
1272
Time Despreader for Data
1274
IDFT/ Frequency Despreader
1276
LLR Computation
1278
Decoder
Decoded ACK and/or CQI Info

FIG. 12

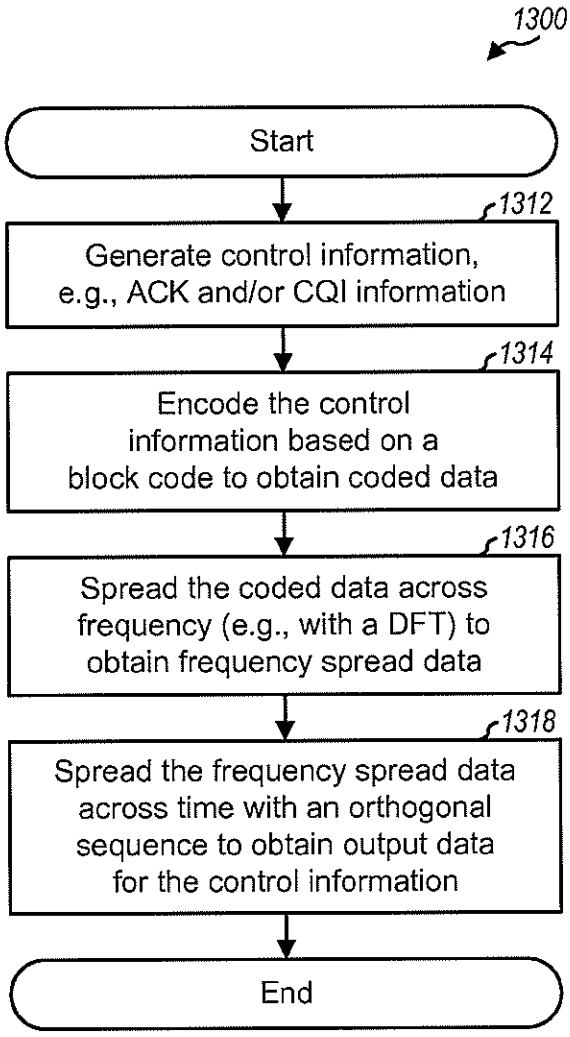

1300
Start
1312
Generate control information, e.g., ACK and/or CQI information
1314
Encode the control information based on a block code to obtain coded data
1316
Spread the coded data across frequency (e.g., with a DFT) to obtain frequency spread data
1318
Spread the frequency spread data across time with an orthogonal sequence to obtain output data for the control information
End

FIG. 13

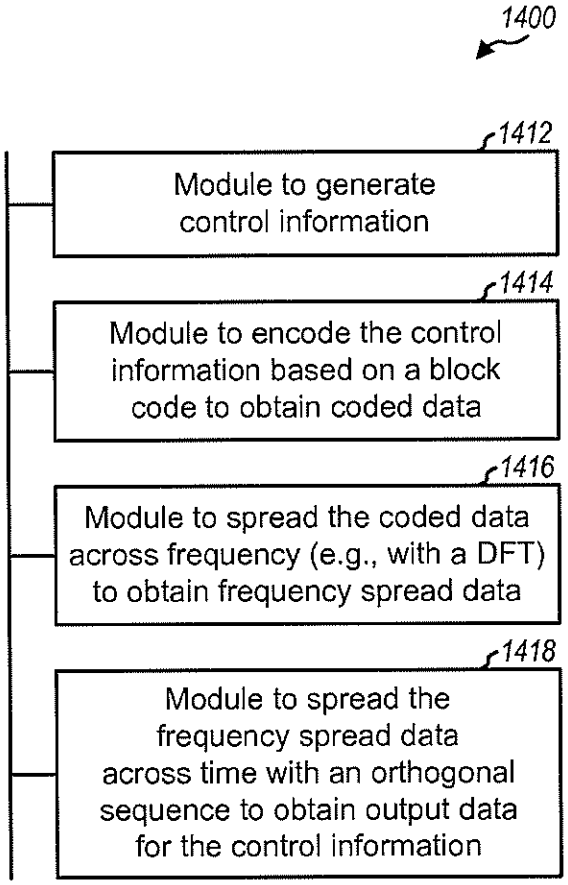

1400
1412
Module to generate control information
1414
Module to encode the control information based on a block code to obtain coded data
1416
Module to spread the coded data across frequency (e.g., with a DFT) to obtain frequency spread data
1418
Module to spread the frequency spread data across time with an orthogonal sequence to obtain output data for the control information

FIG. 14

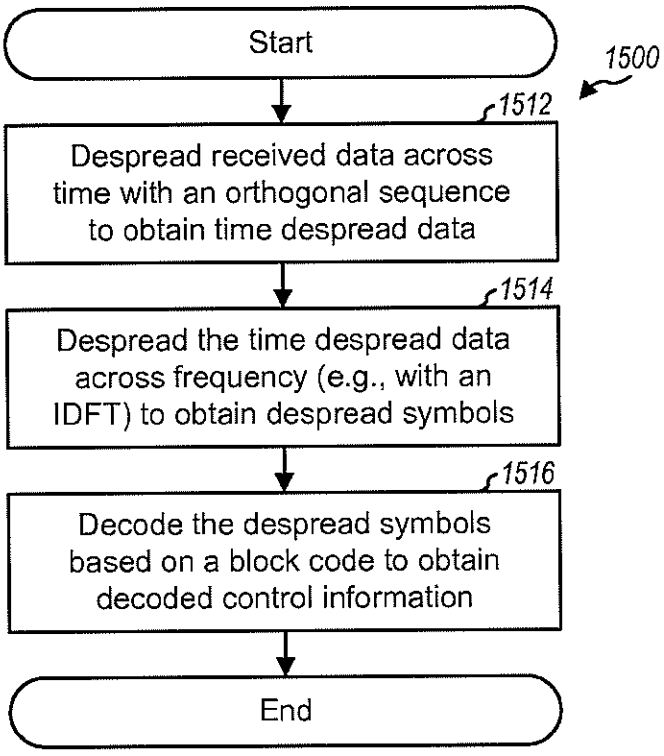


FIG. 15

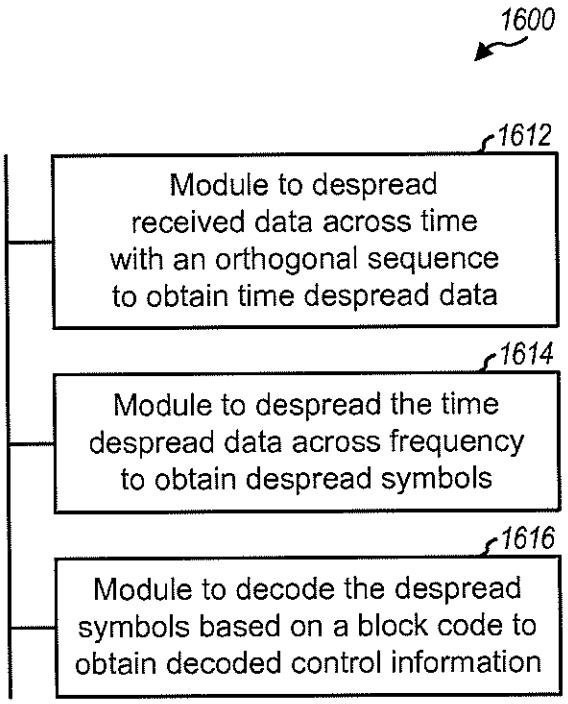


FIG. 16

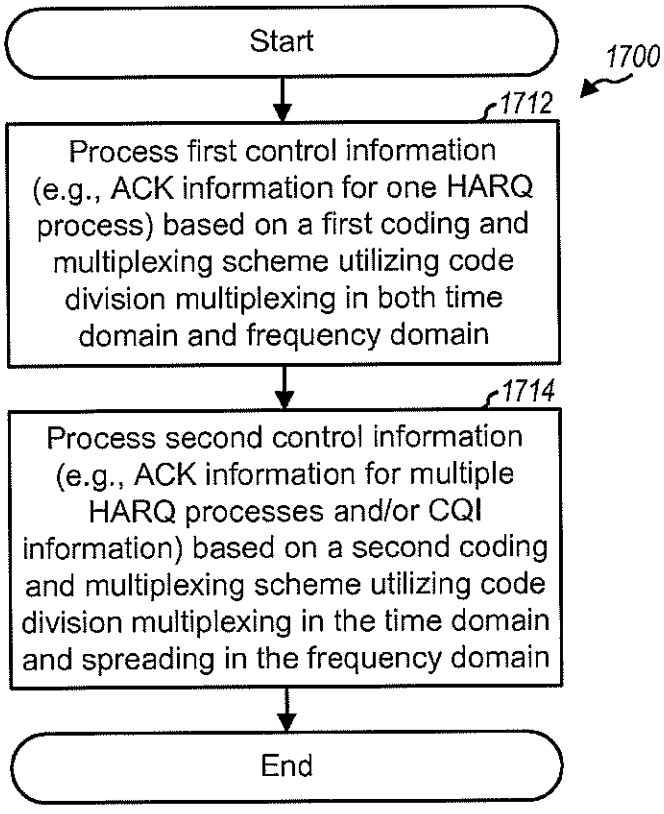


FIG. 17

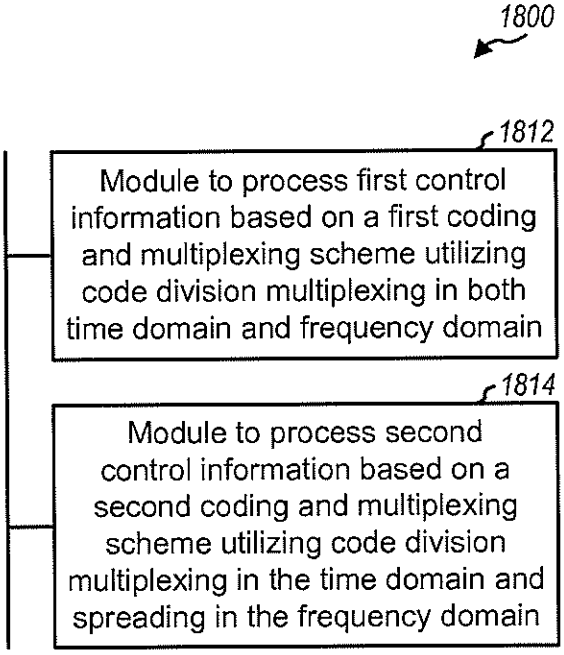


FIG. 18

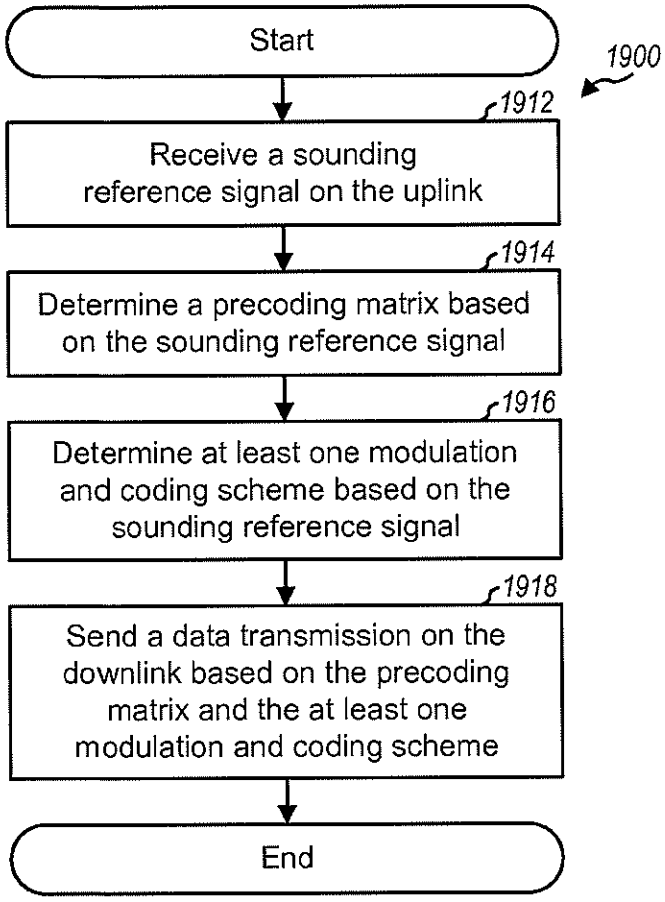


FIG. 19

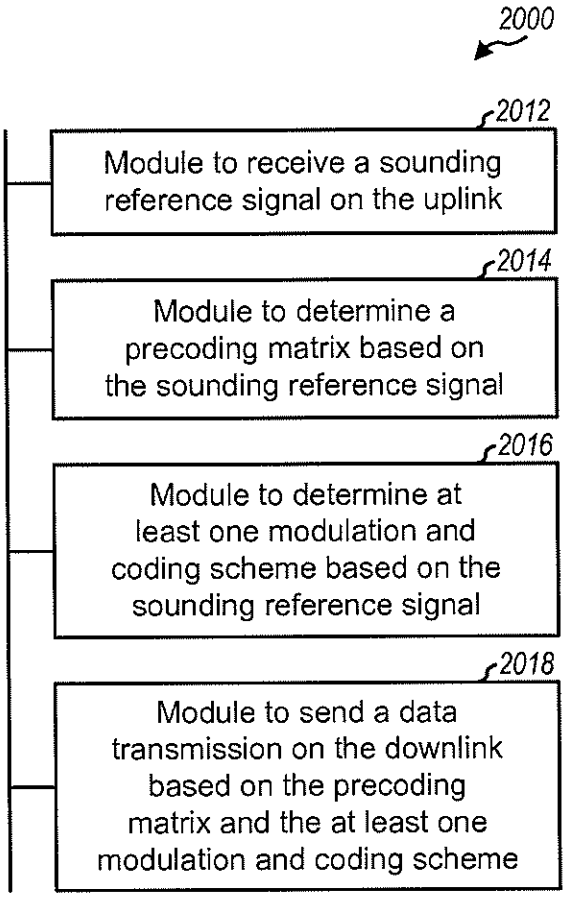


FIG. 20

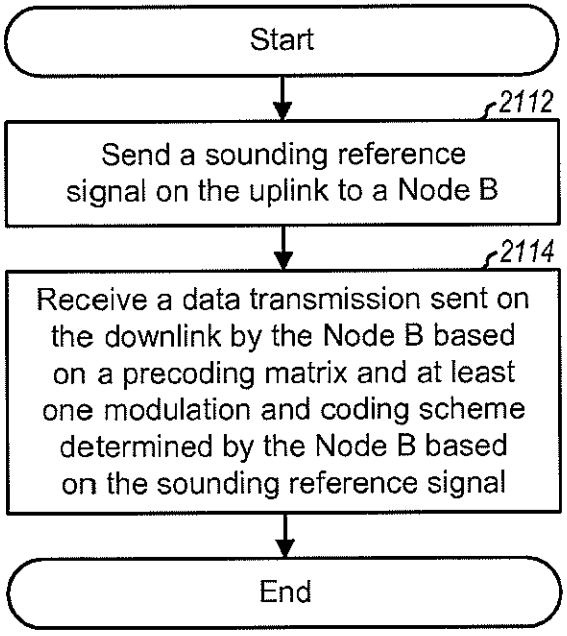


FIG. 21

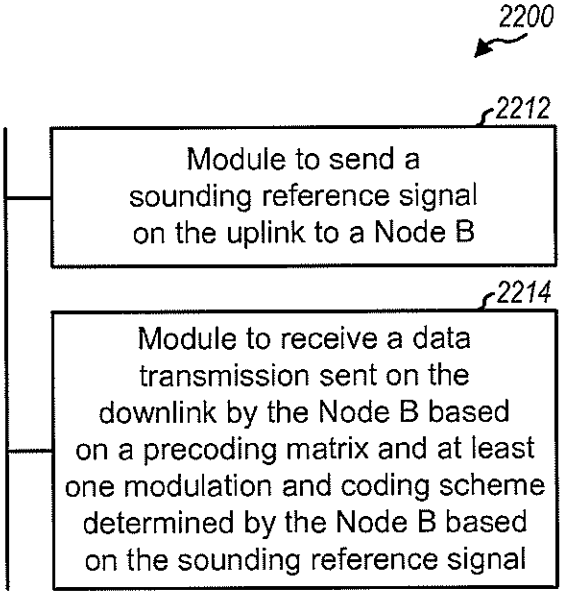


FIG. 22