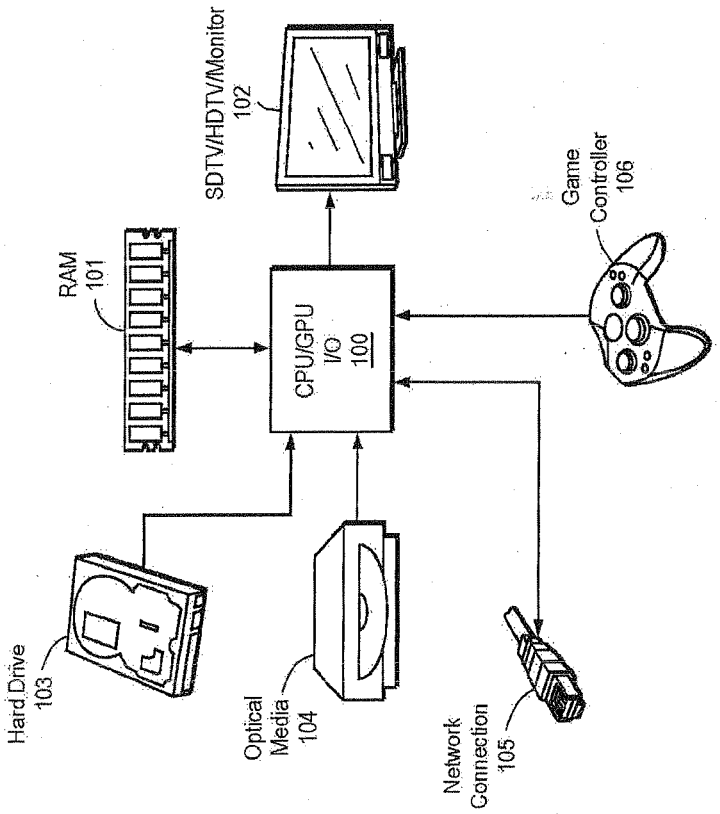


FIG. 1
(Prior Art)

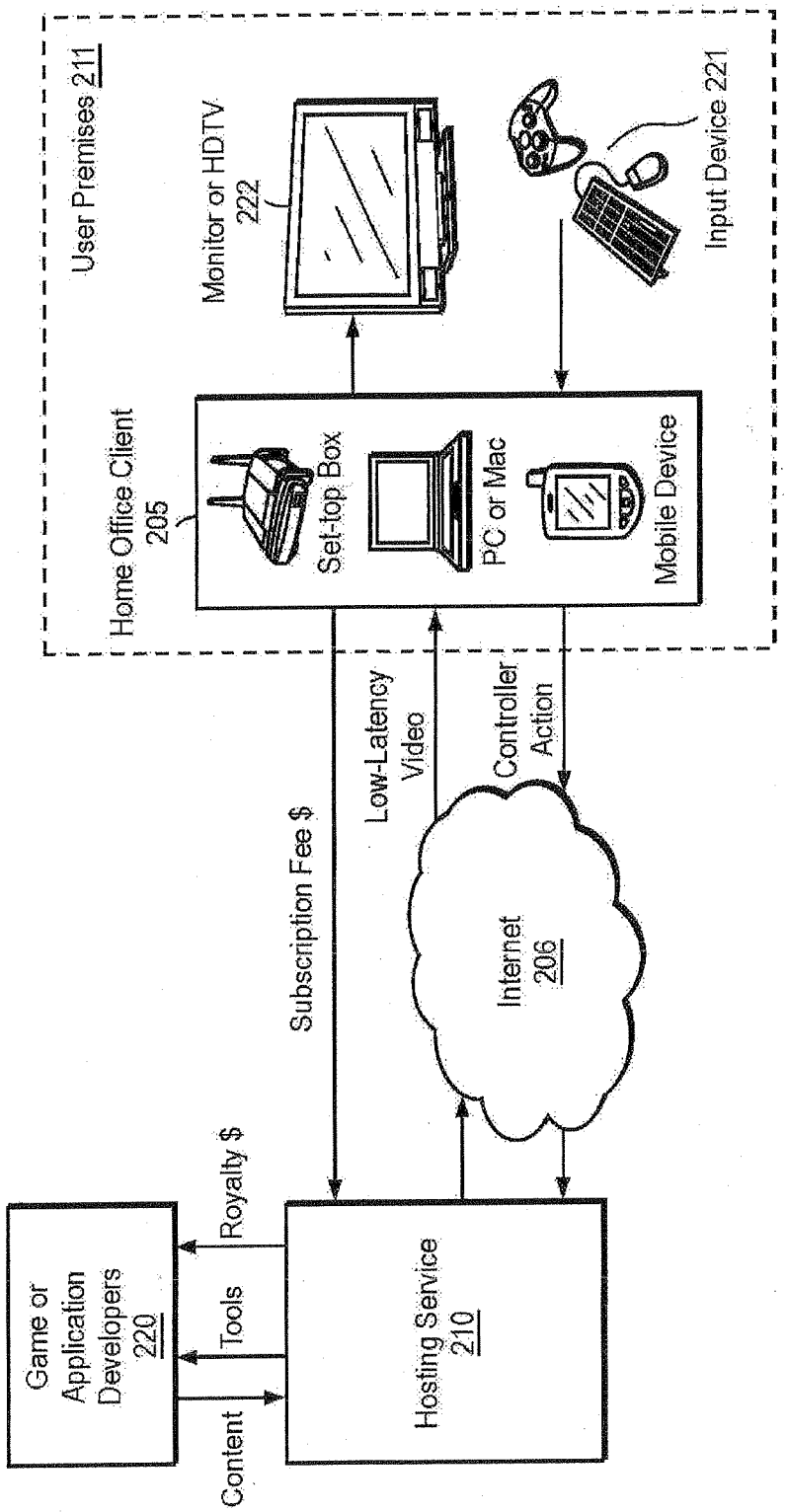

User Premises 211
Monitor or HDTV 222
Input Device 221
Home Office Client 205
Set-top Box
PC or Mac
Mobile Device
Subscription Fee $
Low-Latency Video
Controller Action
Internet 206
Royalty $
Tools
Content
Game or Application Developers 220
Hosting Service 210

FIG. 2a

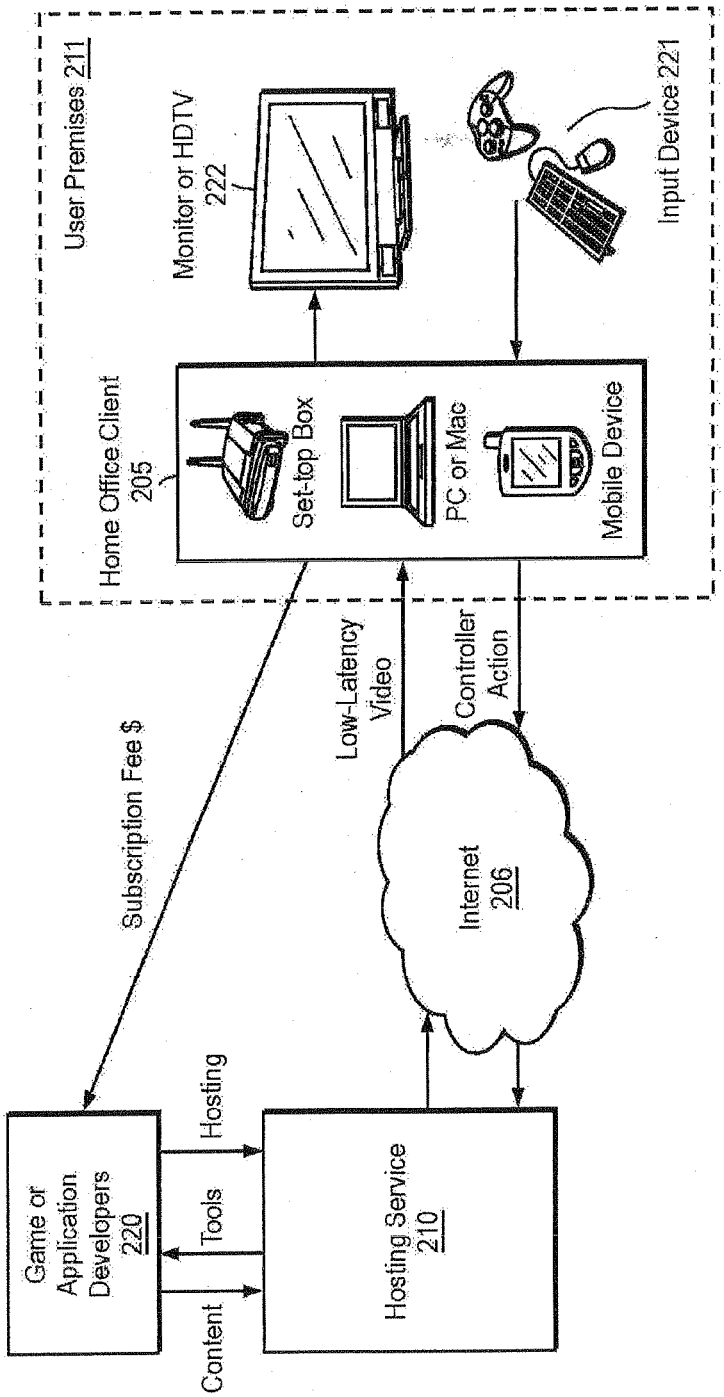

User Premises 211
Monitor or HDTV 222
Input Device 221
Home Office Client 205
Set-top Box
PC or Mac
Mobile Device
Subscription Fee $
Low-Latency Video
Controller Action
Internet 206
Hosting
Tools
Content
Game or Application Developers 220
Hosting Service 210

FIG. 2b

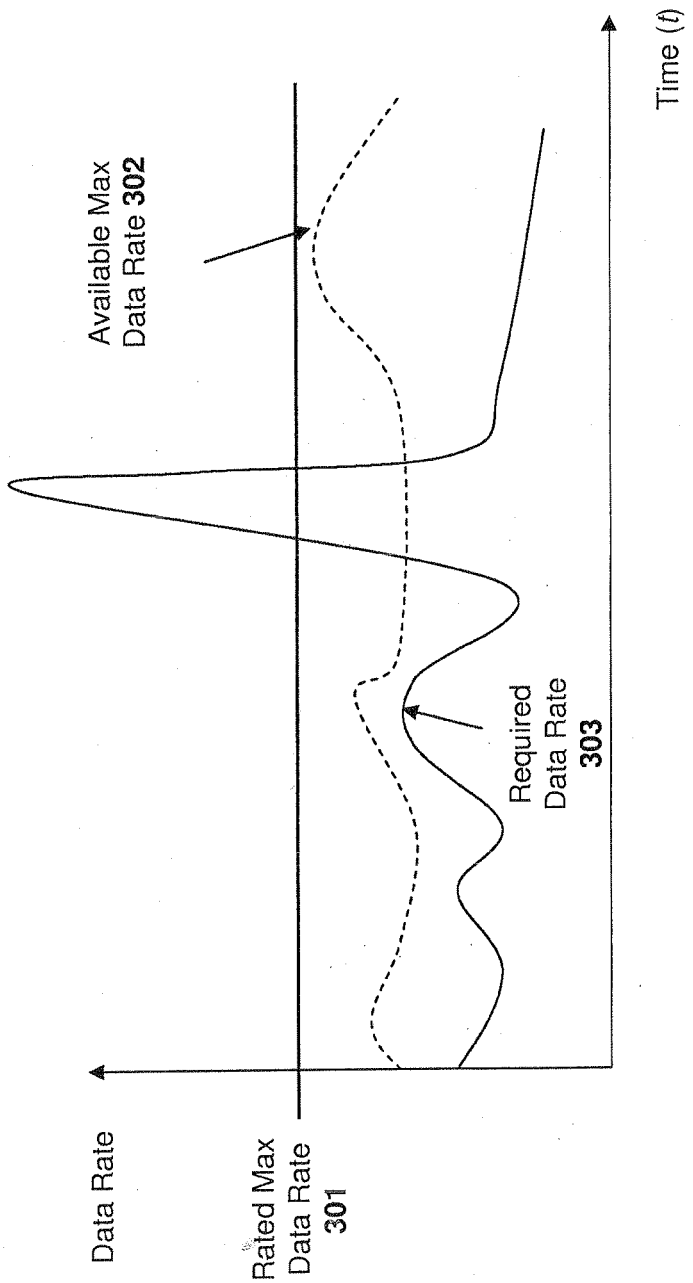

Data Rate
Time (t)
Rated Max Data Rate 301
Available Max Data Rate 302
Required Data Rate 303

Fig. 3

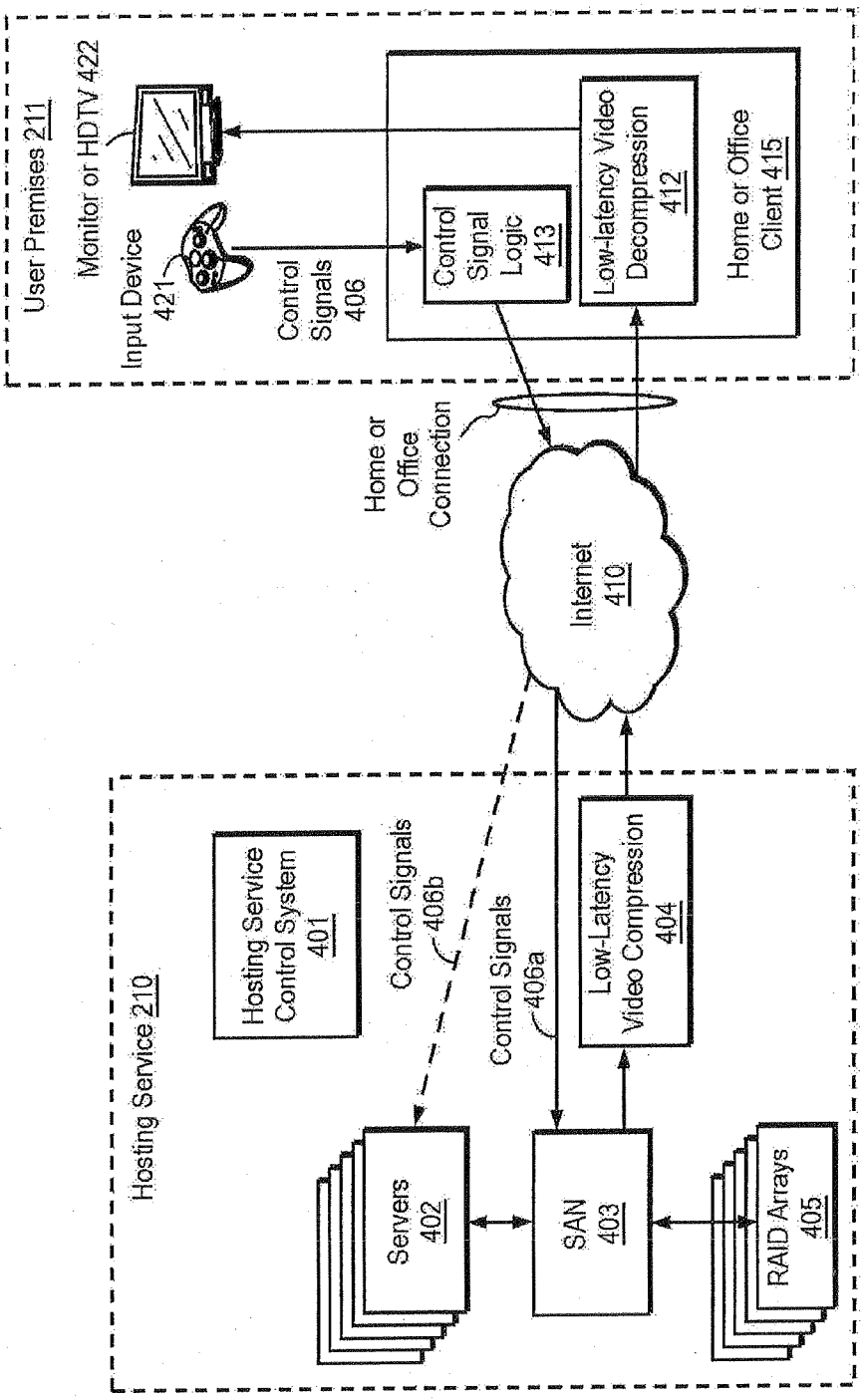

User Premises 211
Monitor or HDTV 422
Input Device 421
Control Signals 406
Control Signal Logic 413
Low-latency Video Decompression 412
Home or Office Client 415
Home or Office Connection
Internet 410
Hosting Service 210
Hosting Service Control System 401
Control Signals 406b
Control Signals 406a
Low-Latency Video Compression 404
Servers 402
SAN 403
RAID Arrays 405

FIG. 4a

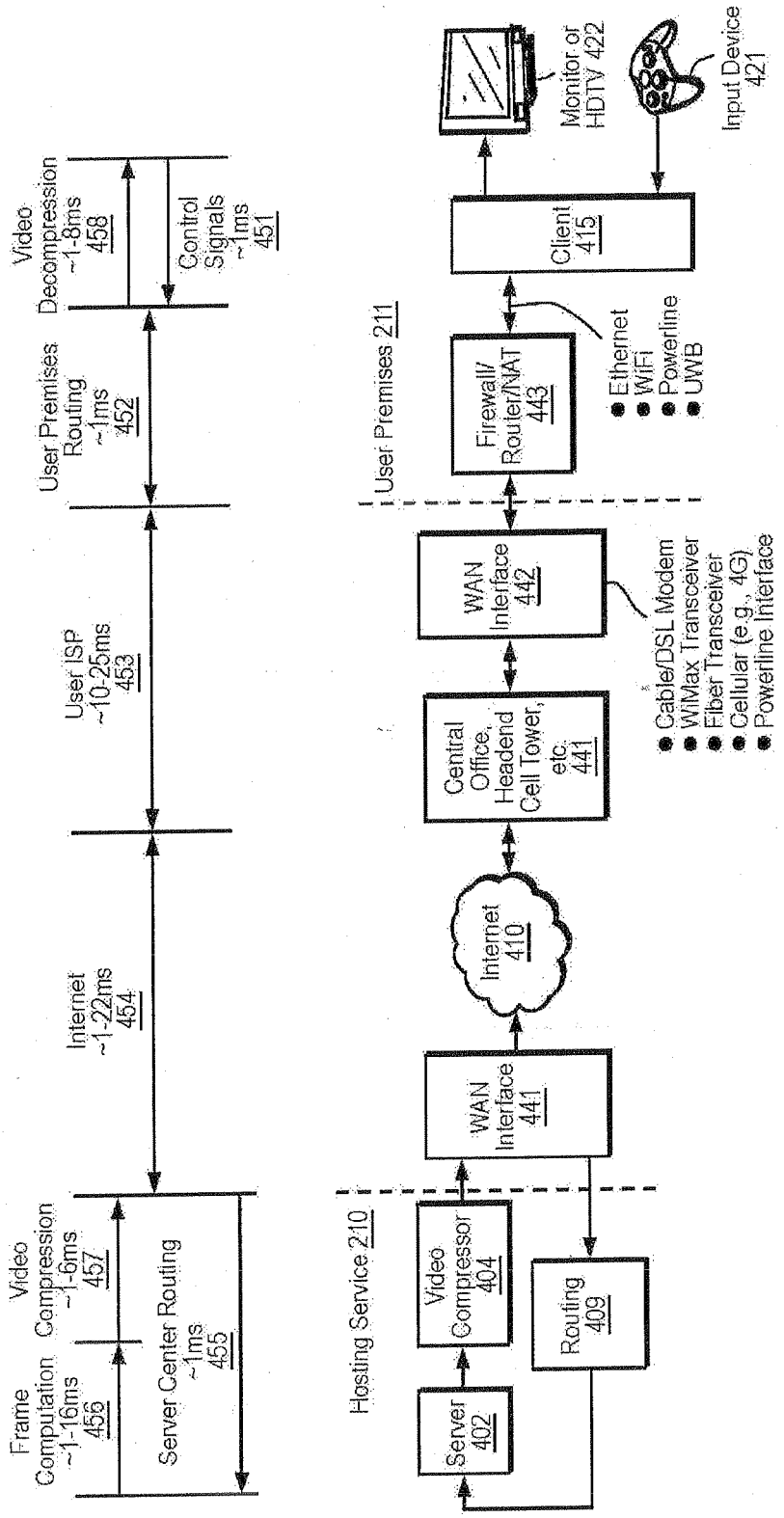

Hosting Service 210
Server 402
Video Compressor 404
Routing 409
WAN Interface 441
Internet 410
Central Office, Headend Cell Tower, etc. 441
WAN Interface 442
Cable/DSL Modem
WiMax Transceiver
Fiber Transceiver
Cellular (e.g., 4G)
Powerline Interface
User Premises 211
Firewall/ Router/NAT 443
Ethernet
WiFi
Powerline
UWB
Client 415
Monitor or HDTV 422
Input Device 421
Frame Computation ~1-16ms 456
Video Compression ~1-6ms 457
Server Center Routing ~1ms 455
Internet ~1-22ms 454
User ISP ~10-25ms 453
User Premises Routing ~1ms 452
Video Decompression ~1-8ms 458
Control Signals ~1ms 451

FIG. 4b

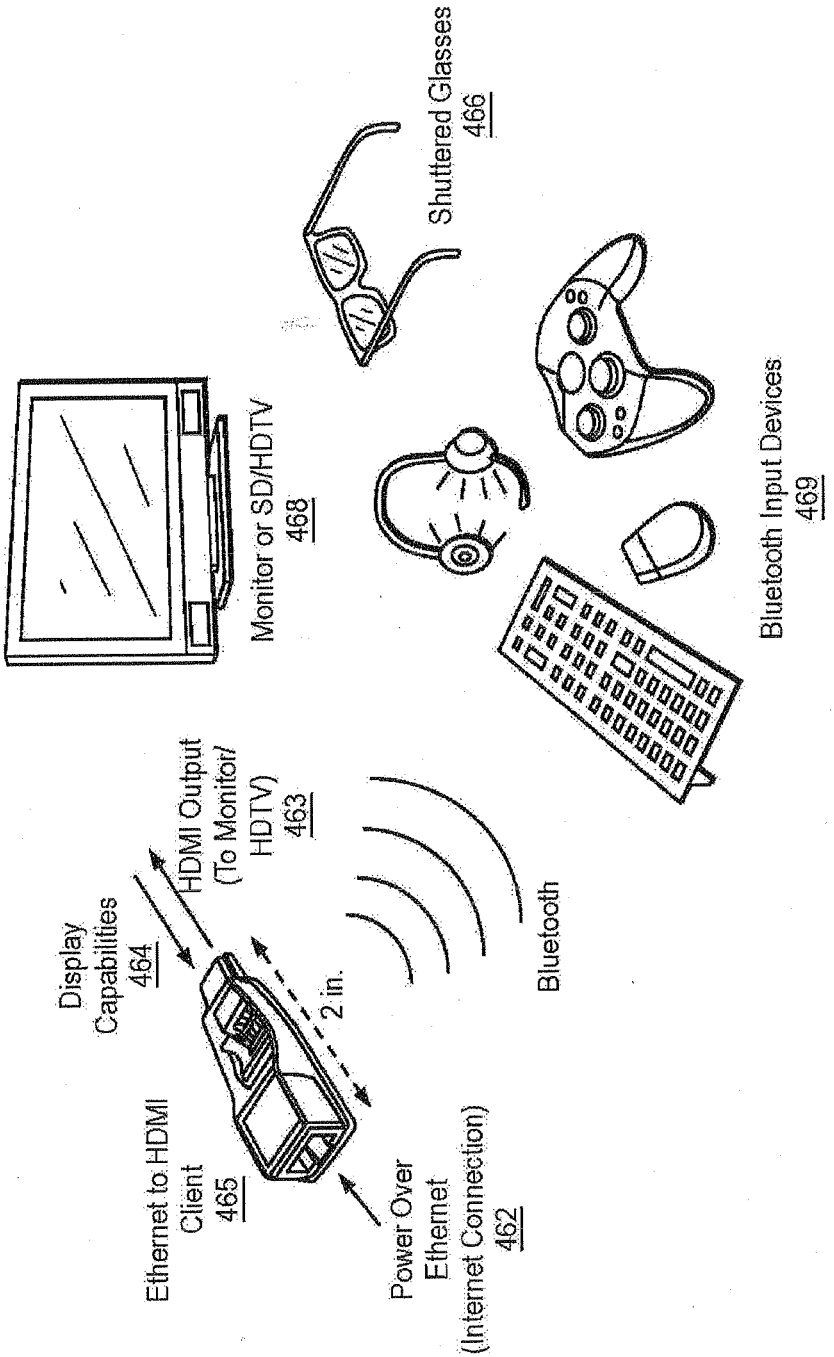

Shuttered Glasses
466
Monitor or SD/HDTV
468
Bluetooth Input Devices
469
HDMI Output
(To Monitor/
HDTV)
463
Display
Capabilities
464
2 in.
Bluetooth
Ethernet to HDMI
Client
465
Power Over
Ethernet
(Internet Connection)
462

FIG. 4C

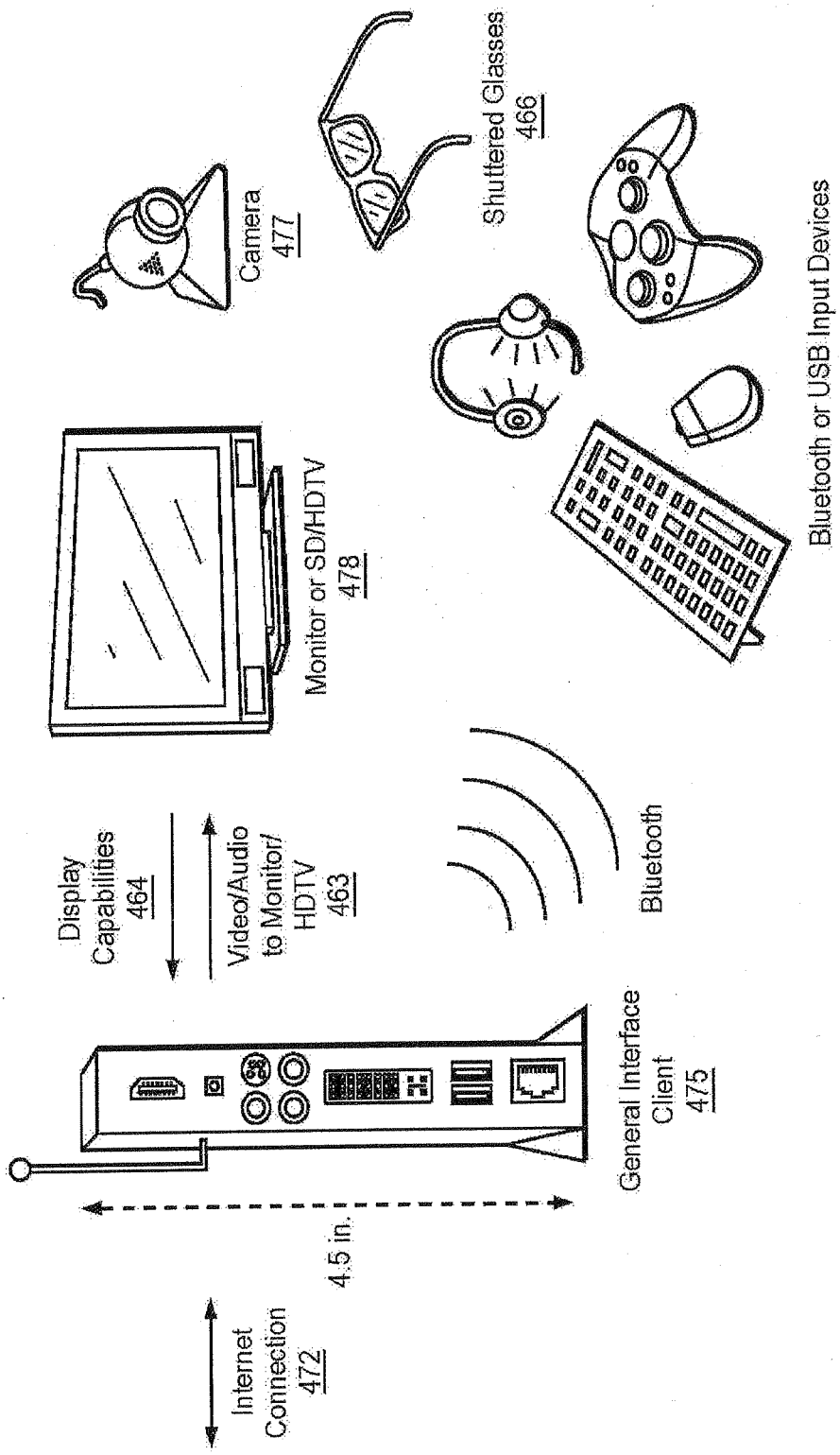

Internet Connection 472
4.5 in.
General Interface Client 475
Display Capabilities 464
Video/Audio to Monitor/ HDTV 463
Bluetooth
Monitor or SD/HDTV 478
Camera 477
Shuttered Glasses 466
Bluetooth or USB Input Devices 479

FIG. 4d

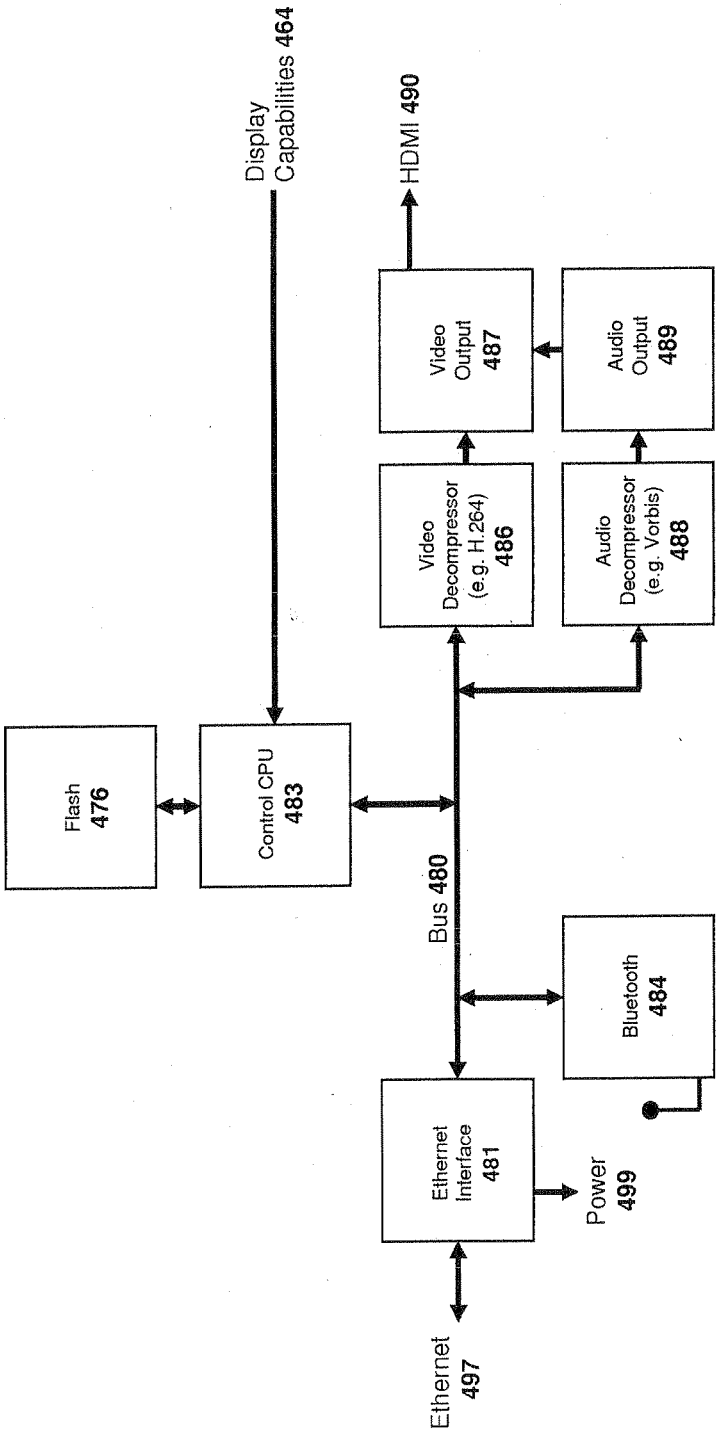

Display Capabilities 464
HDMI 490
Video Output 487
Audio Output 489
Video Decompressor (e.g. H.264) 486
Audio Decompressor (e.g. Vorbis) 488
Flash 476
Control CPU 483
Bus 480
Bluetooth 484
Ethernet Interface 481
Power 499
Ethernet 497

Fig. 4e

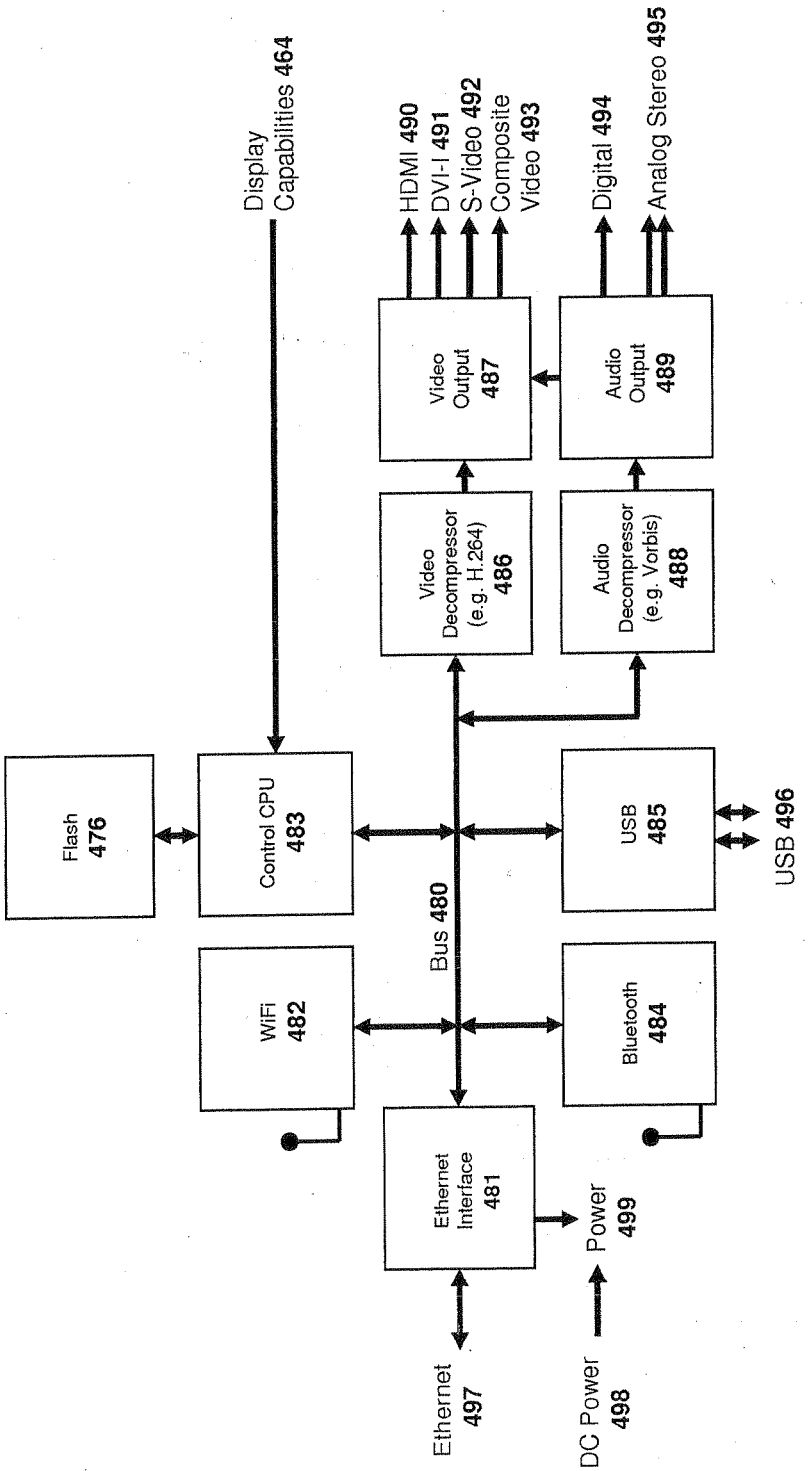

Display Capabilities 464
HDMI 490
DVI-I 491
S-Video 492
Composite Video 493
Digital 494
Analog Stereo 495
Video Output 487
Audio Output 489
Video Decompressor (e.g. H.264) 486
Audio Decompressor (e.g. Vorbis) 488
Flash 476
Control CPU 483
USB 485
USB 496
Bus 480
WiFi 482
Bluetooth 484
Ethernet Interface 481
Power 499
Ethernet 497
DC Power 498

Fig. 4f

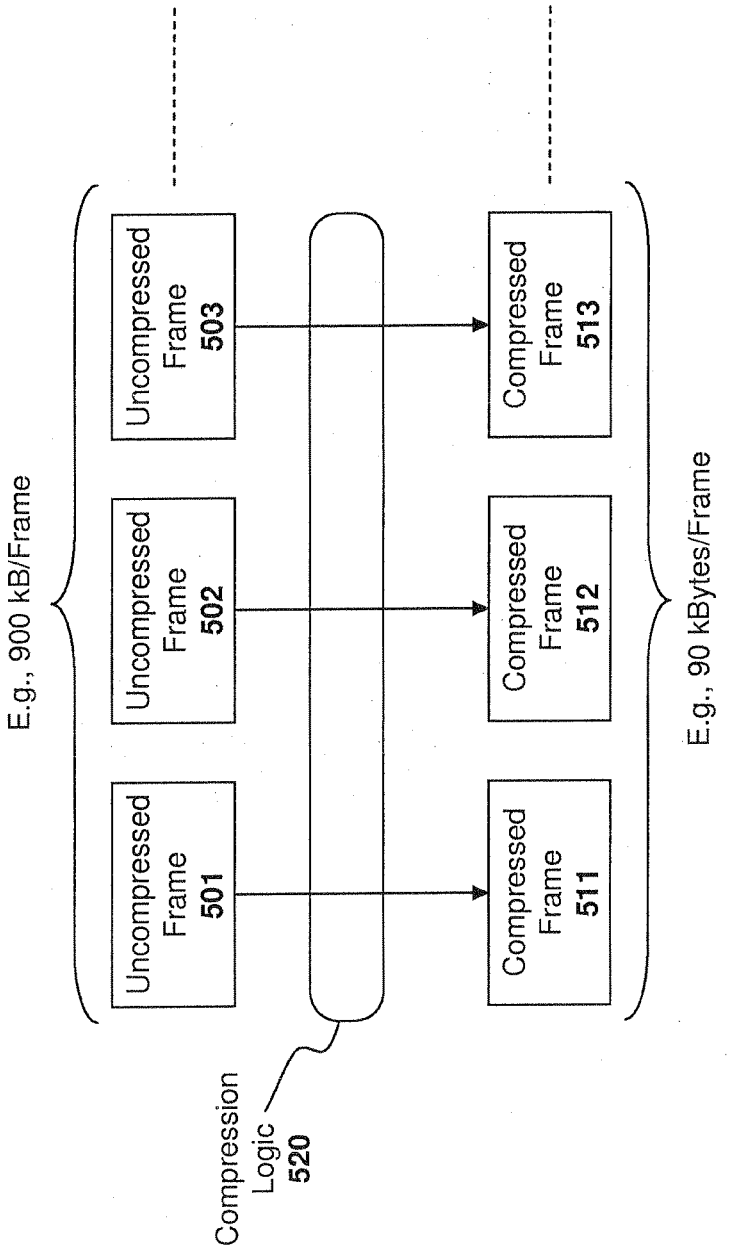


Fig. 5
(prior art)

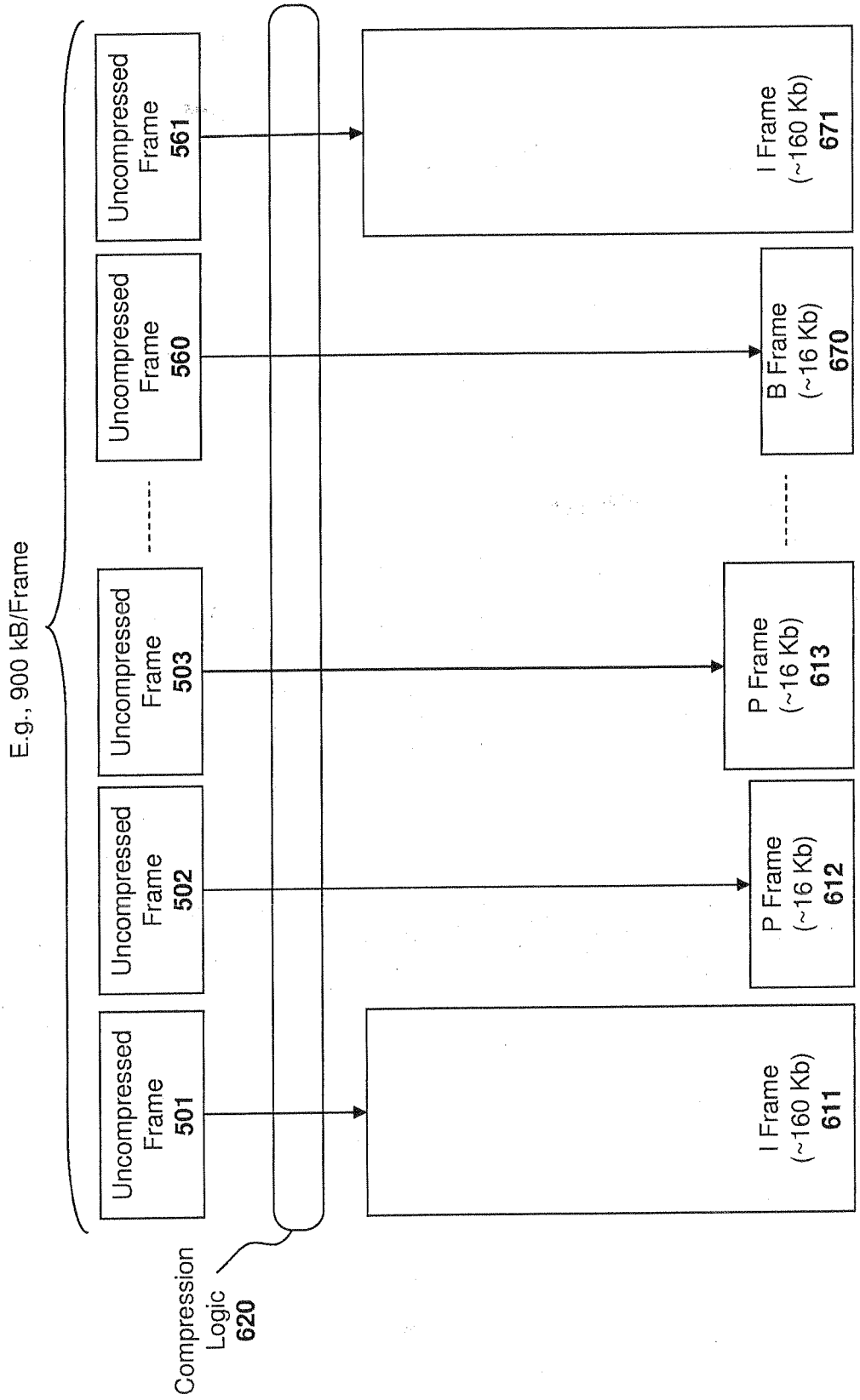


Fig. 6a
(prior art)

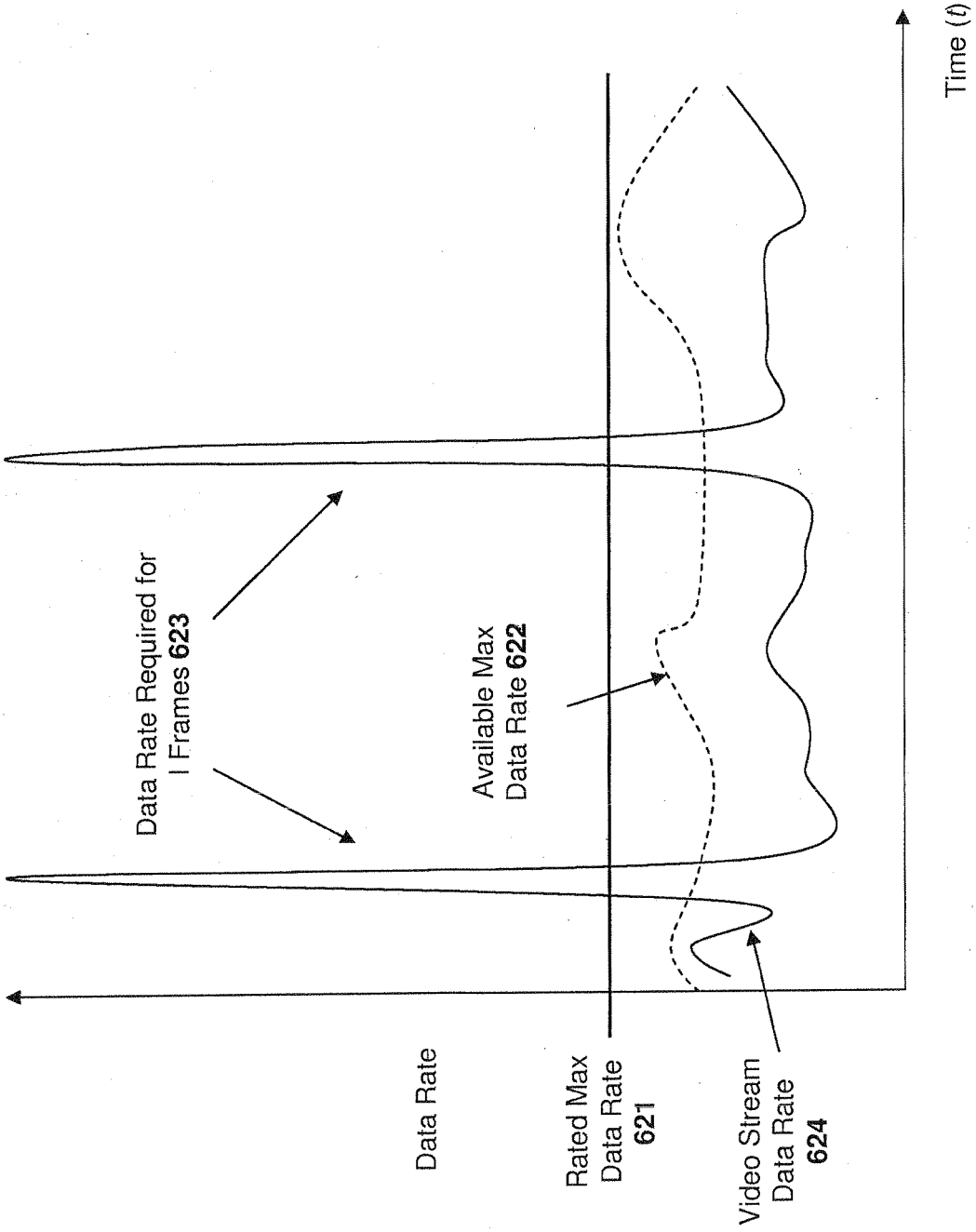

Data Rate Required for I Frames 623
Available Max Data Rate 622
Data Rate
Rated Max Data Rate 621
Video Stream Data Rate 624
Time (t)

Fig. 6b

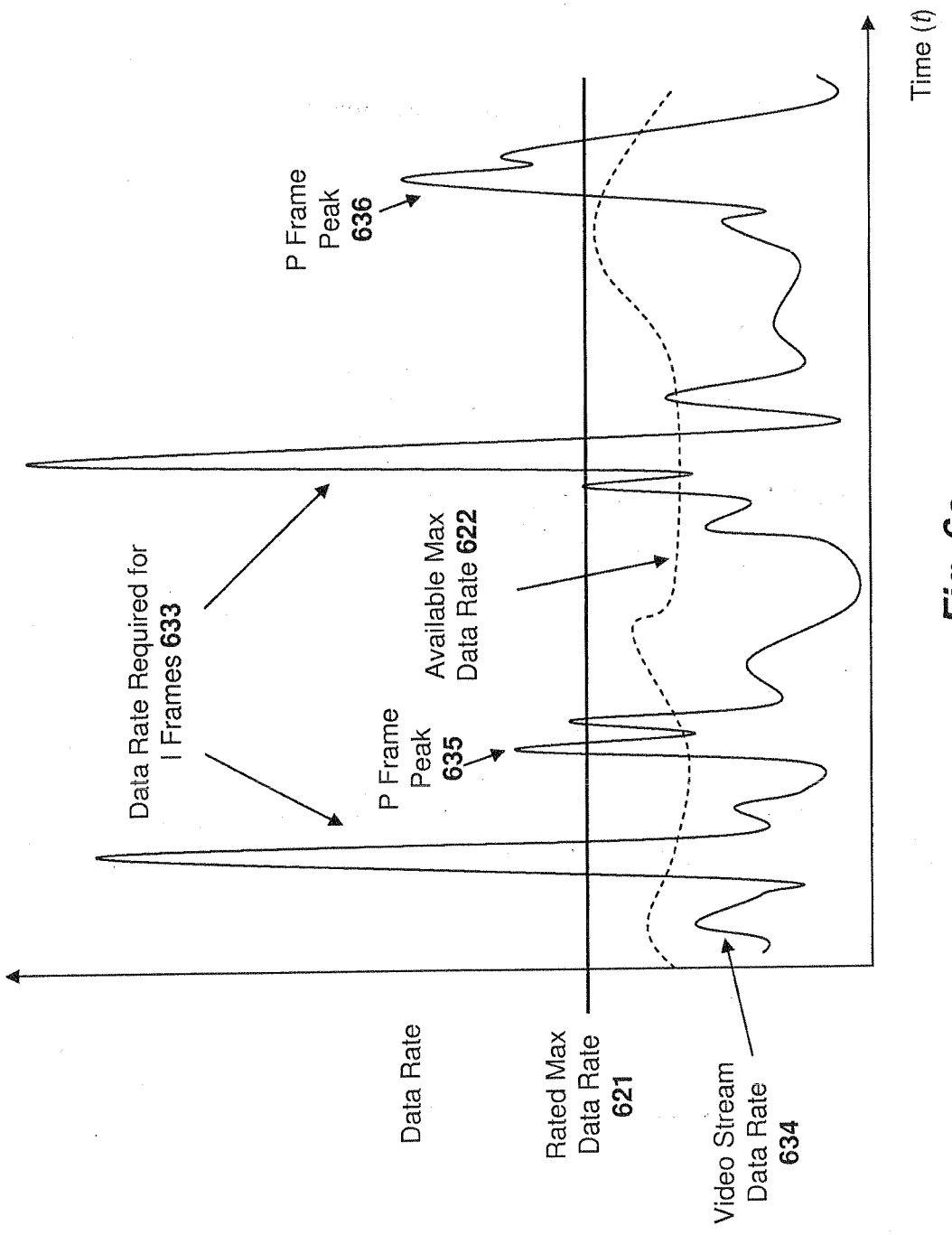

Time (t)
P Frame Peak 636
Data Rate Required for I Frames 633
Available Max Data Rate 622
P Frame Peak 635
Data Rate
Rated Max Data Rate 621
Video Stream Data Rate 634

Fig. 6c

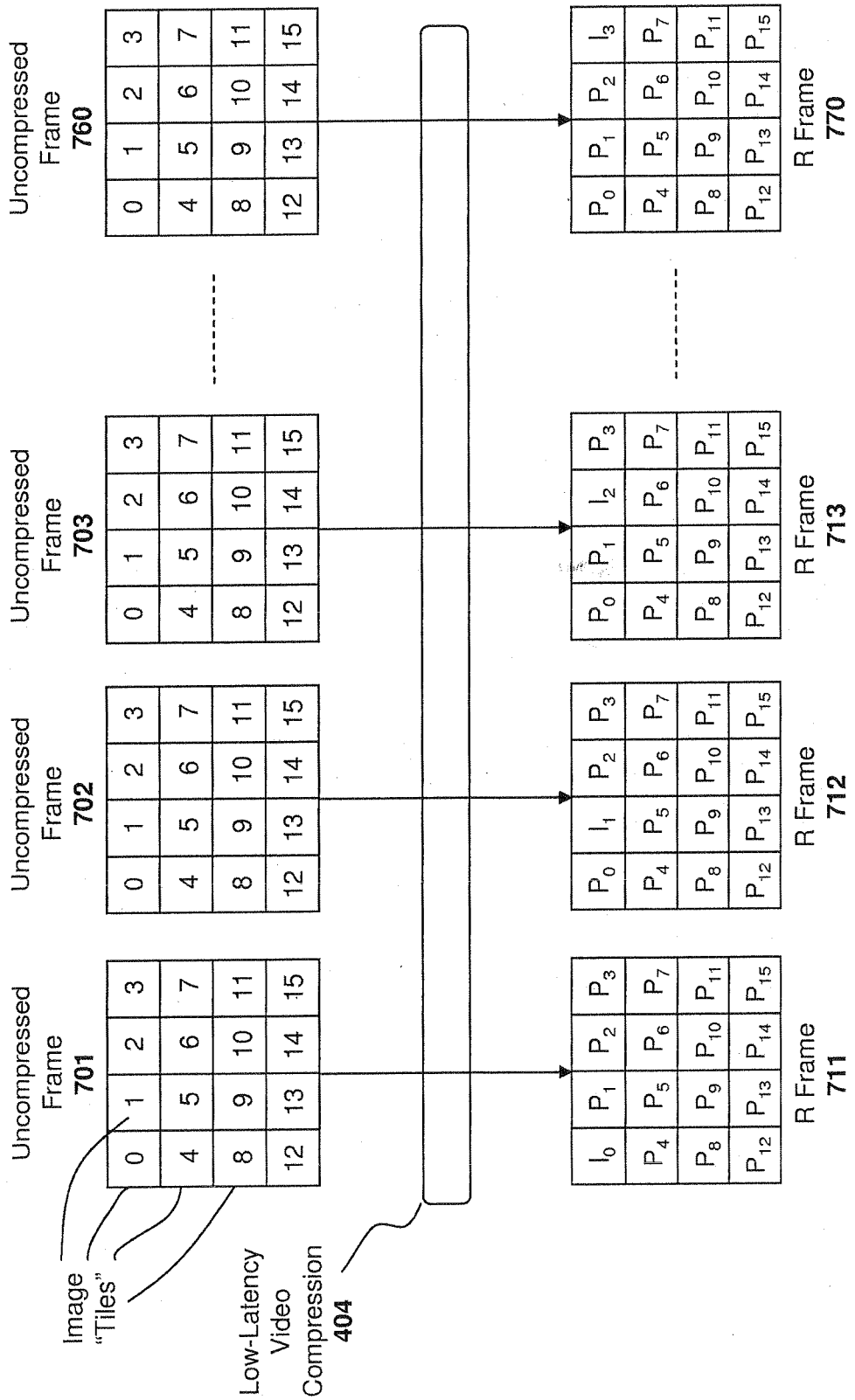

Uncompressed Frame 760
Uncompressed Frame 703
Uncompressed Frame 702
Uncompressed Frame 701
R Frame 770
R Frame 713
R Frame 712
R Frame 711
Image "Tiles"
Low-Latency Video Compression 404

Fig. 7a

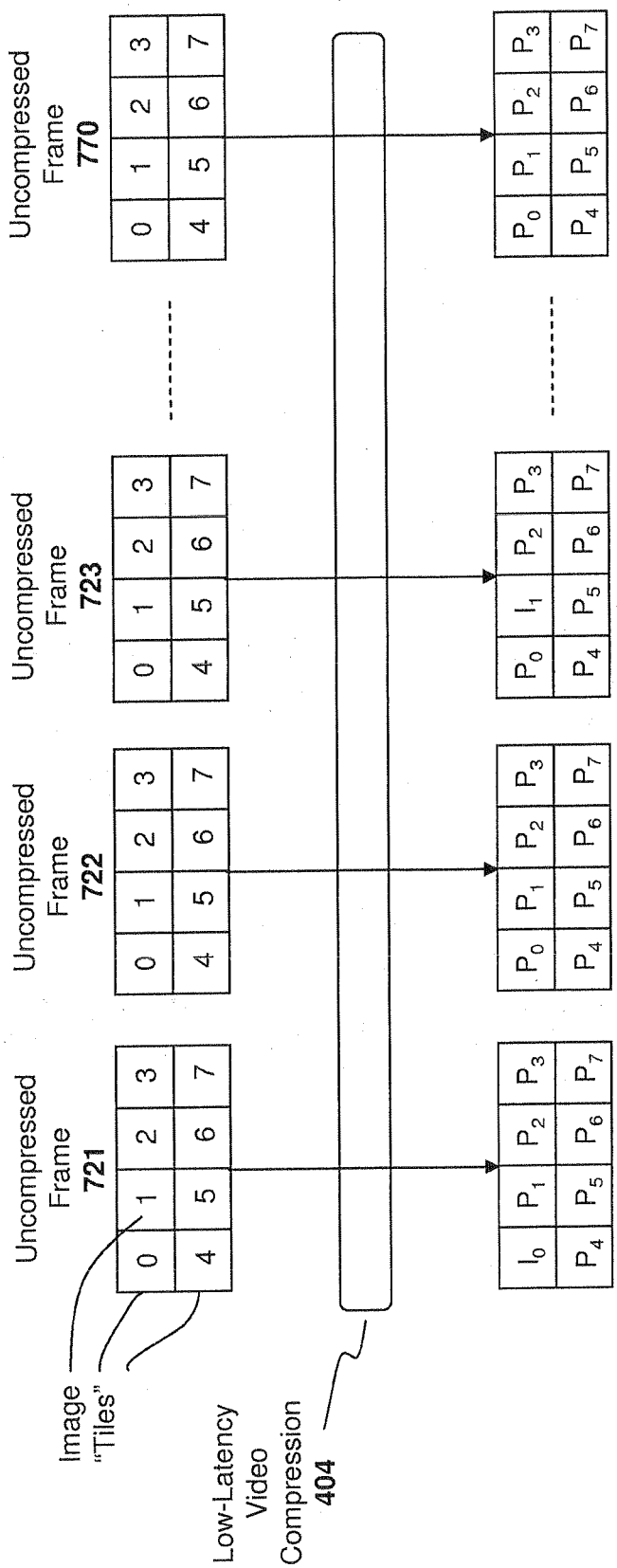

Uncompressed Frame 721
Uncompressed Frame 722
Uncompressed Frame 723
Uncompressed Frame 770
Image "Tiles"
Low-Latency Video Compression 404
R Frame 731
R Frame 732
R Frame 733
R Frame 780

Fig. 7b

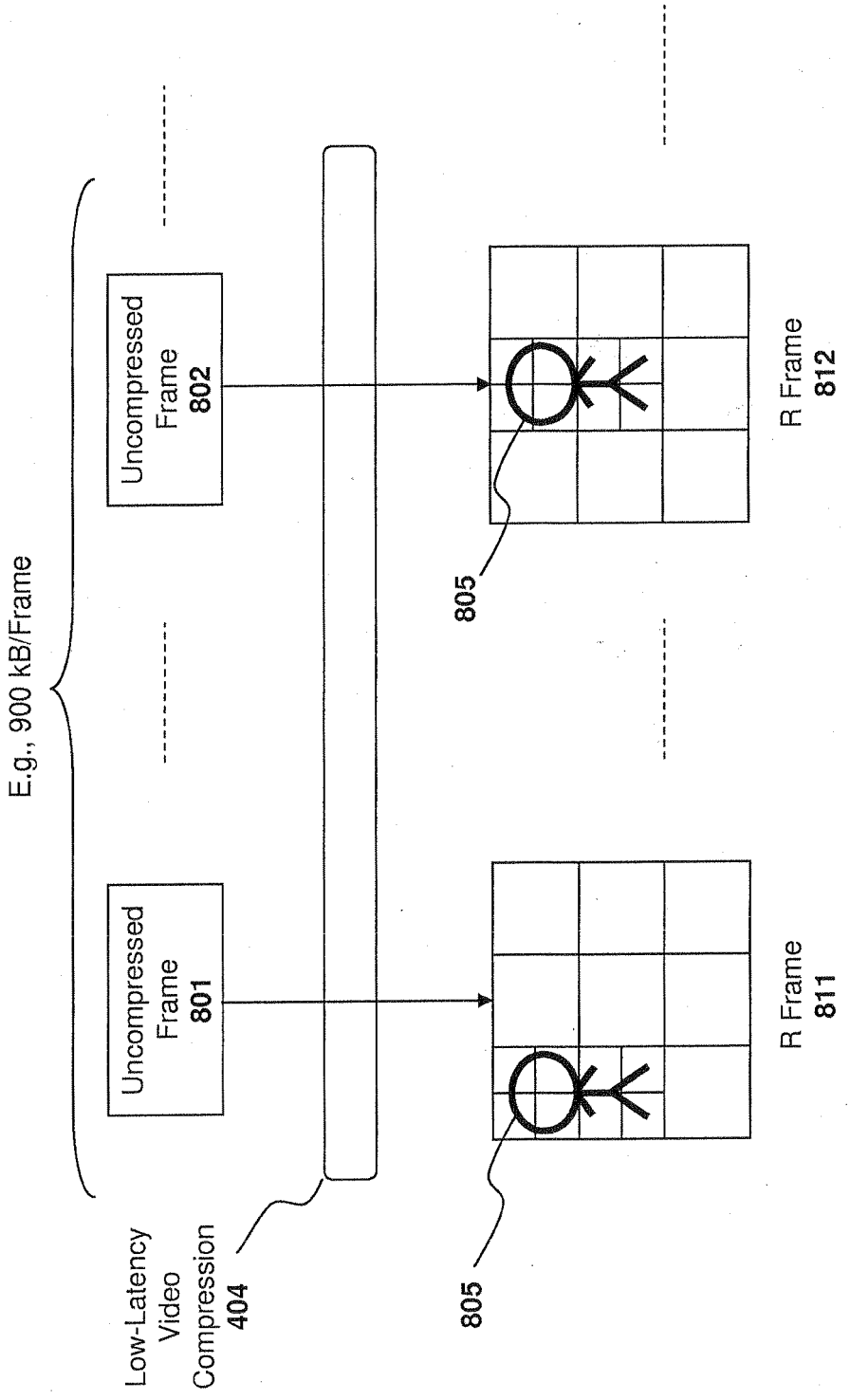

E.g., 900 kB/Frame
Uncompressed Frame 802
Uncompressed Frame 801
Low-Latency Video Compression 404
805
805
R Frame 812
R Frame 811

Fig. 8

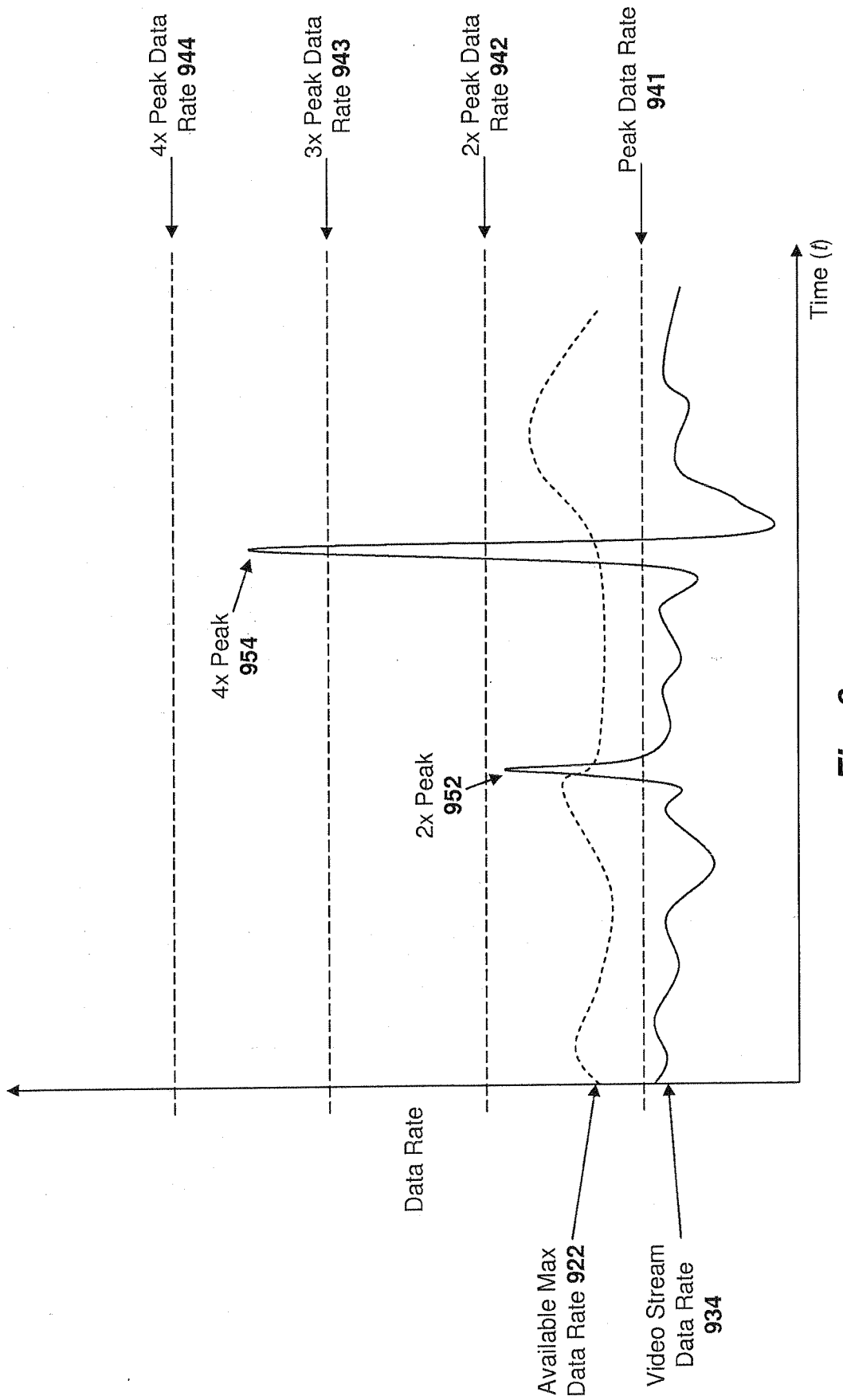

4x Peak Data Rate 944
3x Peak Data Rate 943
2x Peak Data Rate 942
Peak Data Rate 941
4x Peak 954
2x Peak 952
Time (t)
Data Rate
Available Max Data Rate 922
Video Stream Data Rate 934

Fig. 9a

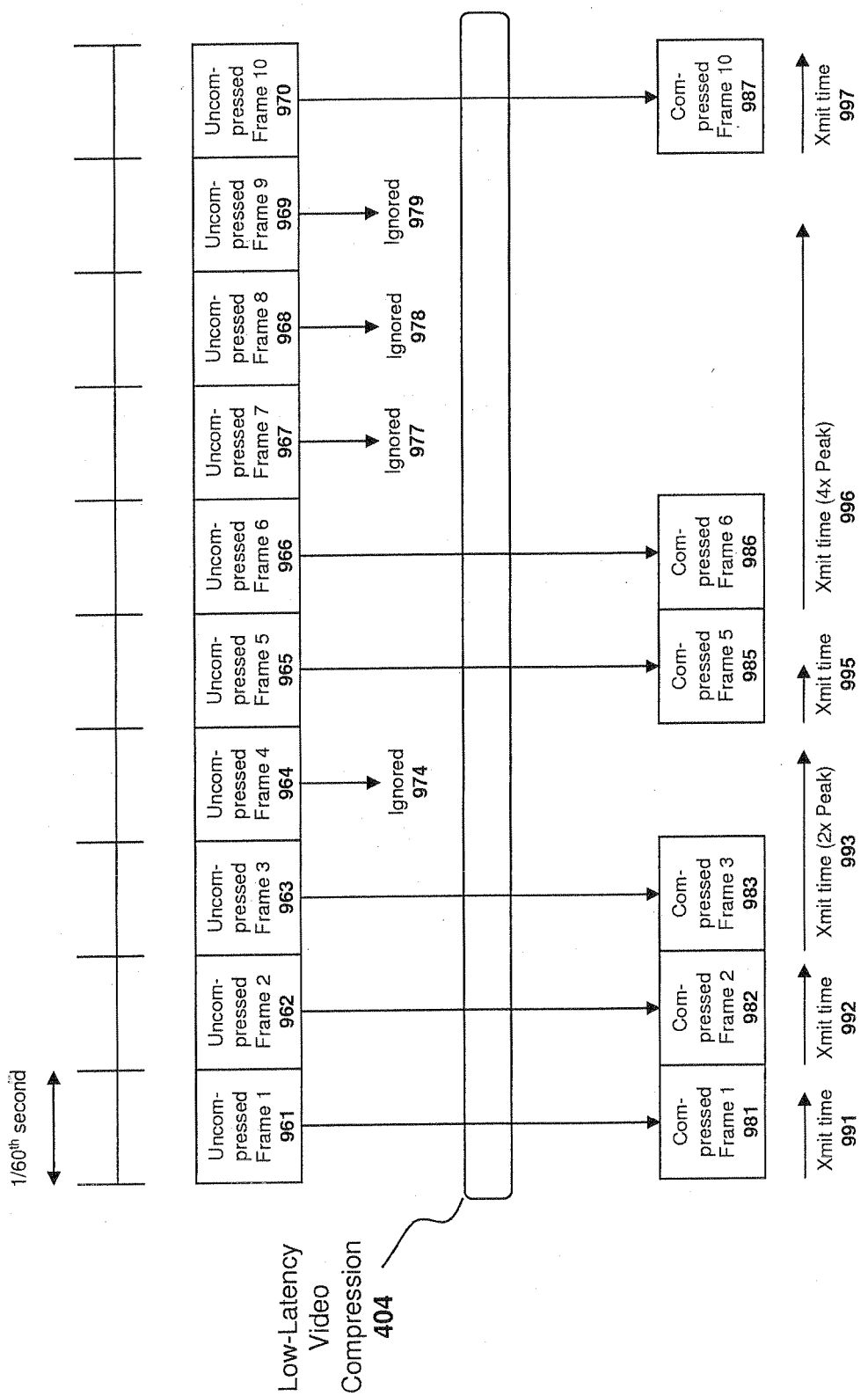

1/60th second
Uncom-pressed Frame 1 961
Uncom-pressed Frame 2 962
Uncom-pressed Frame 3 963
Uncom-pressed Frame 4 964
Uncom-pressed Frame 5 965
Uncom-pressed Frame 6 966
Uncom-pressed Frame 7 967
Uncom-pressed Frame 8 968
Uncom-pressed Frame 9 969
Uncom-pressed Frame 10 970
Ignored 974
Ignored 977
Ignored 978
Ignored 979
Low-Latency Video Compression 404
Com-pressed Frame 1 981
Com-pressed Frame 2 982
Com-pressed Frame 3 983
Com-pressed Frame 5 985
Com-pressed Frame 6 986
Com-pressed Frame 10 987
Xmit time 991
Xmit time 992
Xmit time (2x Peak) 993
Xmit time 995
Xmit time (4x Peak) 996
Xmit time 997

Fig. 9b

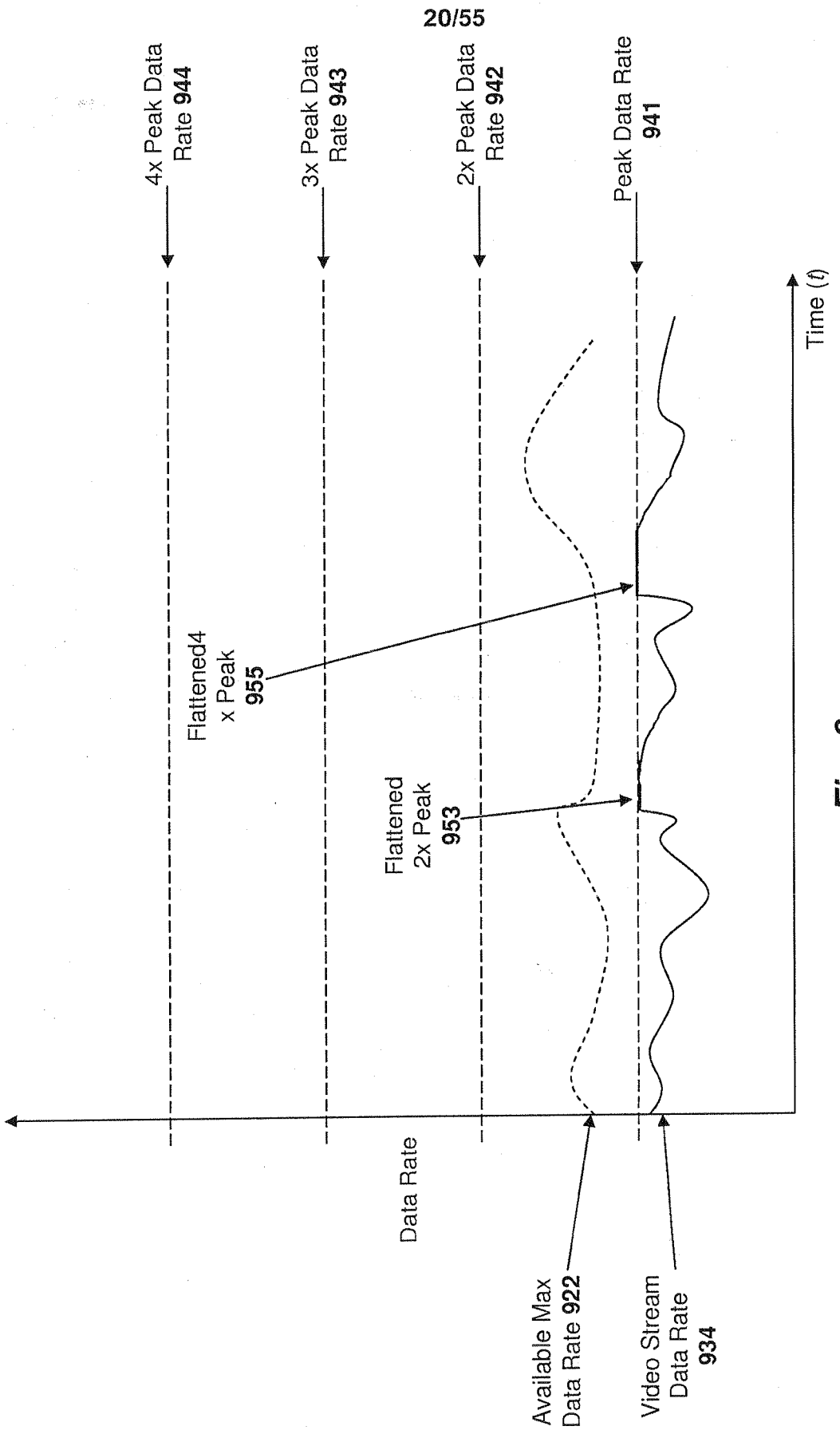

4x Peak Data Rate 944
3x Peak Data Rate 943
2x Peak Data Rate 942
Peak Data Rate 941
Flattened4 x Peak 955
Flattened 2x Peak 953
Data Rate
Time (t)
Available Max Data Rate 922
Video Stream Data Rate 934

Fig. 9c

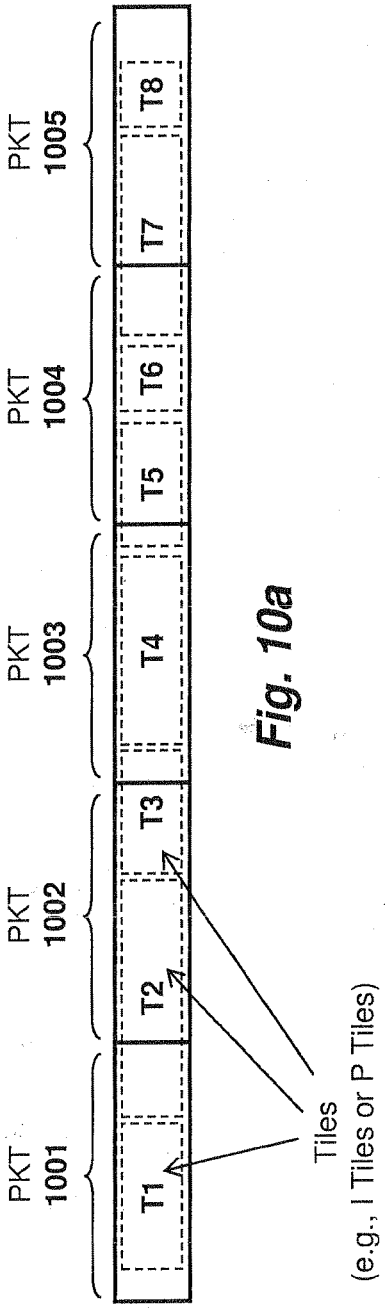

PKT 1001
PKT 1002
PKT 1003
PKT 1004
PKT 1005
T1
T2
T3
T4
T5
T6
T7
T8
Tiles
(e.g., I Tiles or P Tiles)

Fig. 10a

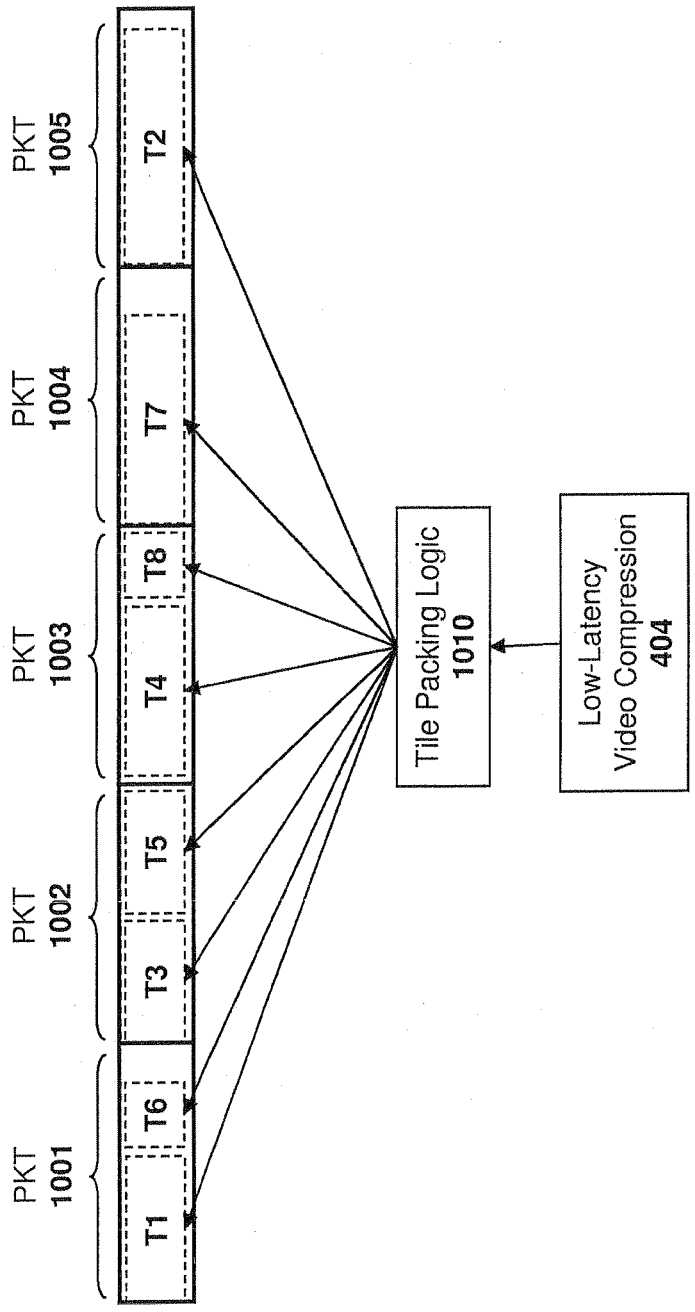

PKT 1001
PKT 1002
PKT 1003
PKT 1004
PKT 1005
T1
T6
T3
T5
T4
T8
T7
T2
Tile Packing Logic 1010
Low-Latency Video Compression 404

Fig. 10b

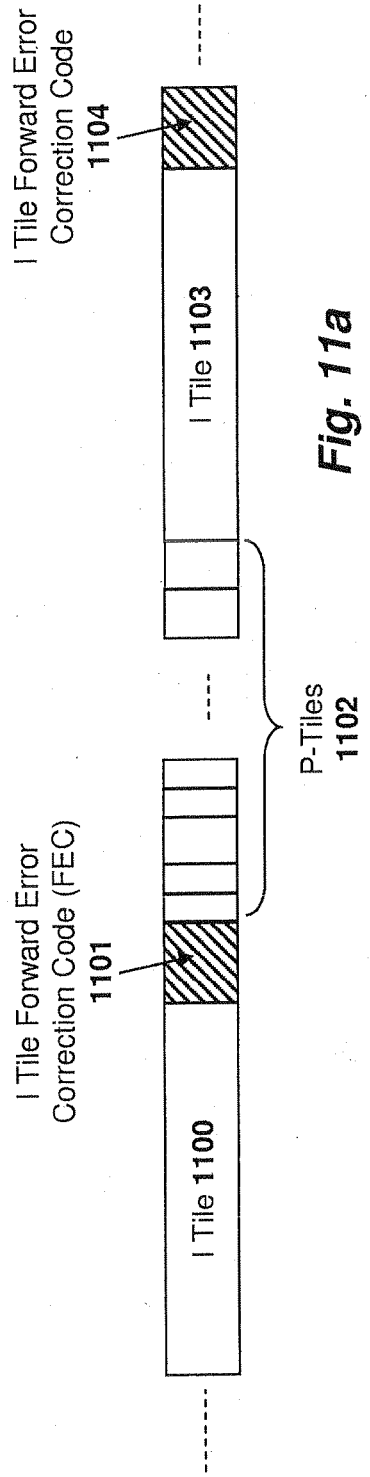


Fig. 11a

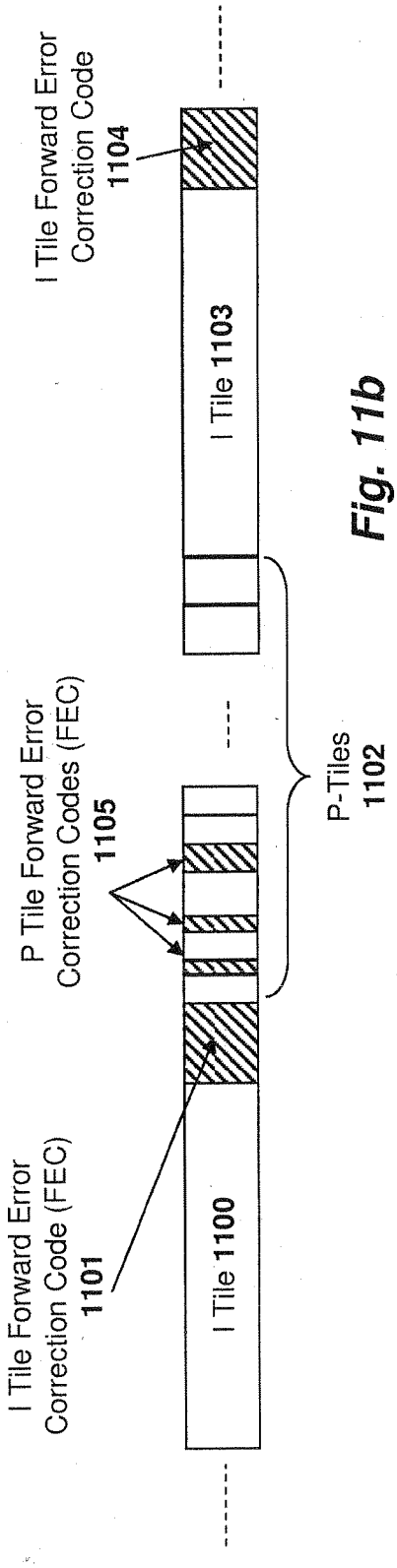


Fig. 11b

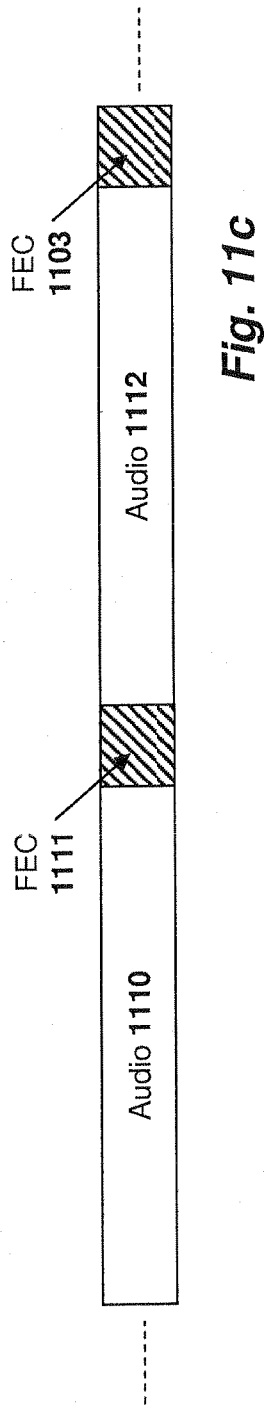


Fig. 11c

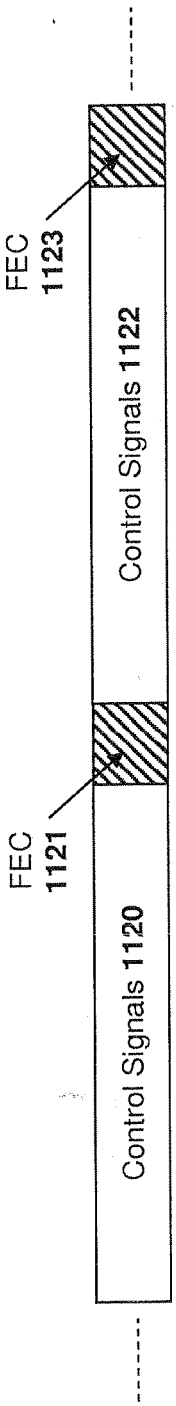

FEC
1123
Control Signals 1122
FEC
1121
Control Signals 1120

Fig. 11d

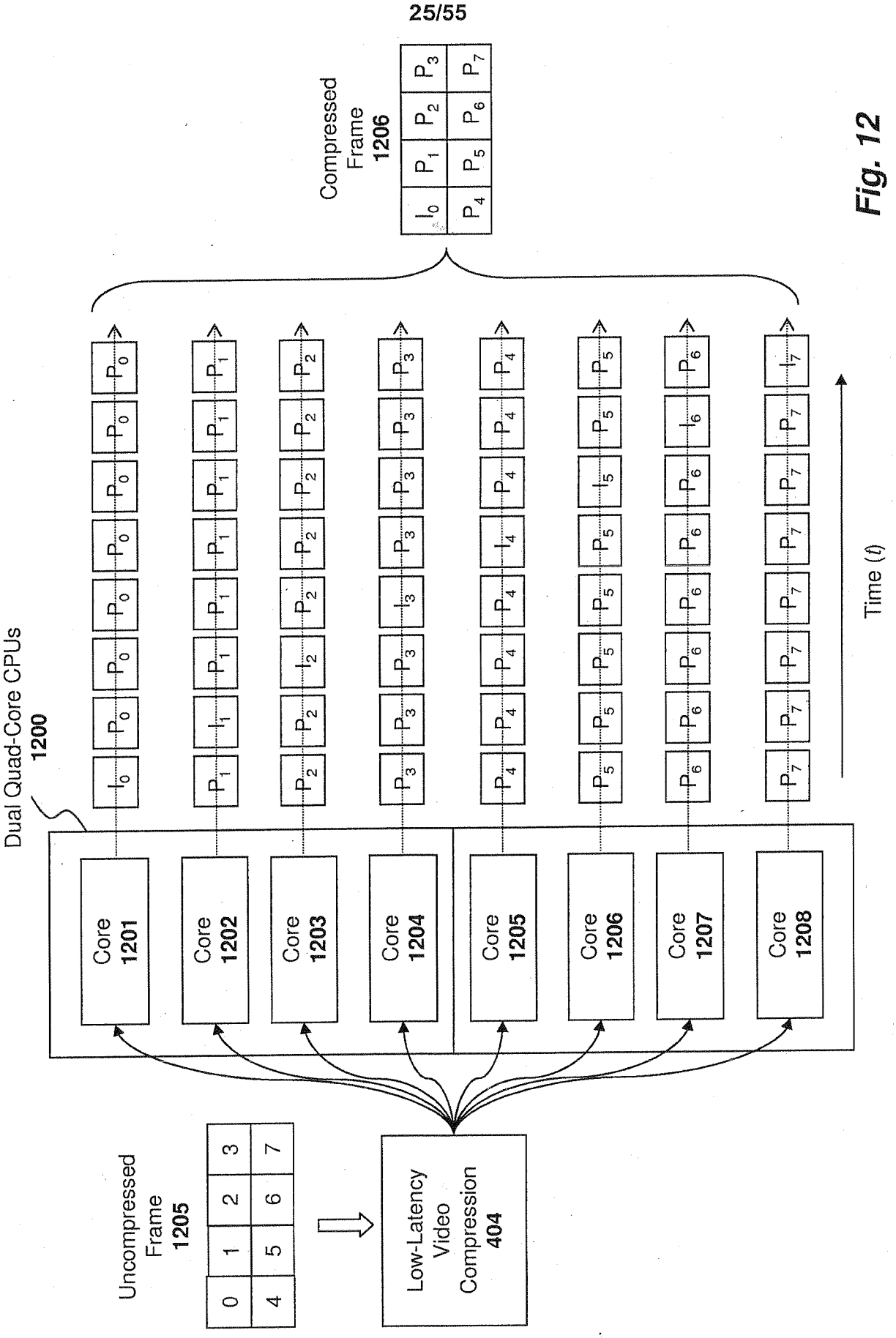

Compressed Frame 1206
I0 P1 P2 P3
P4 P5 P6 P7
Dual Quad-Core CPUs 1200
Core 1201
Core 1202
Core 1203
Core 1204
Core 1205
Core 1206
Core 1207
Core 1208
Time (t)
Uncompressed Frame 1205
0 1 2 3
4 5 6 7
Low-Latency Video Compression 404

Fig. 12

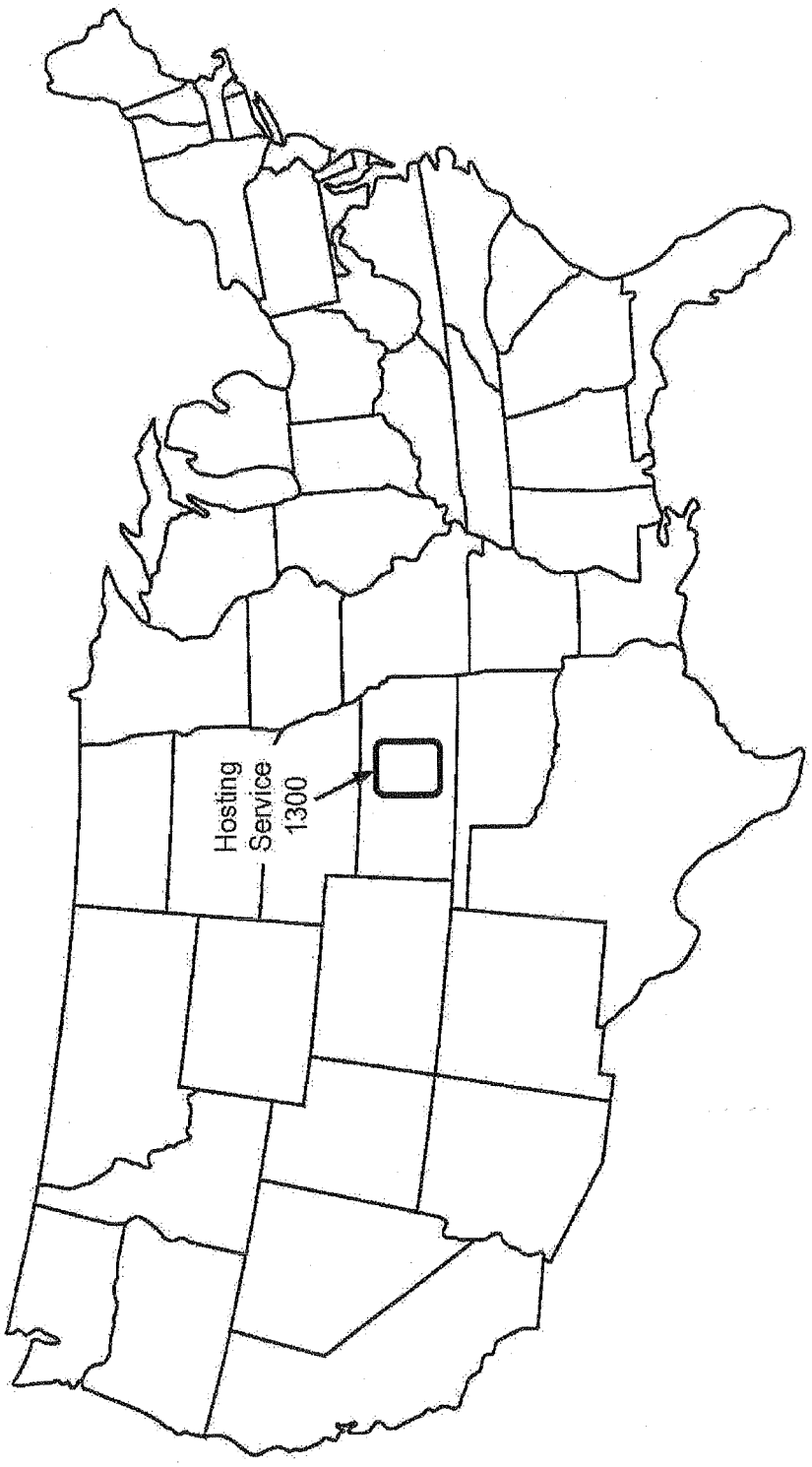


FIG. 13a

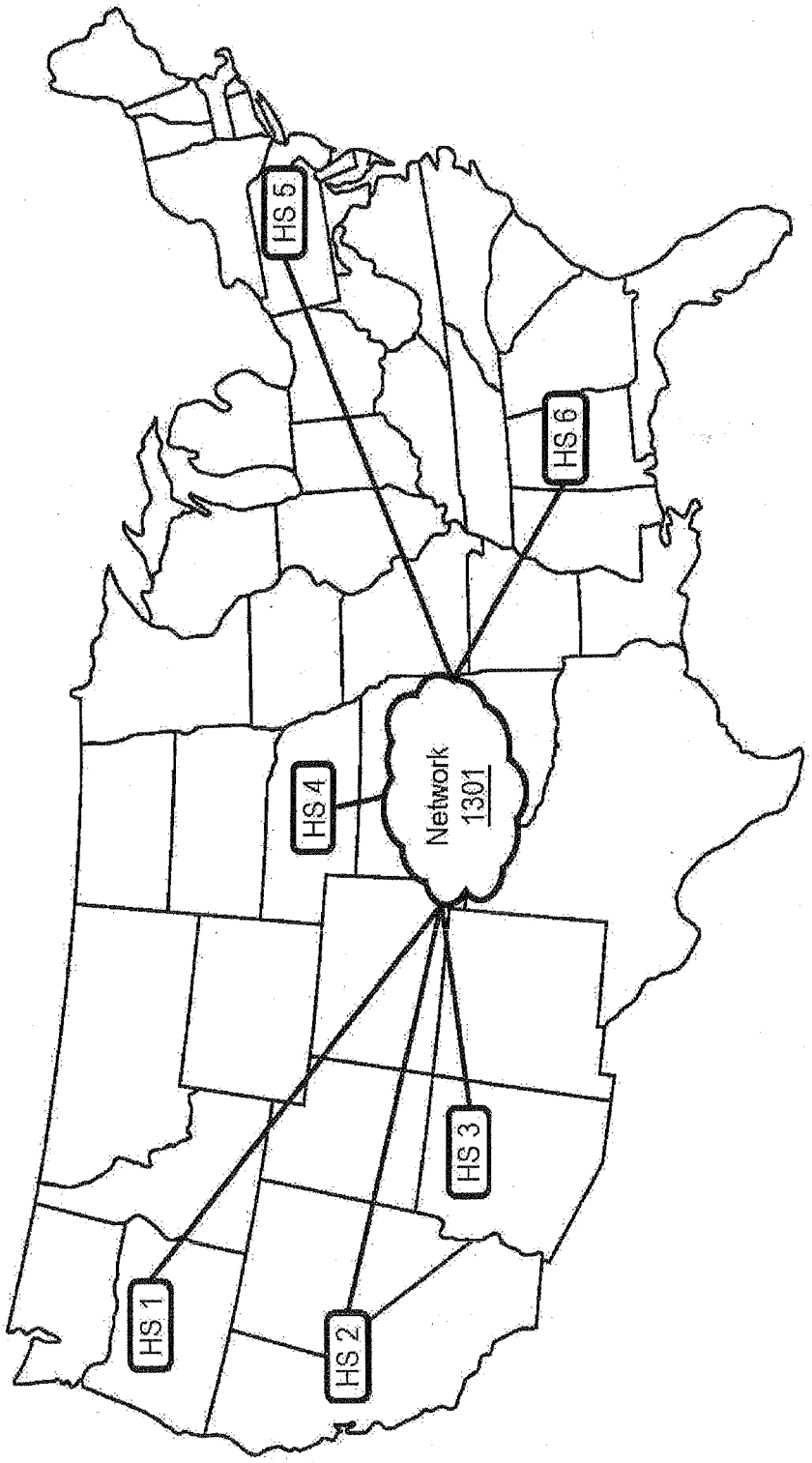


FIG. 13b

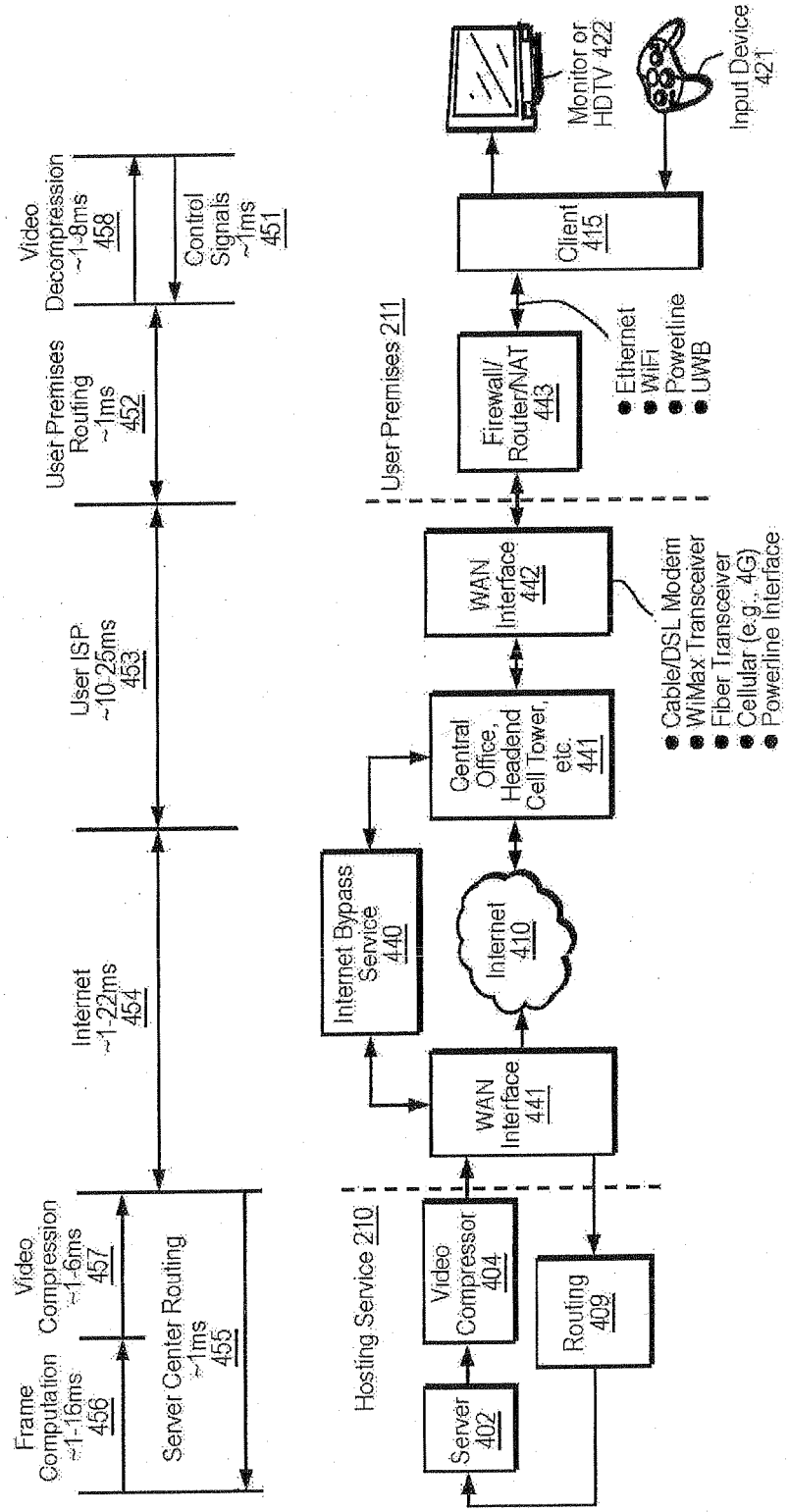

Frame Computation ~1-16ms 456
Video Compression ~1-6ms 457
Server Center Routing ~1ms 455
Internet ~1-22ms 454
User ISP ~10-25ms 453
User Premises Routing ~1ms 452
Video Decompression ~1-8ms 458
Control Signals ~1ms 451
Hosting Service 210
Server 402
Video Compressor 404
Routing 409
WAN Interface 441
Internet Bypass Service 440
Internet 410
Central Office, Headend Cell Tower, etc. 441
WAN Interface 442
Cable/DSL Modem
WiMax Transceiver
Fiber Transceiver
Cellular (e.g., 4G)
Powerline Interface
User Premises 211
Firewall/ Router/NAT 443
Ethernet
WiFi
Powerline
UWB
Client 415
Monitor or HDTV 422
Input Device 421

FIG. 14

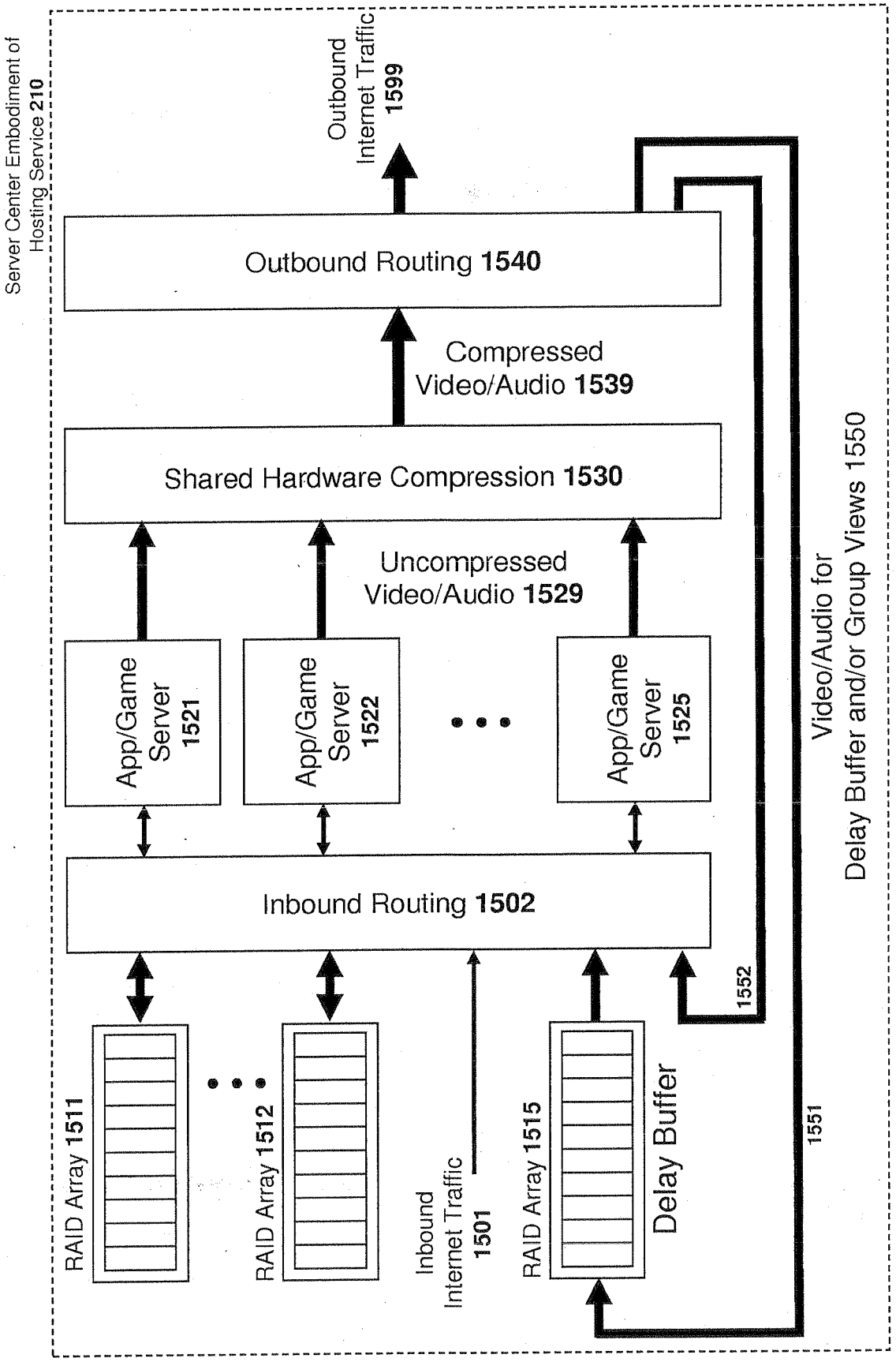

Server Center Embodiment of Hosting Service 210
Outbound Internet Traffic 1599
Outbound Routing 1540
Compressed Video/Audio 1539
Shared Hardware Compression 1530
Uncompressed Video/Audio 1529
App/Game Server 1521
App/Game Server 1522
App/Game Server 1525
Inbound Routing 1502
RAID Array 1511
RAID Array 1512
Inbound Internet Traffic 1501
RAID Array 1515
Delay Buffer
1552
1551
Video/Audio for Delay Buffer and/or Group Views 1550

Fig. 15

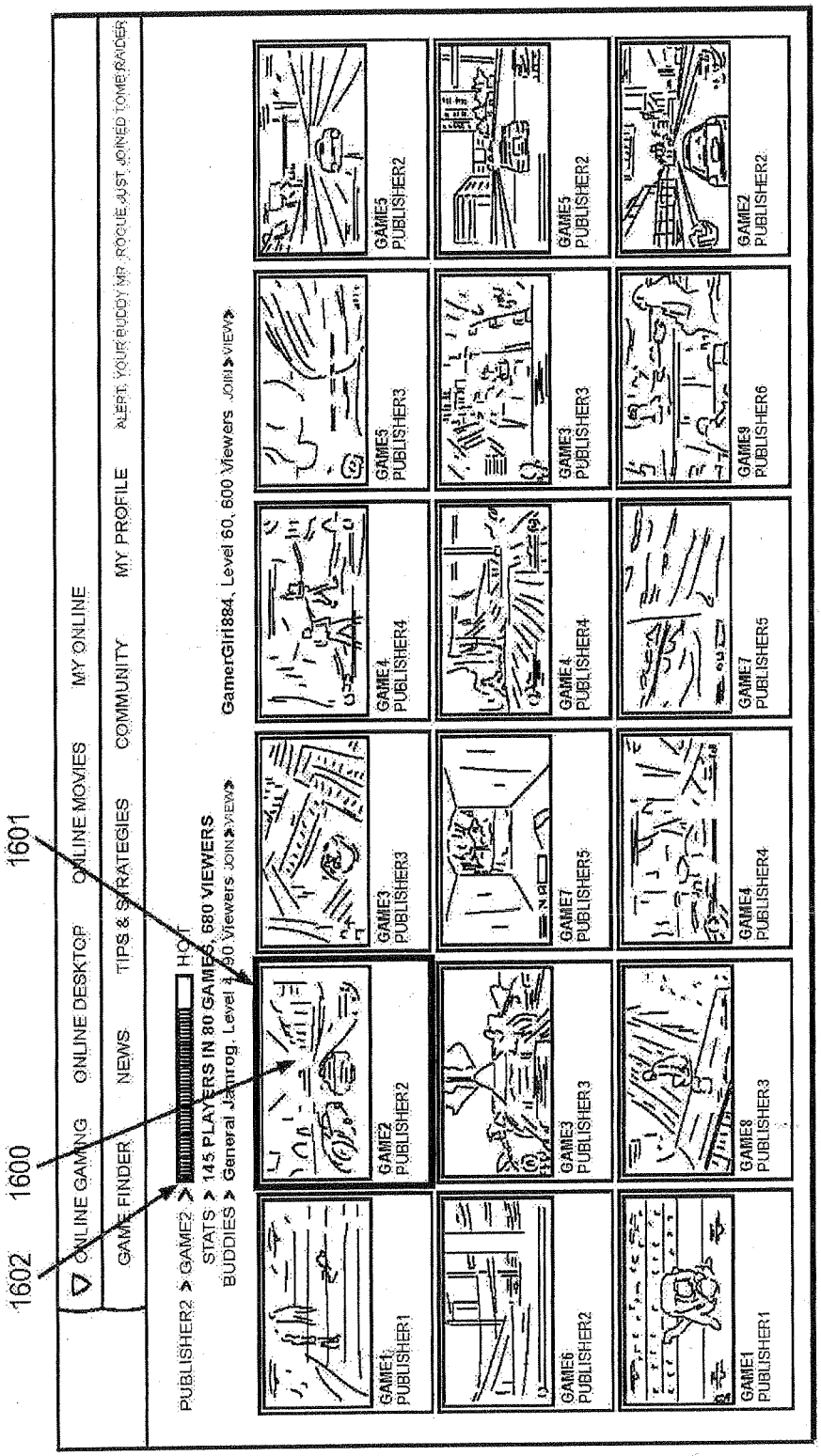

1601
1600
1602
ONLINE GAMING
ONLINE DESKTOP
ONLINE MOVIES
MY ONLINE
GAME FINDER
NEWS
TIPS & STRATEGIES
COMMUNITY
MY PROFILE
ALERT! YOUR BUDDY MR_ROGUE JUST JOINED TOMB RAIDER
PUBLISHER2 > GAME2 >
HOT
STATS > 145 PLAYERS IN 80 GAMES, 680 VIEWERS
BUDDIES > General Jarrog, Level 4, 90 Viewers JOIN > VIEW >
GamerGirl884, Level 60, 600 Viewers JOIN > VIEW >
GAME1 PUBLISHER1
GAME2 PUBLISHER2
GAME3 PUBLISHER3
GAME4 PUBLISHER4
GAME5 PUBLISHER2
GAME6 PUBLISHER2
GAME3 PUBLISHER3
GAME7 PUBLISHER5
GAME4 PUBLISHER4
GAME3 PUBLISHER3
GAME5 PUBLISHER2
GAME1 PUBLISHER1
GAME8 PUBLISHER3
GAME4 PUBLISHER4
GAME7 PUBLISHER5
GAME9 PUBLISHER6
GAME2 PUBLISHER2

FIG. 16

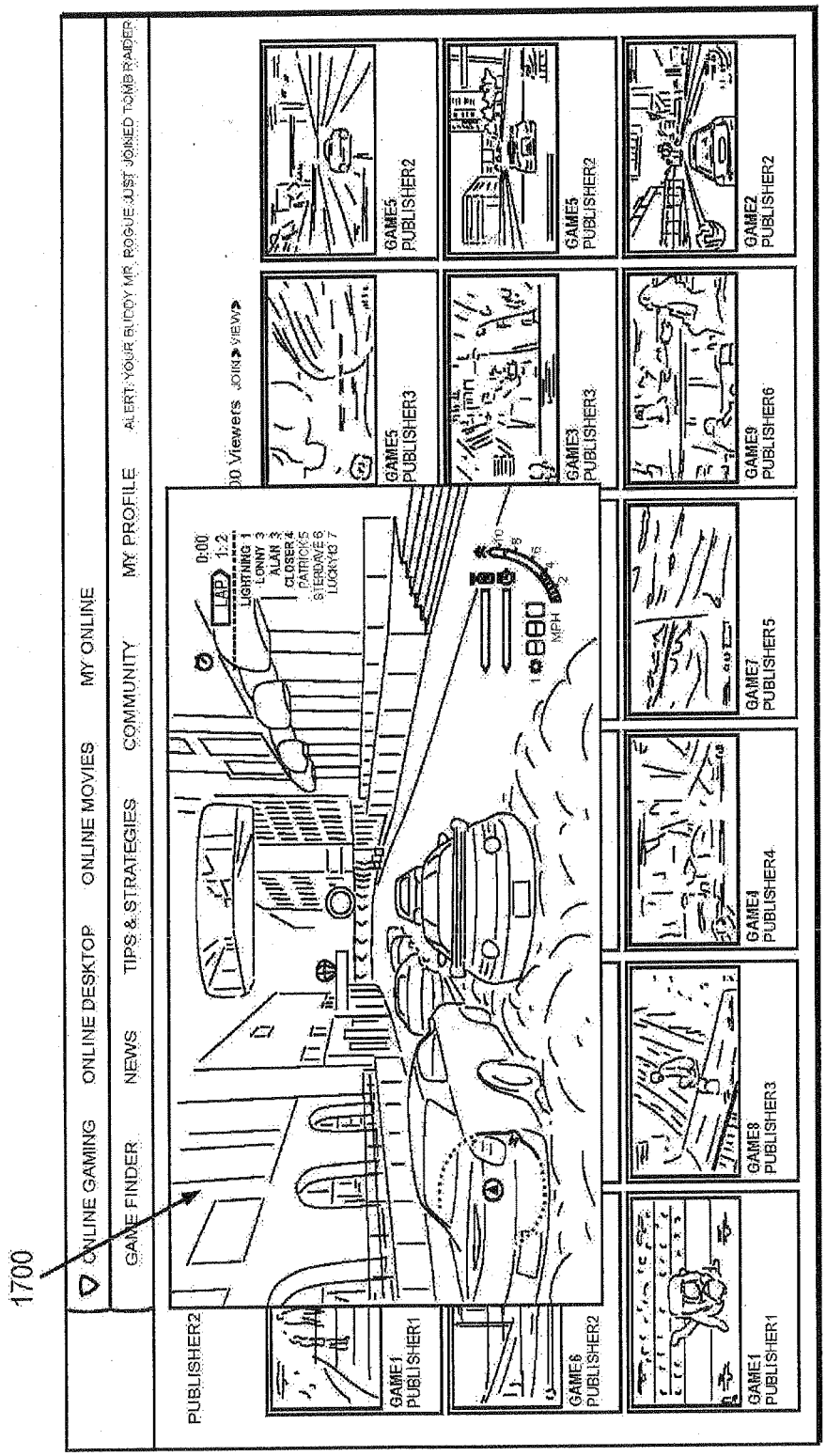

1700
ONLINE GAMING
ONLINE DESKTOP
ONLINE MOVIES
MY ONLINE
GAME FINDER
NEWS
TIPS & STRATEGIES
COMMUNITY
MY PROFILE
ALERT: YOUR BUDDY MR. ROGUE JUST JOINED TOMB RAIDER
PUBLISHER2
LAP 1:2
0:00
LIGHTNING 1
LONNY 3
ALAN 3
CLOSER 4
PATRICK 5
STERBAVE 6
LUCKY43 7
880
MPH
GAME1 PUBLISHER1
GAME6 PUBLISHER2
GAME8 PUBLISHER3
GAME4 PUBLISHER4
GAME7 PUBLISHER5
GAME9 PUBLISHER6
GAME3 PUBLISHER3
GAME5 PUBLISHER3
GAME5 PUBLISHER2
GAME5 PUBLISHER2
GAME2 PUBLISHER2

FIG. 17

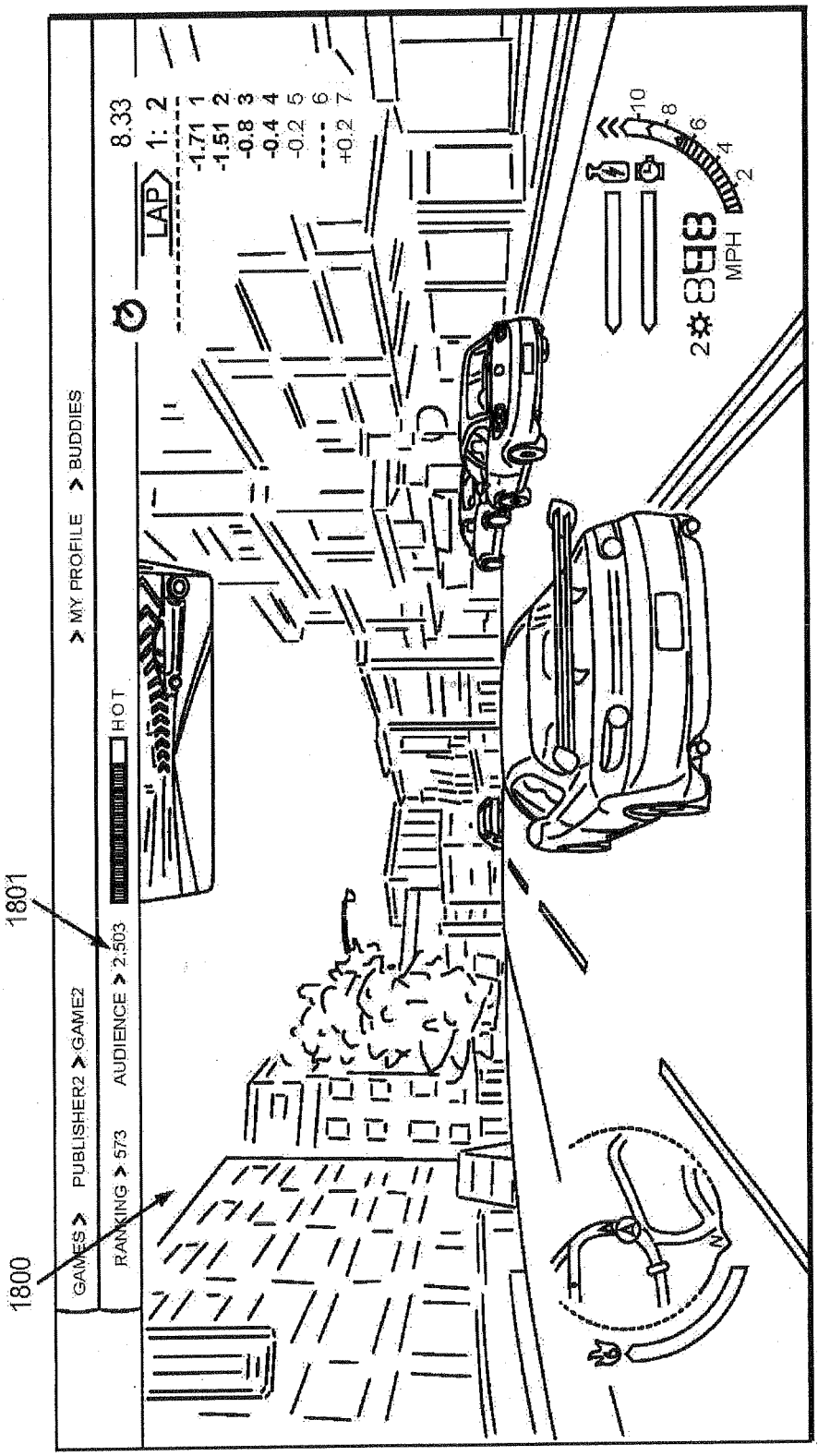

1801
1800
GAMES > PUBLISHER2 > GAME2
RANKING > 573
AUDIENCE > 2,503
HOT
> MY PROFILE
> BUDDIES
LAP
8.33
1: 2
-1.71 1
-1.51 2
-0.8 3
-0.4 4
-0.2 5
6
+0.2 7
MPH
2
4
6
8
10

FIG. 18

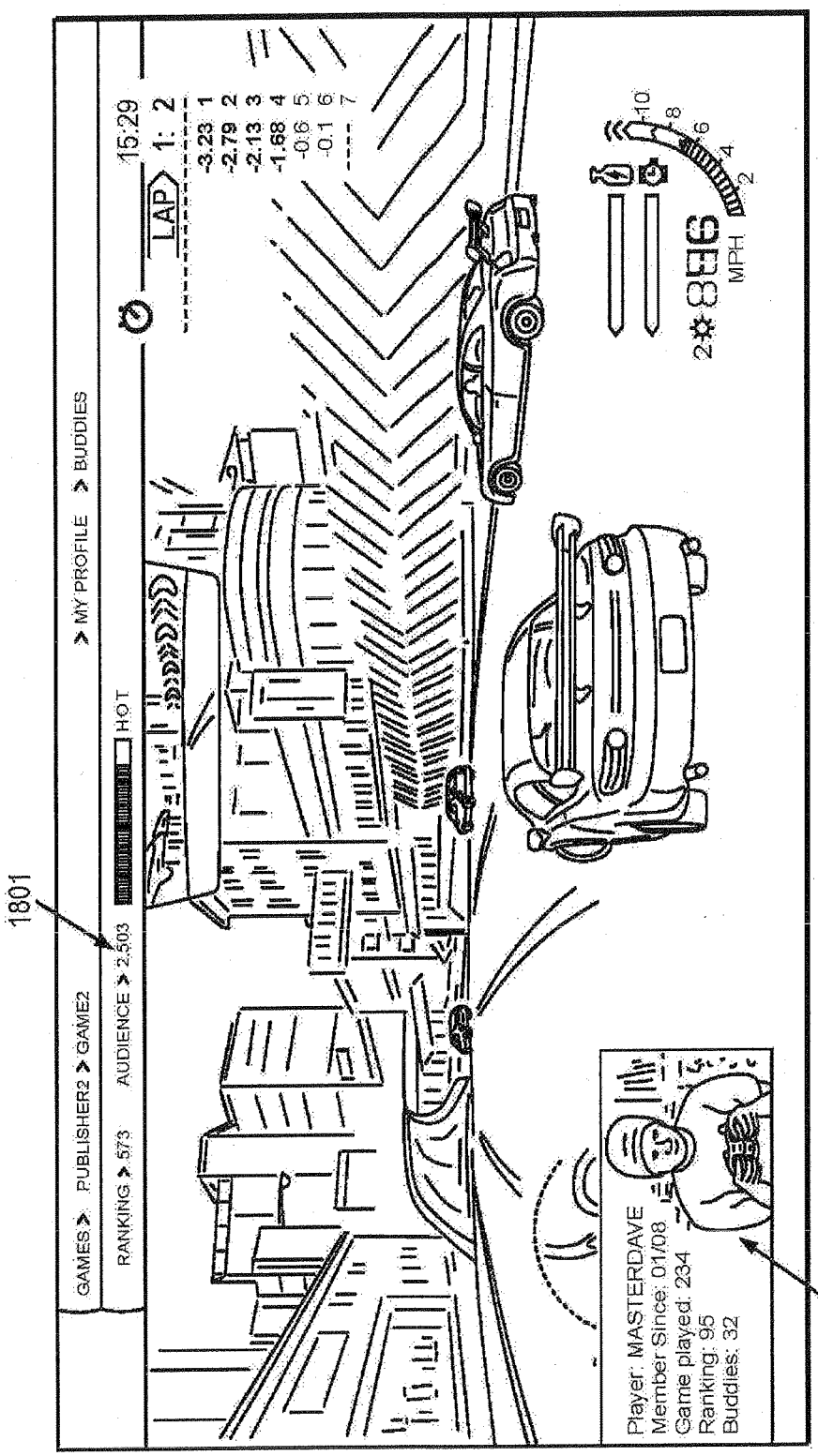

1801
GAMES > PUBLISHER2 > GAME2
> MY PROFILE > BUDDIES
RANKING > 573 AUDIENCE > 2,503 HOT
15:29
LAP 1: 2
-3.23 1
-2.79 2
-2.13 3
-1.68 4
-0.6 5
-0.1 6
7
MPH
Player: MASTERDAVE
Member Since: 01/08
Game played: 234
Ranking: 95
Buddies: 32
1900

FIG. 19

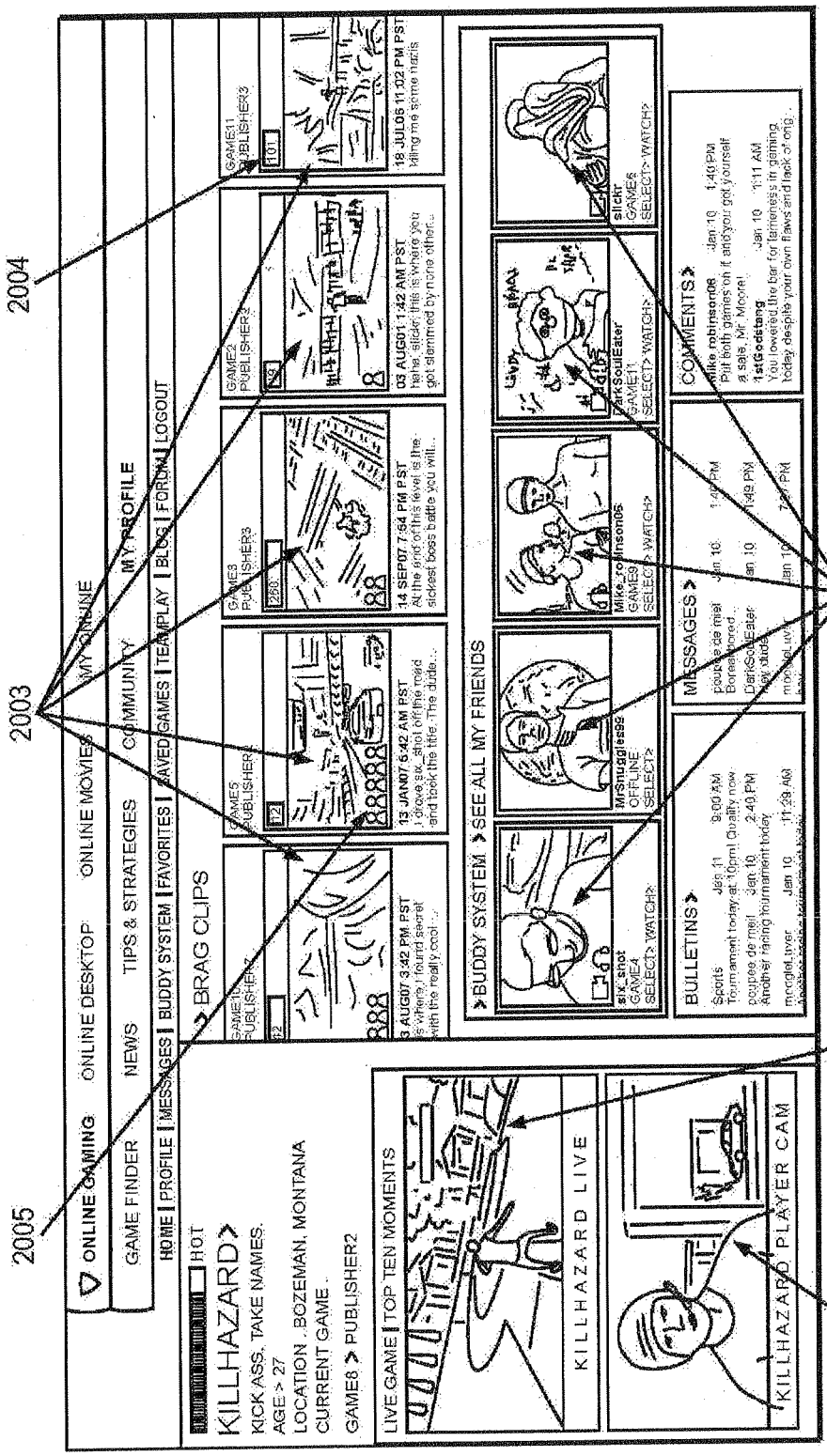

2005
2003
2004
ONLINE GAMING
ONLINE DESKTOP
ONLINE MOVIES
MY ONLINE
GAME FINDER
NEWS
TIPS & STRATEGIES
COMMUNITY
MY PROFILE
HOME | PROFILE | MESSAGES | BUDDY SYSTEM | FAVORITES | SAVED GAMES | TEAMPLAY | BLOG | FORUM | LOGOUT
HOT
KILLHAZARD>
KICK ASS, TAKE NAMES.
AGE > 27
LOCATION . BOZEMAN, MONTANA
CURRENT GAME .
GAME8 > PUBLISHER2
> BRAG CLIPS
> BUDDY SYSTEM > SEE ALL MY FRIENDS
LIVE GAME | TOP TEN MOMENTS
KILLHAZARD LIVE
KILLHAZARD PLAYER CAM
BULLETINS >
MESSAGES >
COMMENTS >
2000
2001
2002

FIG. 20

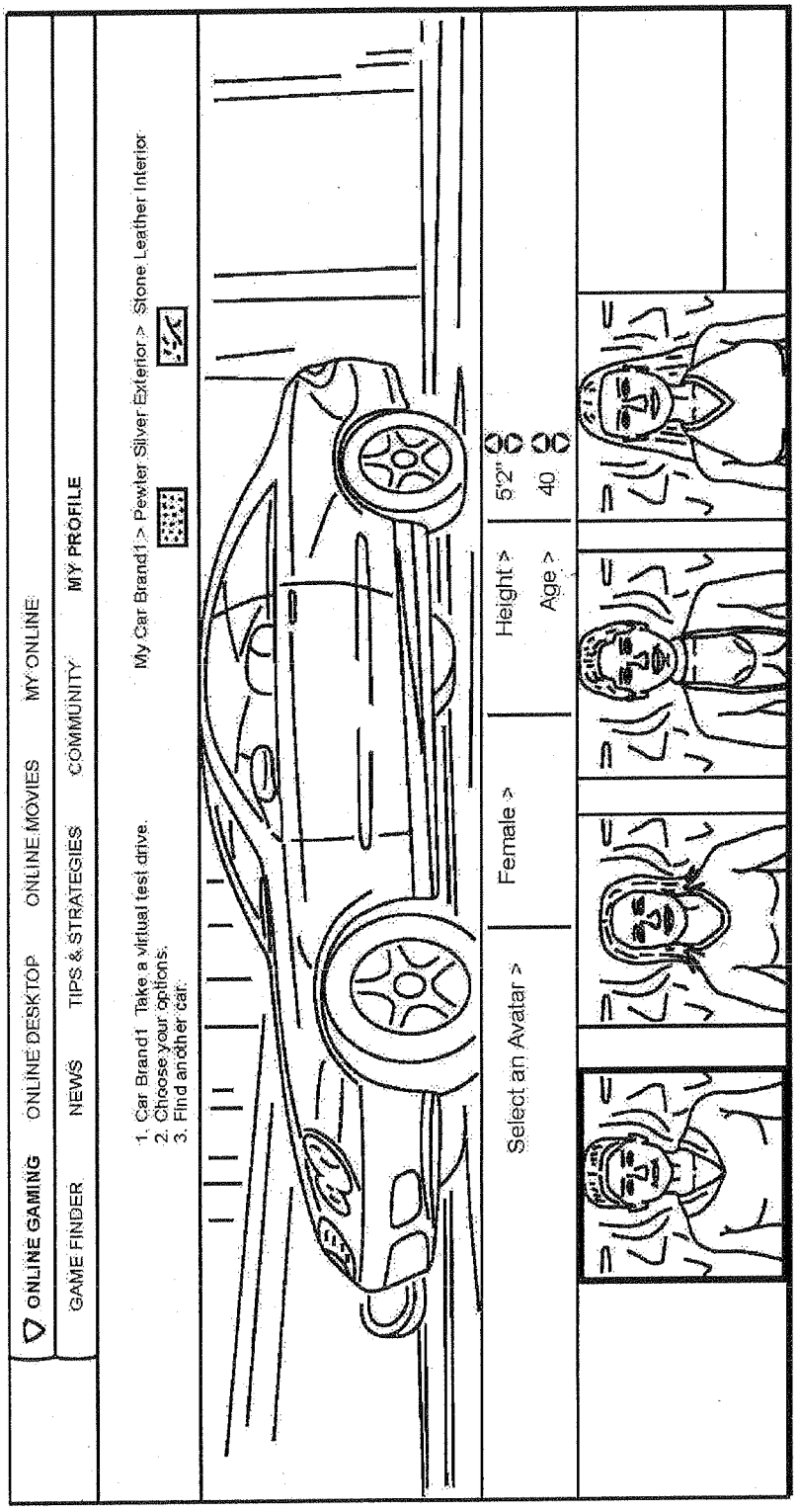

ONLINE GAMING
ONLINE DESKTOP
ONLINE MOVIES
MY ONLINE
GAME FINDER
NEWS
TIPS & STRATEGIES
COMMUNITY
MY PROFILE
1. Car Brand1 Take a virtual test drive.
2. Choose your options.
3. Find another car.
My Car Brand1 > Pewter Silver Exterior > Stone Leather Interior
Select an Avatar >
Female >
Height >
5'2"
Age >
40

FIG. 21

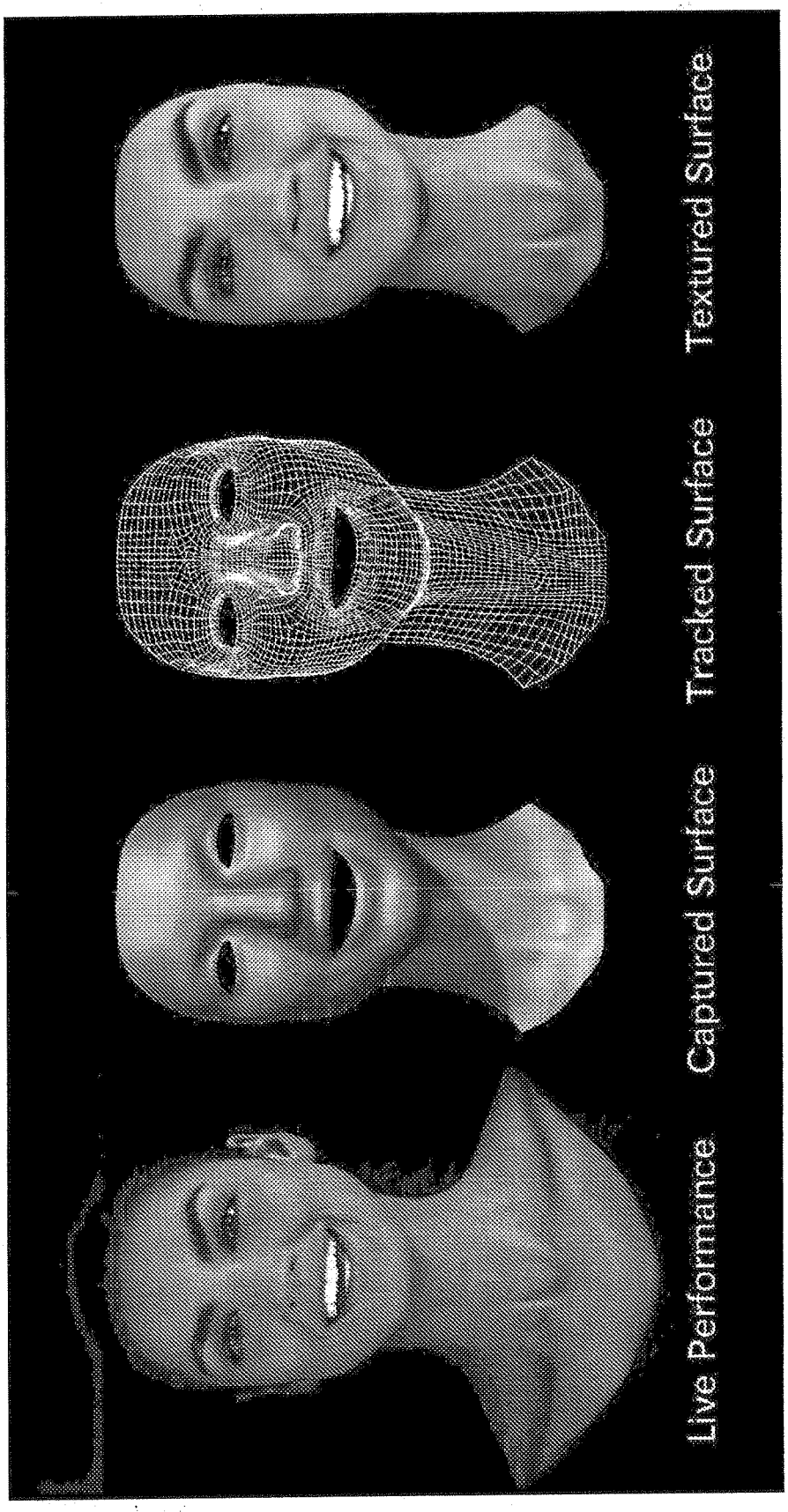

Live Performance
Captured Surface
Tracked Surface
Textured Surface

Fig. 22

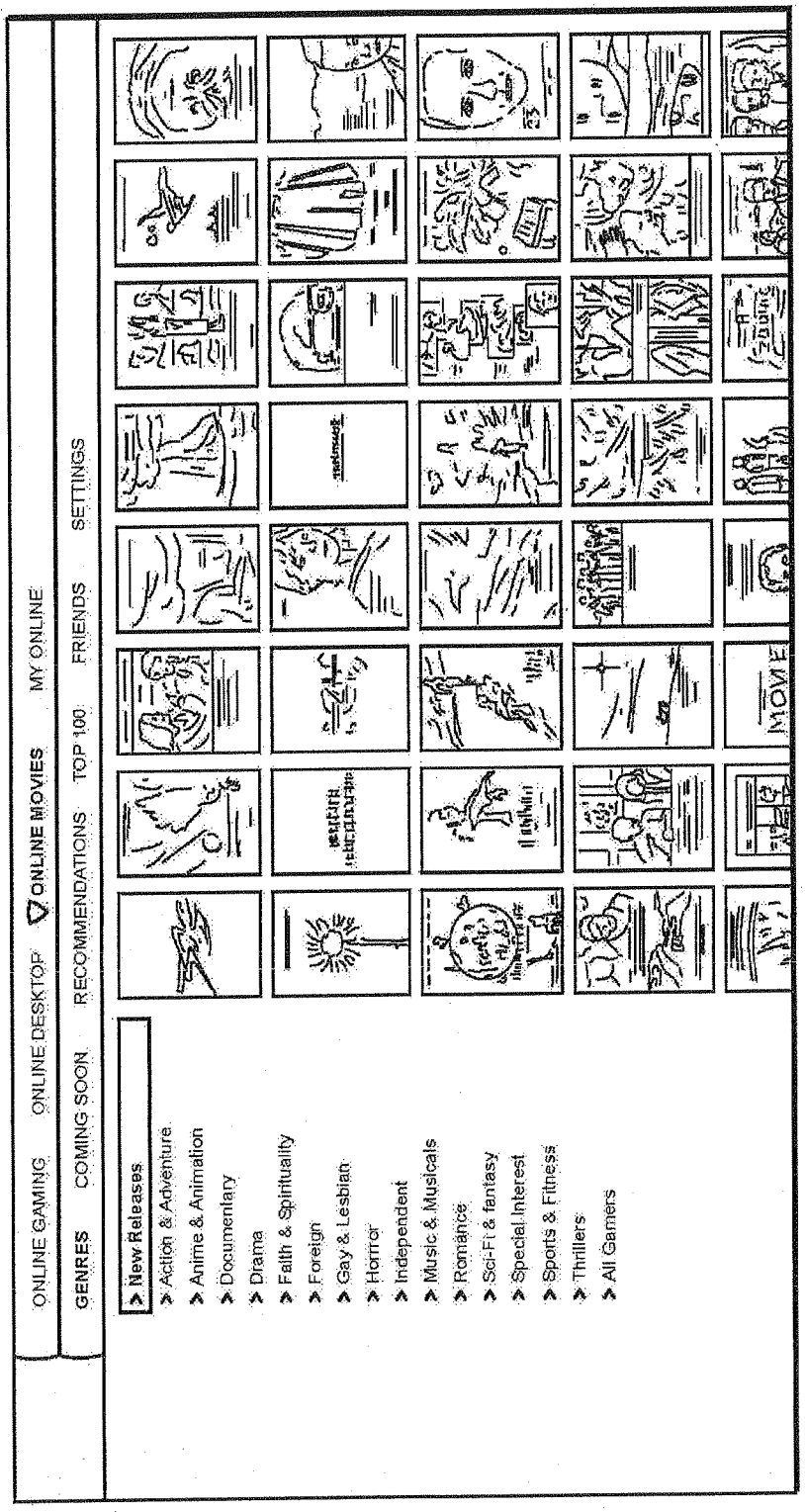

ONLINE GAMING
ONLINE DESKTOP
ONLINE MOVIES
MY ONLINE
GENRES
COMING SOON
RECOMMENDATIONS
TOP 100
FRIENDS
SETTINGS
> New Releases
> Action & Adventure
> Anime & Animation
> Documentary
> Drama
> Faith & Spirituality
> Foreign
> Gay & Lesbian
> Horror
> Independent
> Music & Musicals
> Romance
> Sci-Fi & fantasy
> Special Interest
> Sports & Fitness
> Thrillers
> All Gamers
MOVIE

FIG. 23

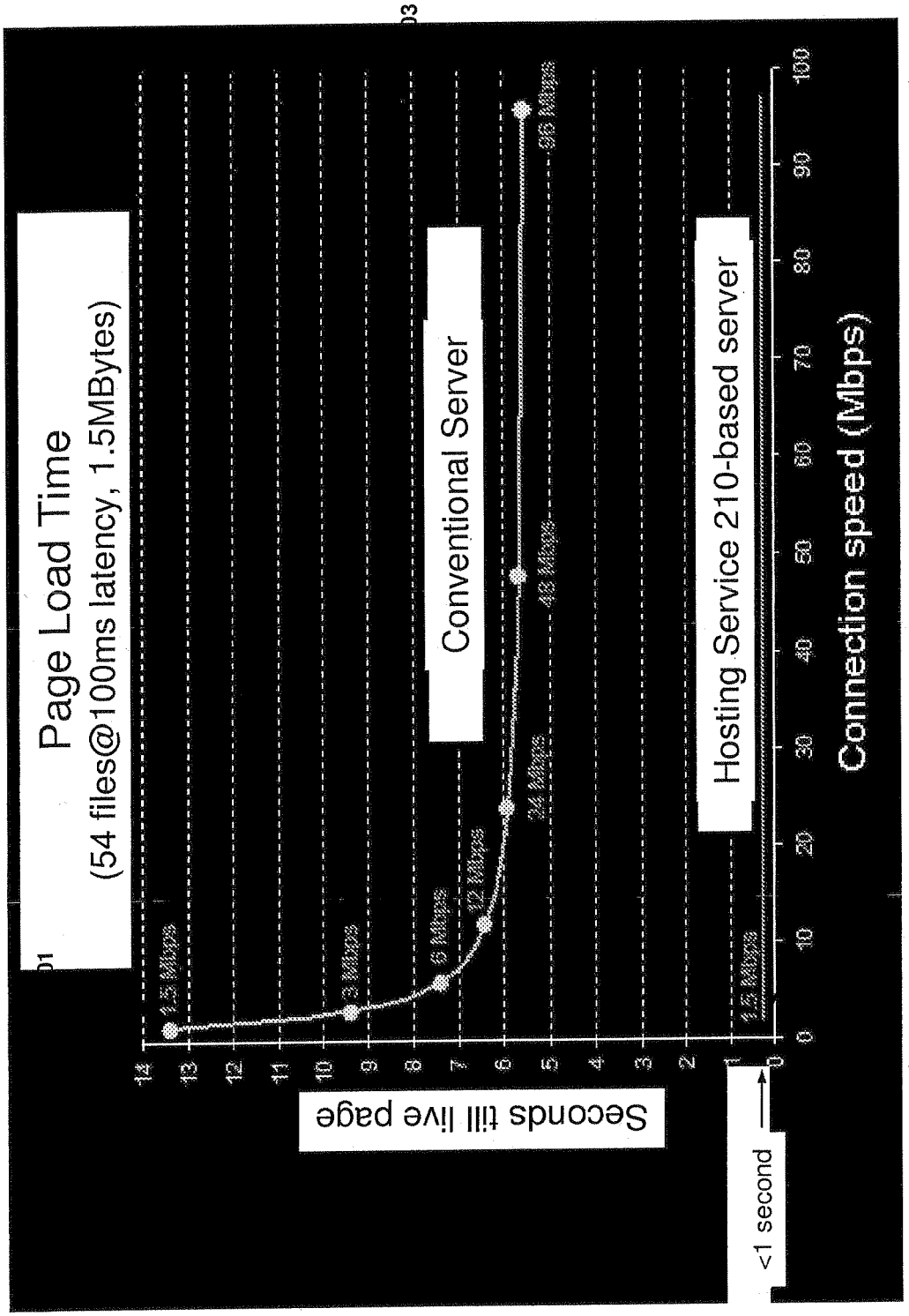

Page Load Time
(54 files@100ms latency, 1.5MBytes)
Conventional Server
Hosting Service 210-based server
Seconds till live page
Connection speed (Mbps)
<1 second
1.5 Mbps
3 Mbps
6 Mbps
12 Mbps
24 Mbps
48 Mbps
96 Mbps
0
10
20
30
40
50
60
70
80
90
100
1
2
3
4
5
6
7
8
9
10
11
12
13
14

Fig. 24

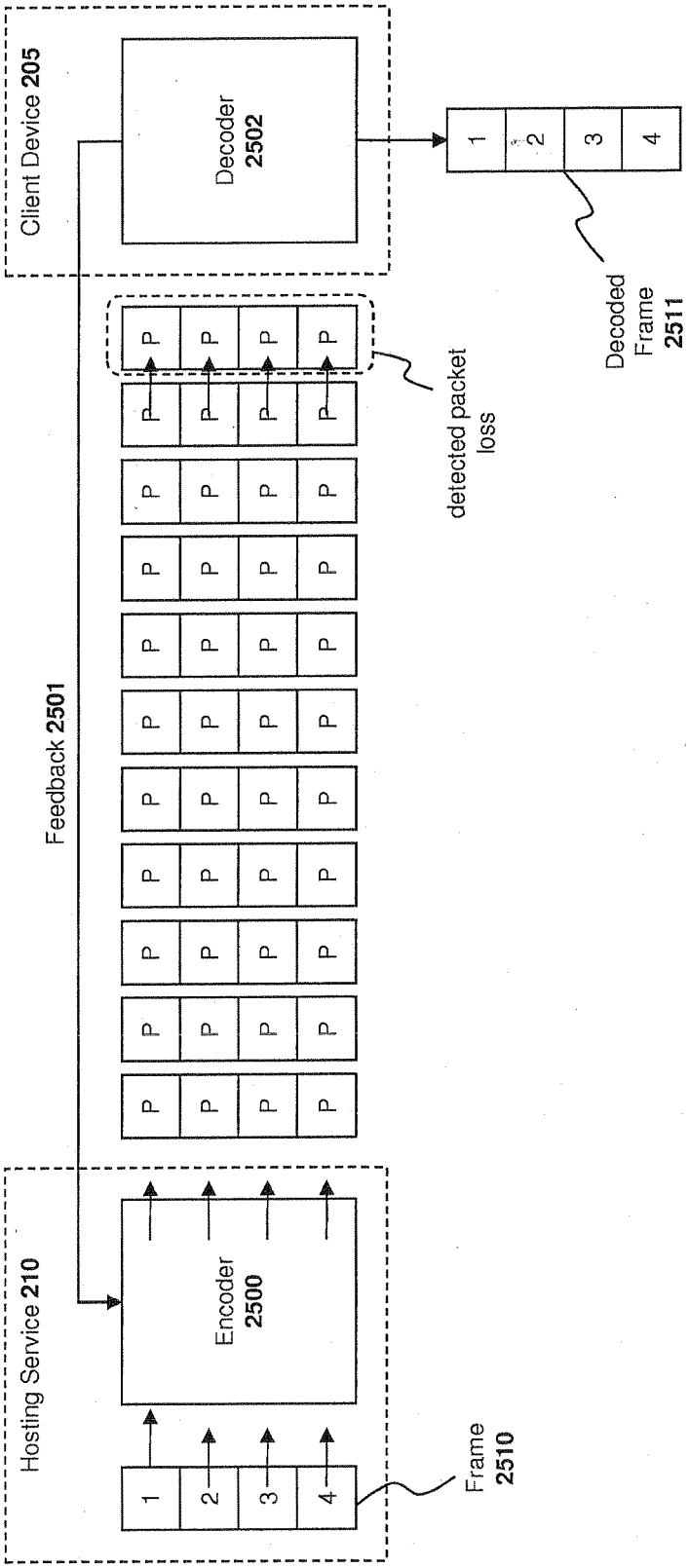

Client Device 205
Decoder 2502
1
2
3
4
Decoded Frame 2511
detected packet loss
P
Feedback 2501
Hosting Service 210
Encoder 2500
Frame 2510

Fig. 25a

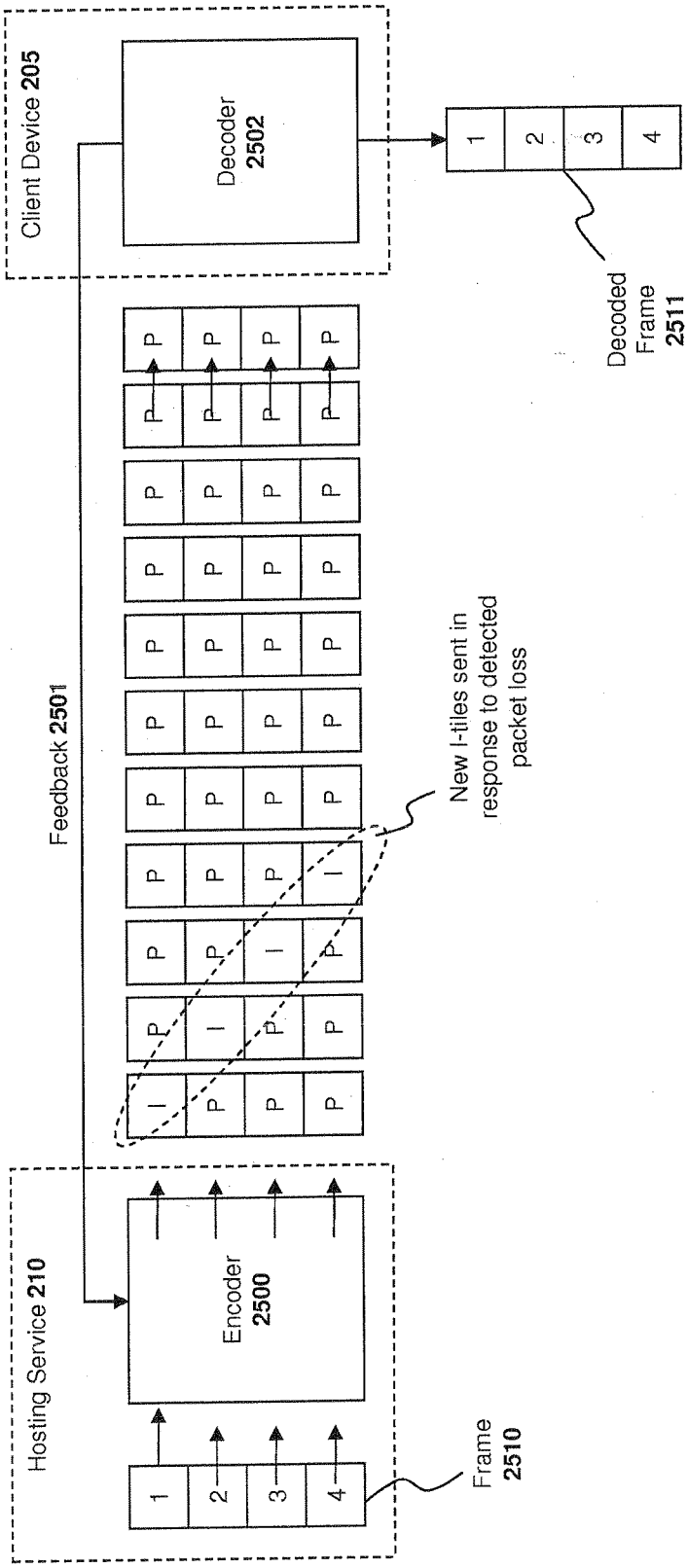

Client Device 205
Decoder 2502
1
2
3
4
Decoded Frame 2511
Feedback 2501
New I-tiles sent in response to detected packet loss
Hosting Service 210
Encoder 2500
Frame 2510

Fig. 25b

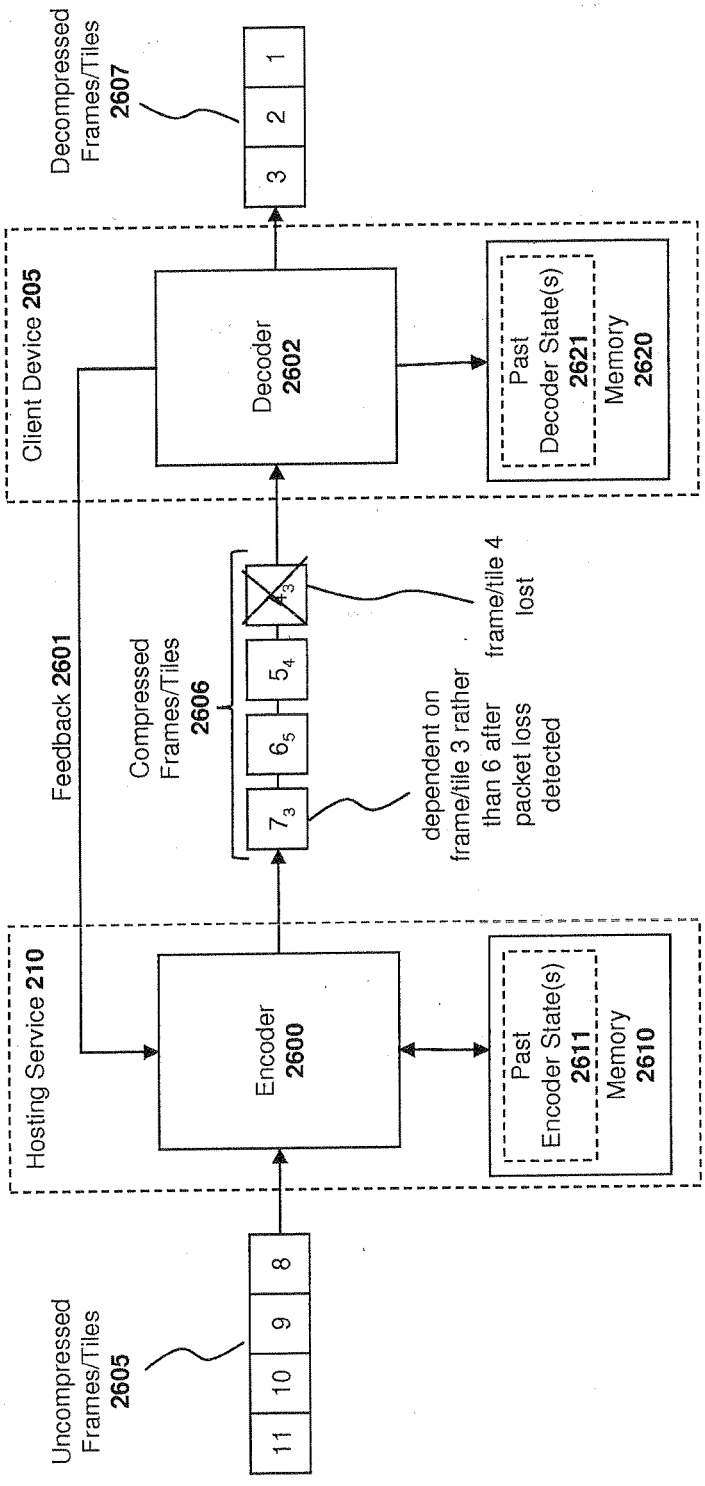

Uncompressed Frames/Tiles 2605
11
10
9
8
Hosting Service 210
Encoder 2600
Past Encoder State(s) 2611
Memory 2610
Feedback 2601
Compressed Frames/Tiles 2606
7_3
6_5
5_4
F_3
dependent on frame/tile 3 rather than 6 after packet loss detected
frame/tile 4 lost
Client Device 205
Decoder 2602
Past Decoder State(s) 2621
Memory 2620
Decompressed Frames/Tiles 2607
3
2
1

Fig. 26a

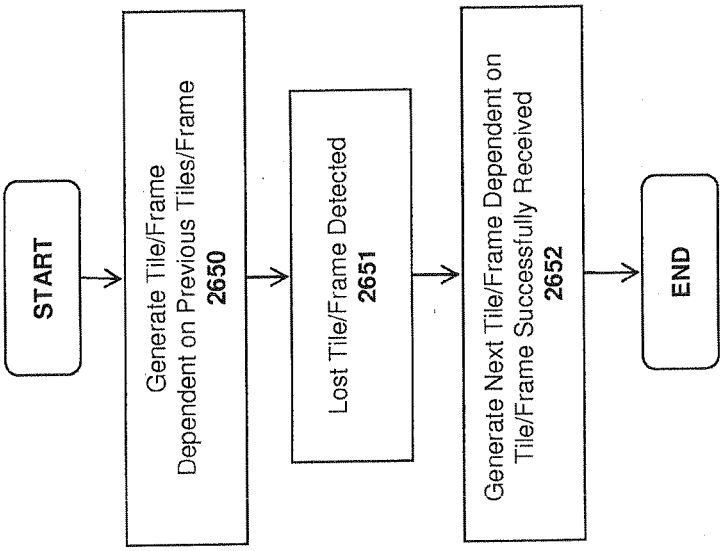

START
Generate Tile/Frame Dependent on Previous Tiles/Frame 2650
Lost Tile/Frame Detected 2651
Generate Next Tile/Frame Dependent on Tile/Frame Successfully Received 2652
END

Fig. 26b

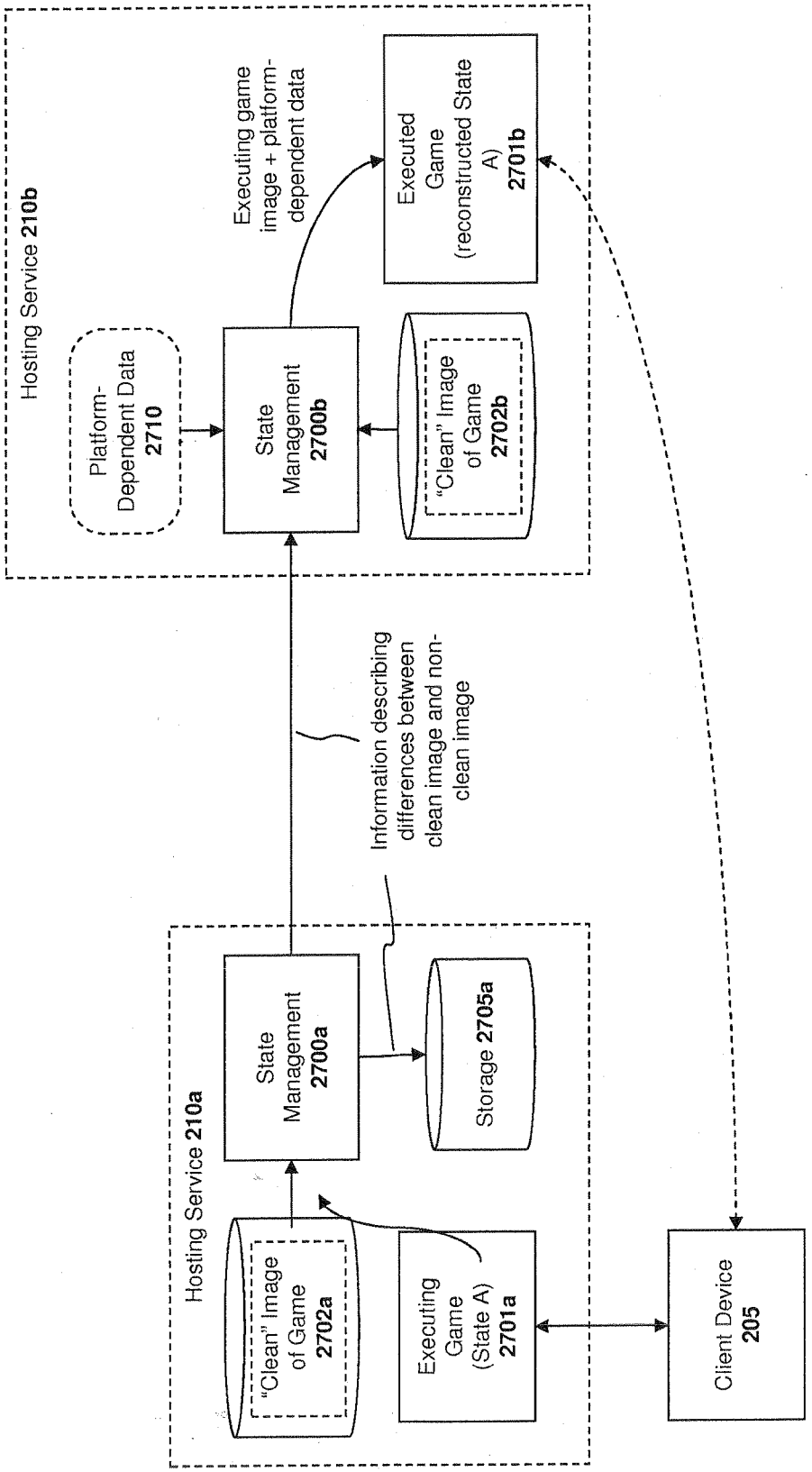

Hosting Service 210b
Platform-Dependent Data 2710
State Management 2700b
"Clean" Image of Game 2702b
Executing game image + platform-dependent data
Executed Game (reconstructed State A) 2701b
Information describing differences between clean image and non-clean image
Hosting Service 210a
State Management 2700a
Storage 2705a
"Clean" Image of Game 2702a
Executing Game (State A) 2701a
Client Device 205

Fig. 27a

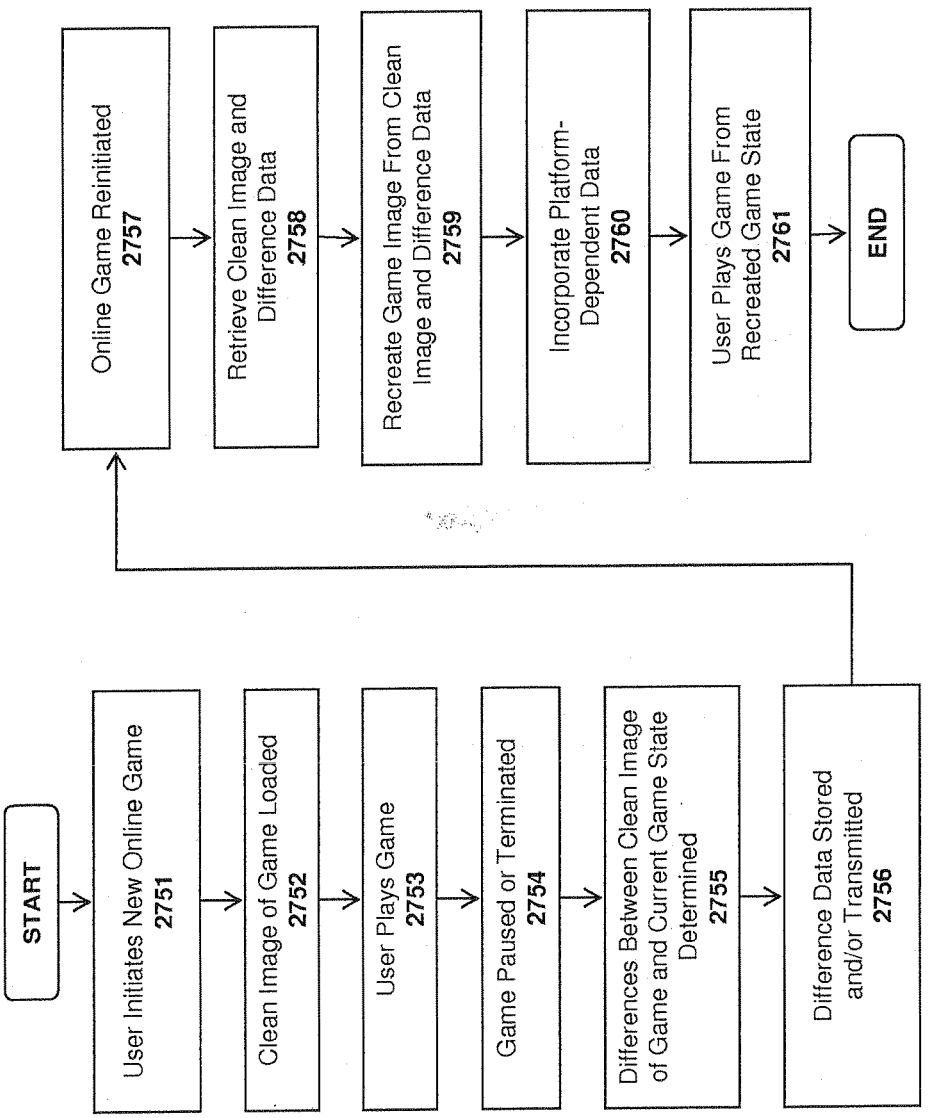

START
User Initiates New Online Game
2751
Clean Image of Game Loaded
2752
User Plays Game
2753
Game Paused or Terminated
2754
Differences Between Clean Image of Game and Current Game State Determined
2755
Difference Data Stored and/or Transmitted
2756
Online Game Reinitiated
2757
Retrieve Clean Image and Difference Data
2758
Recreate Game Image From Clean Image and Difference Data
2759
Incorporate Platform-Dependent Data
2760
User Plays Game From Recreated Game State
2761
END

Fig. 27b

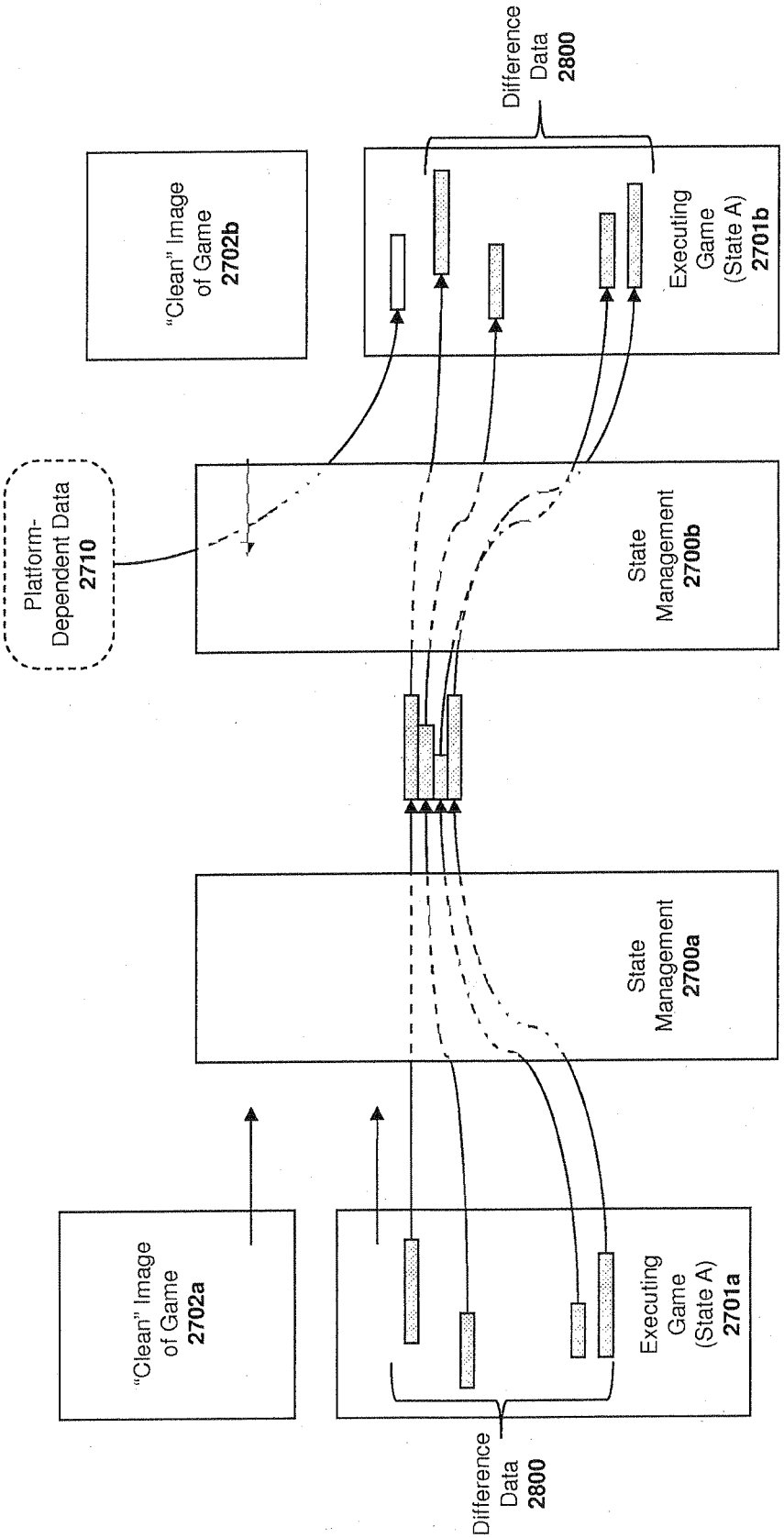

Difference Data 2800
"Clean" Image of Game 2702b
Executing Game (State A) 2701b
Platform-Dependent Data 2710
State Management 2700b
State Management 2700a
"Clean" Image of Game 2702a
Executing Game (State A) 2701a
Difference Data 2800

Fig. 28

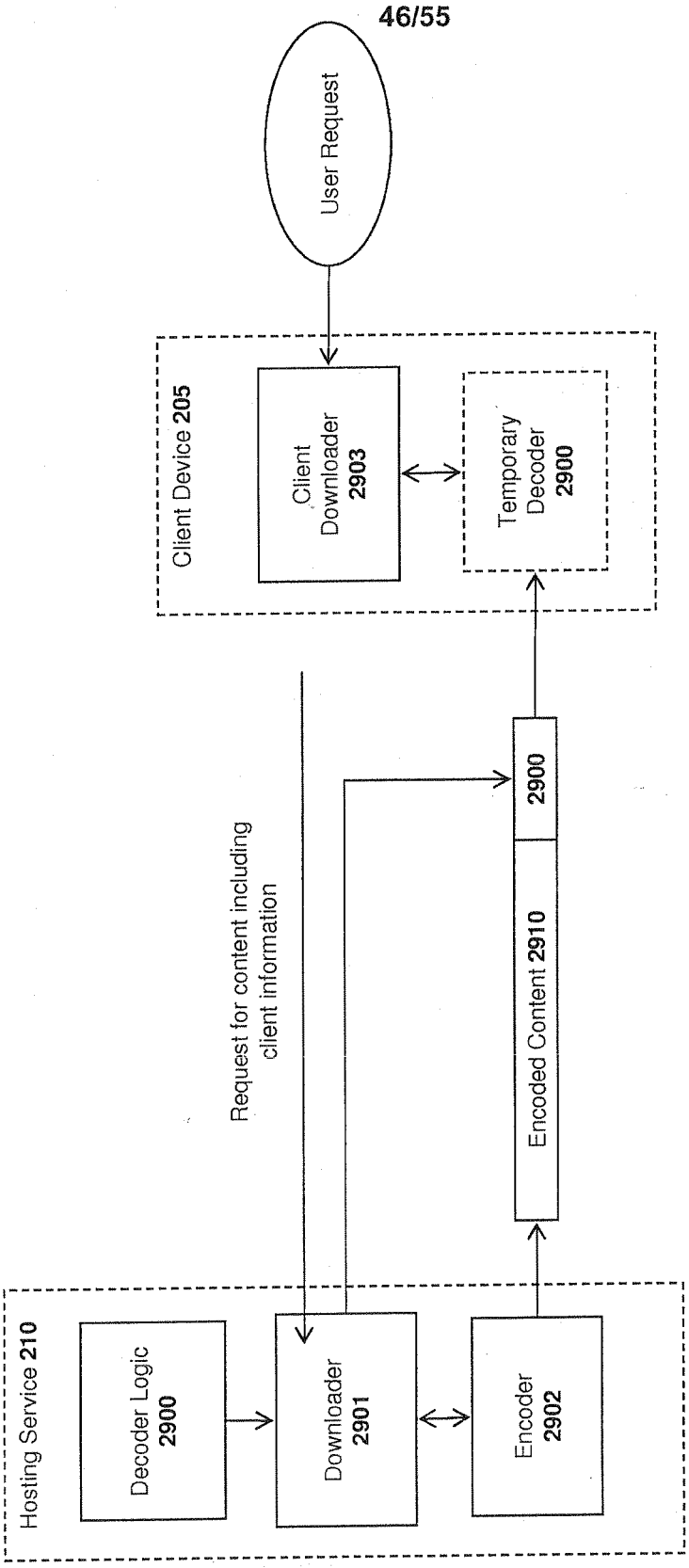

User Request
Client Device 205
Client Downloader 2903
Temporary Decoder 2900
Request for content including client information
2900
Encoded Content 2910
Hosting Service 210
Decoder Logic 2900
Downloader 2901
Encoder 2902

Fig. 29

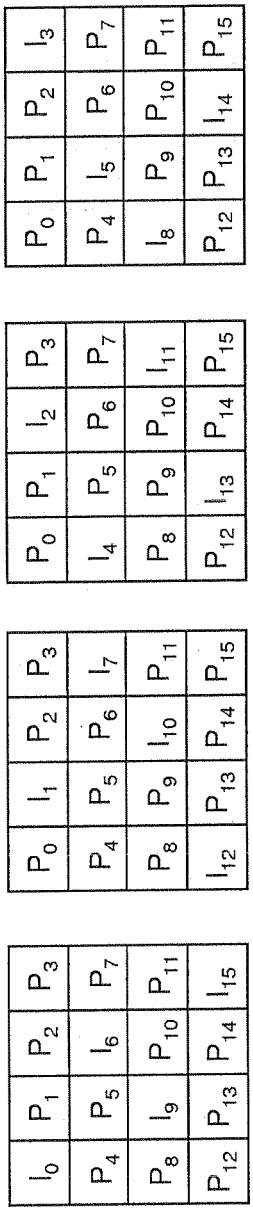

I0 P1 P2 P3
P4 P5 I6 P7
P8 I9 P10 P11
P12 P13 P14 I15
R Frame
3001
P0 I1 P2 P3
P4 P5 P6 I7
P8 P9 I10 P11
I12 P13 P14 P15
R Frame
3002
P0 P1 I2 P3
I4 P5 P6 P7
P8 P9 P10 I11
P12 I13 P14 P15
R Frame
3003
P0 P1 P2 I3
P4 I5 P6 P7
I8 P9 P10 P11
P12 P13 I14 P15
R Frame
3004

Fig. 30

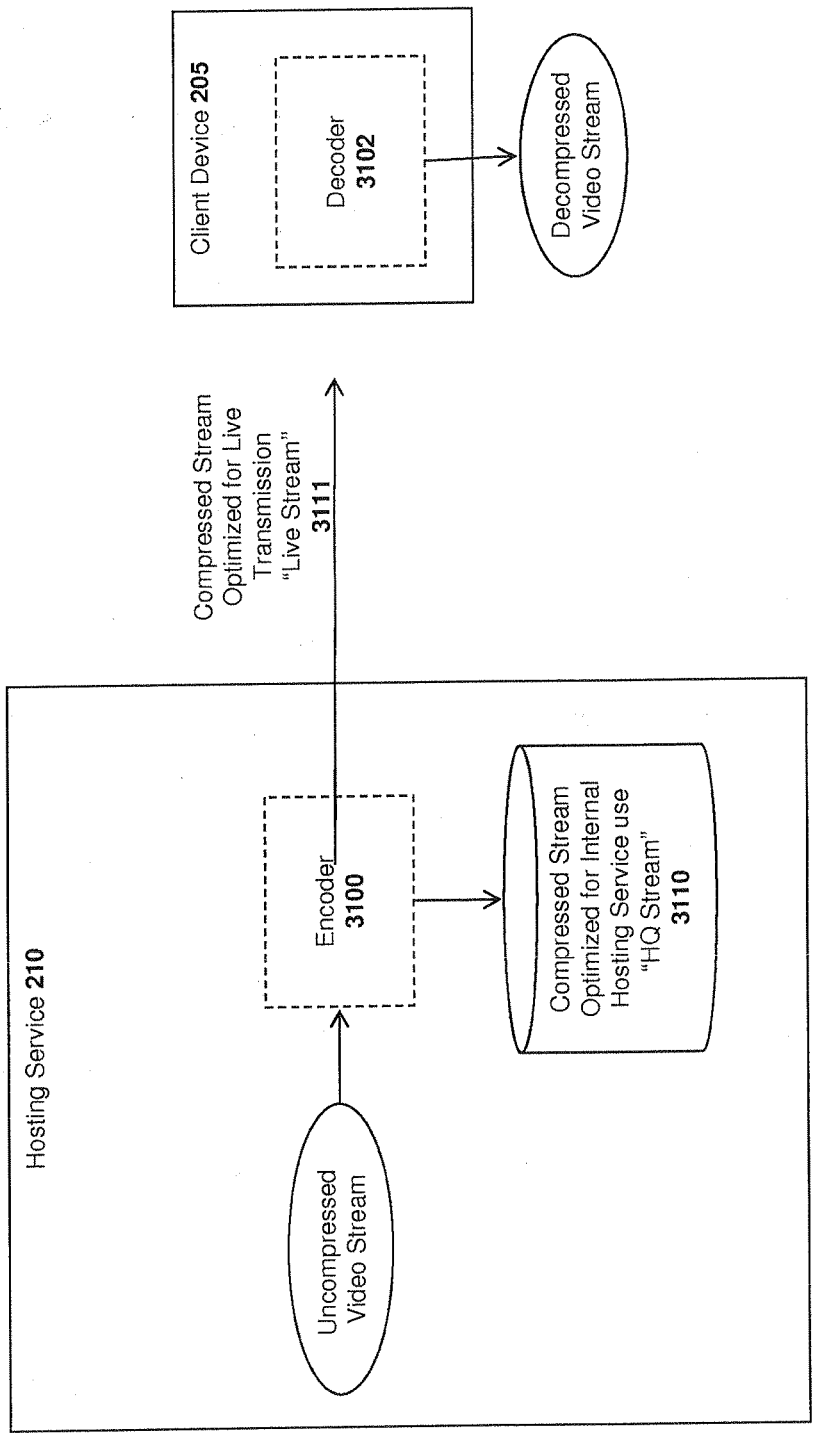

Client Device 205
Decoder 3102
Decompressed Video Stream
Compressed Stream Optimized for Live Transmission "Live Stream" 3111
Hosting Service 210
Encoder 3100
Compressed Stream Optimized for Internal Hosting Service use "HQ Stream" 3110
Uncompressed Video Stream

Fig. 31a

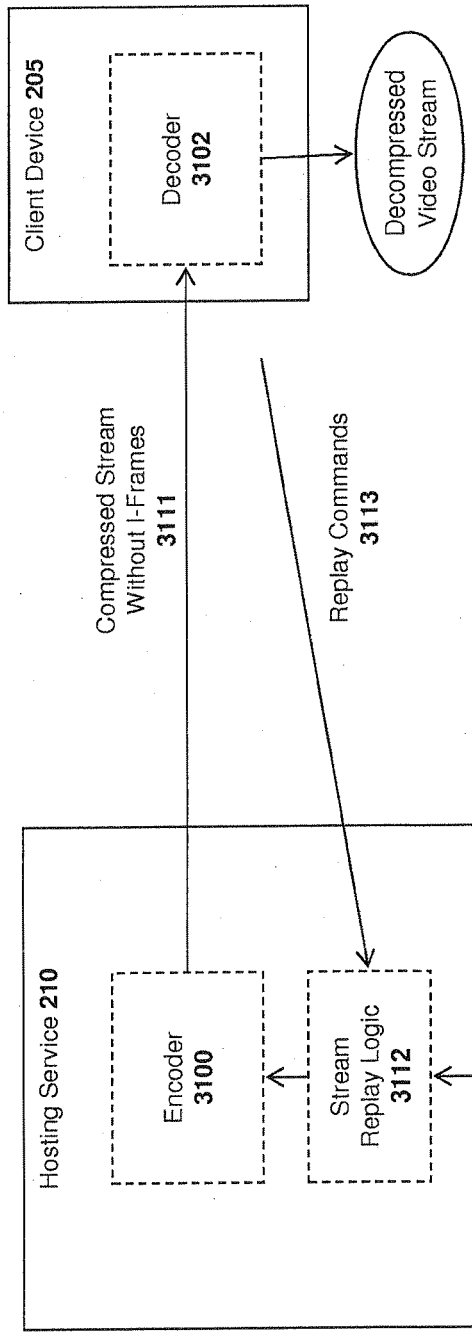

Client Device 205
Decoder 3102
Decompressed Video Stream
Compressed Stream Without I-Frames 3111
Replay Commands 3113
Hosting Service 210
Encoder 3100
Stream Replay Logic 3112
Compressed Stream With I-Frames 3110

Fig. 31b

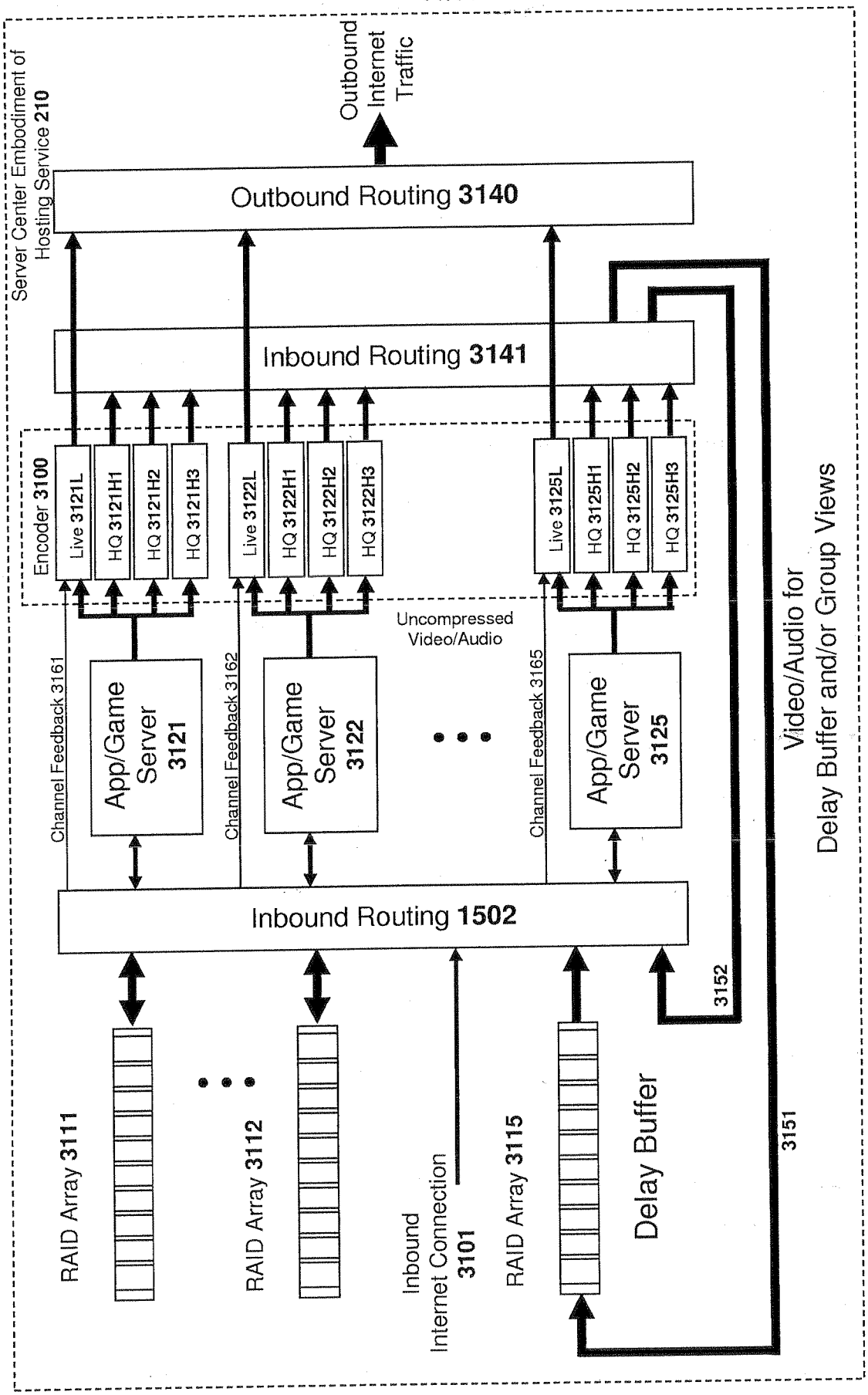

Server Center Embodiment of Hosting Service 210
Outbound Internet Traffic
Outbound Routing 3140
Inbound Routing 3141
Encoder 3100
Live 3121L
HQ 3121H1
HQ 3121H2
HQ 3121H3
Live 3122L
HQ 3122H1
HQ 3122H2
HQ 3122H3
Live 3125L
HQ 3125H1
HQ 3125H2
HQ 3125H3
Uncompressed Video/Audio
Channel Feedback 3161
Channel Feedback 3162
Channel Feedback 3165
App/Game Server 3121
App/Game Server 3122
App/Game Server 3125
Inbound Routing 1502
3152
Video/Audio for Delay Buffer and/or Group Views
3151
RAID Array 3111
RAID Array 3112
Inbound Internet Connection 3101
RAID Array 3115
Delay Buffer

Fig. 31c

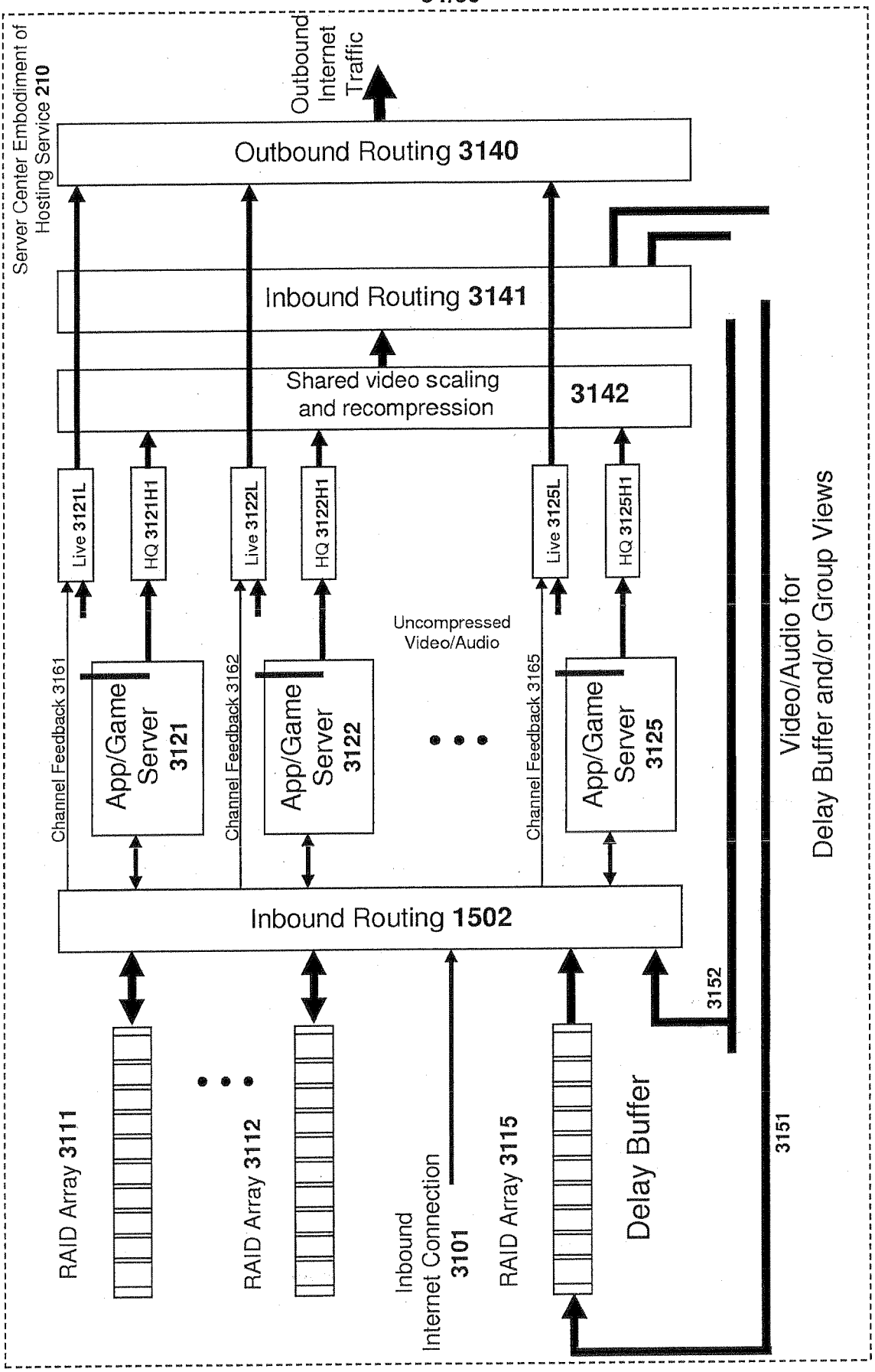

Server Center Embodiment of Hosting Service 210
Outbound Internet Traffic
Outbound Routing 3140
Inbound Routing 3141
Shared video scaling and recompression
3142
Live 3121L
HQ 3121H1
Live 3122L
HQ 3122H1
Live 3125L
HQ 3125H1
Uncompressed Video/Audio
Channel Feedback 3161
Channel Feedback 3162
Channel Feedback 3165
App/Game Server 3121
App/Game Server 3122
App/Game Server 3125
Inbound Routing 1502
RAID Array 3111
RAID Array 3112
RAID Array 3115
Inbound Internet Connection 3101
Delay Buffer
3152
3151
Video/Audio for Delay Buffer and/or Group Views

Fig. 31d

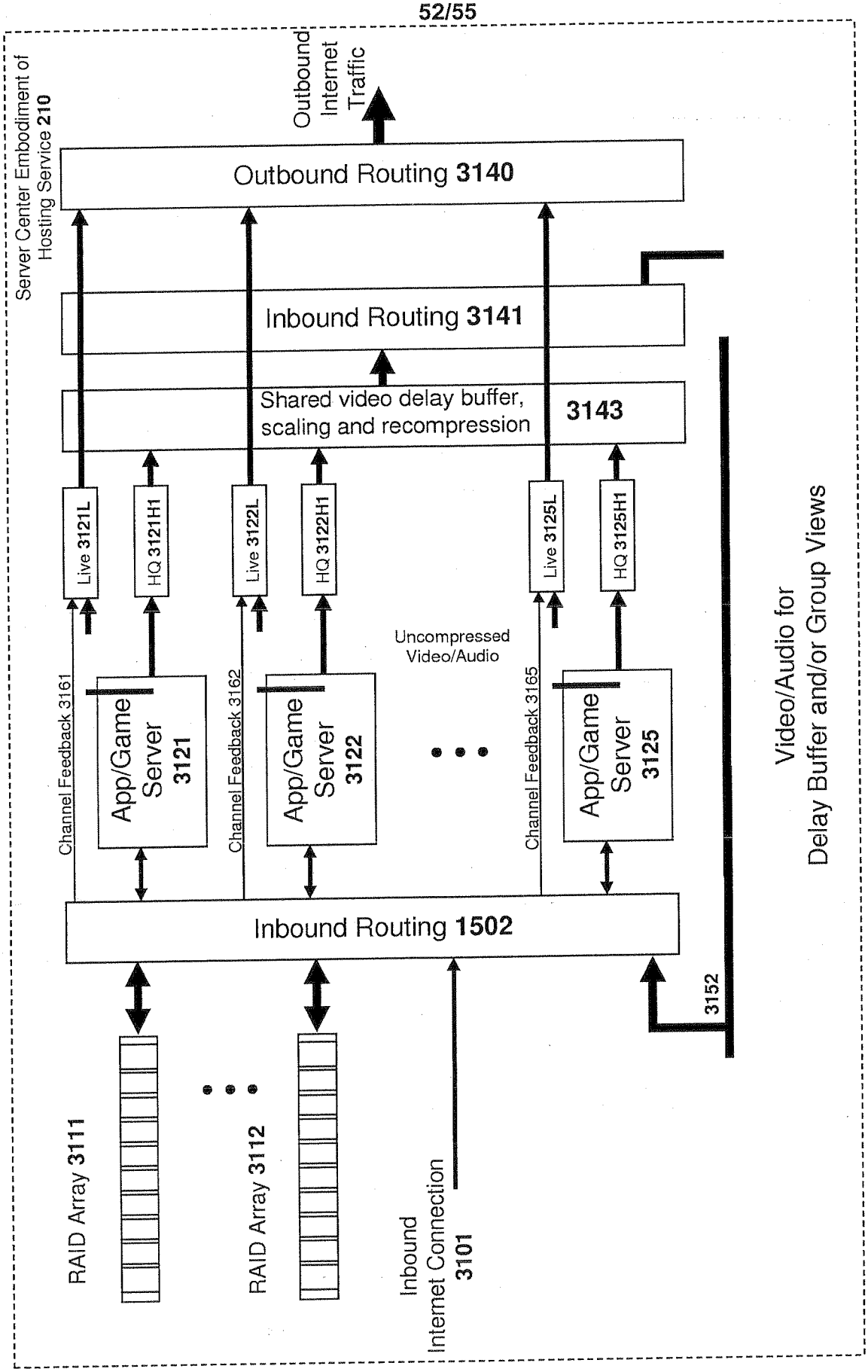

Server Center Embodiment of Hosting Service 210
Outbound Internet Traffic
Outbound Routing 3140
Inbound Routing 3141
Shared video delay buffer, scaling and recompression
3143
Live 3121L
HQ 3121H1
Live 3122L
HQ 3122H1
Live 3125L
HQ 3125H1
Uncompressed Video/Audio
Channel Feedback 3161
Channel Feedback 3162
Channel Feedback 3165
App/Game Server 3121
App/Game Server 3122
App/Game Server 3125
Inbound Routing 1502
3152
Video/Audio for Delay Buffer and/or Group Views
RAID Array 3111
RAID Array 3112
Inbound Internet Connection 3101

Fig. 31e

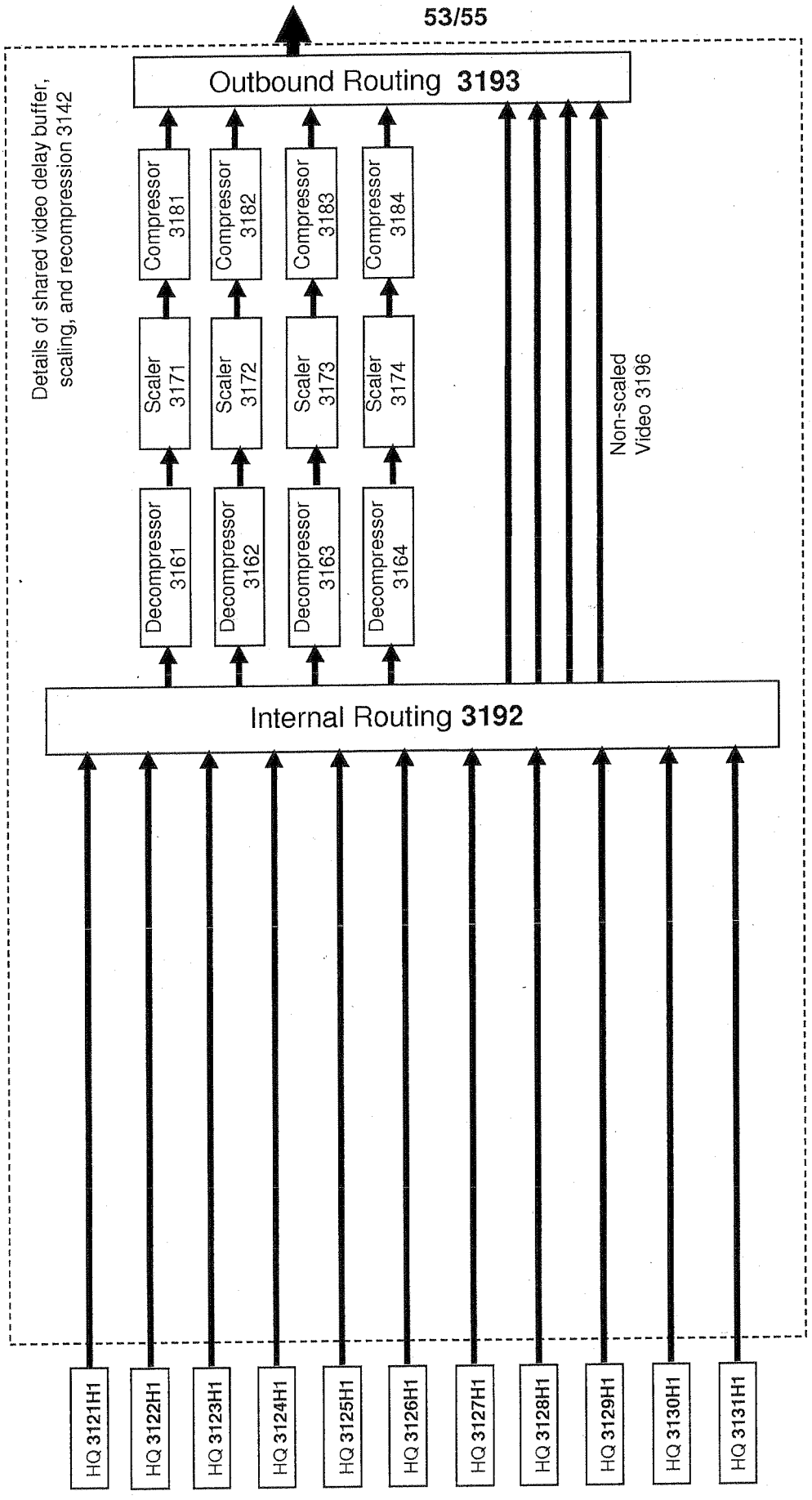

Details of shared video delay buffer, scaling, and recompression 3142
Outbound Routing 3193
Compressor 3181
Compressor 3182
Compressor 3183
Compressor 3184
Scaler 3171
Scaler 3172
Scaler 3173
Scaler 3174
Decompressor 3161
Decompressor 3162
Decompressor 3163
Decompressor 3164
Non-scaled Video 3196
Internal Routing 3192
HQ 3121H1
HQ 3122H1
HQ 3123H1
HQ 3124H1
HQ 3125H1
HQ 3126H1
HQ 3127H1
HQ 3128H1
HQ 3129H1
HQ 3130H1
HQ 3131H1

Fig. 31f

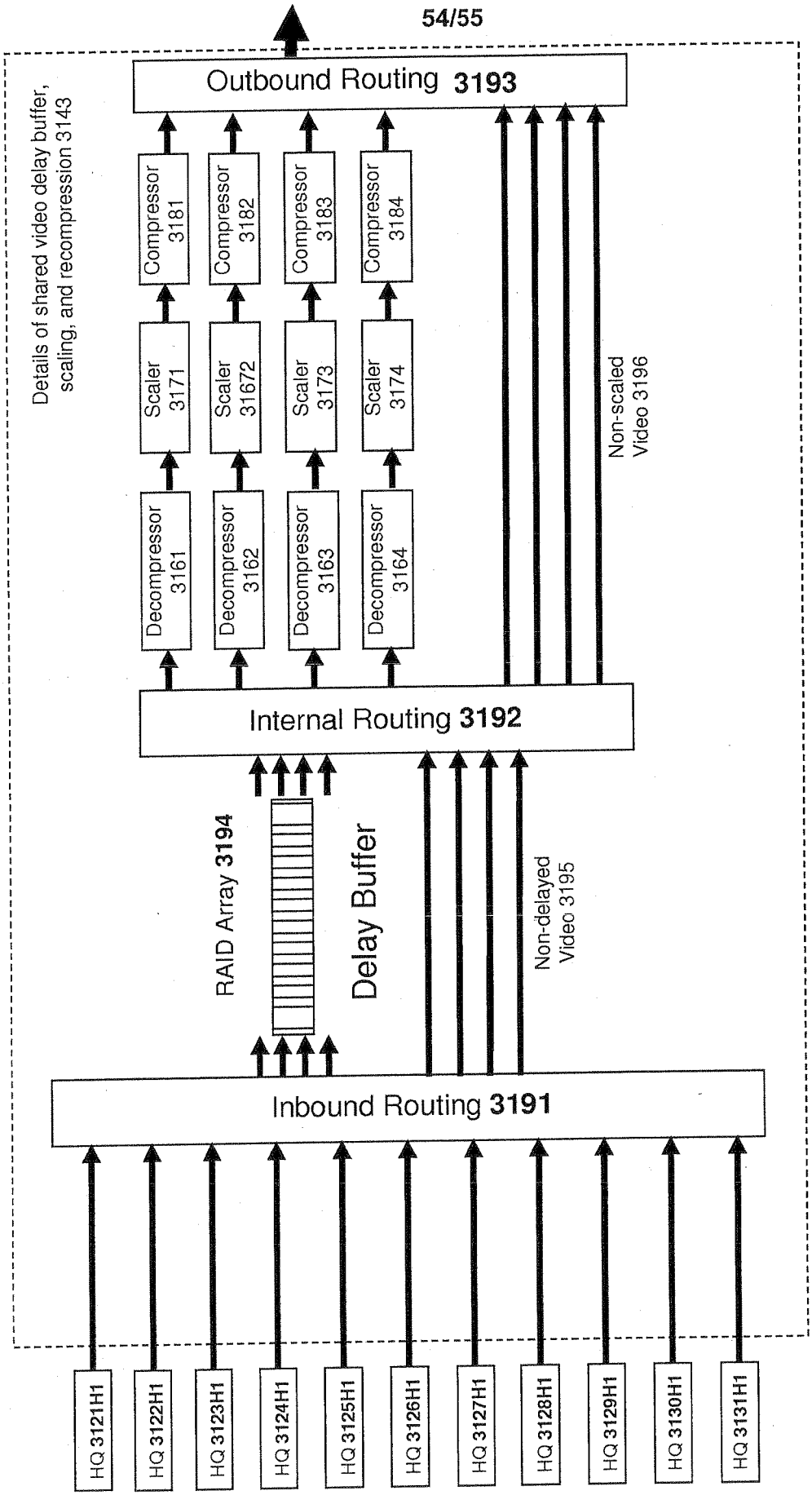

Details of shared video delay buffer, scaling, and recompression 3143
Outbound Routing 3193
Compressor 3181
Compressor 3182
Compressor 3183
Compressor 3184
Scaler 3171
Scaler 31672
Scaler 3173
Scaler 3174
Decompressor 3161
Decompressor 3162
Decompressor 3163
Decompressor 3164
Non-scaled Video 3196
Internal Routing 3192
RAID Array 3194
Delay Buffer
Non-delayed Video 3195
Inbound Routing 3191
HQ 3121H1
HQ 3122H1
HQ 3123H1
HQ 3124H1
HQ 3125H1
HQ 3126H1
HQ 3127H1
HQ 3128H1
HQ 3129H1
HQ 3130H1
HQ 3131H1

Fig. 31g

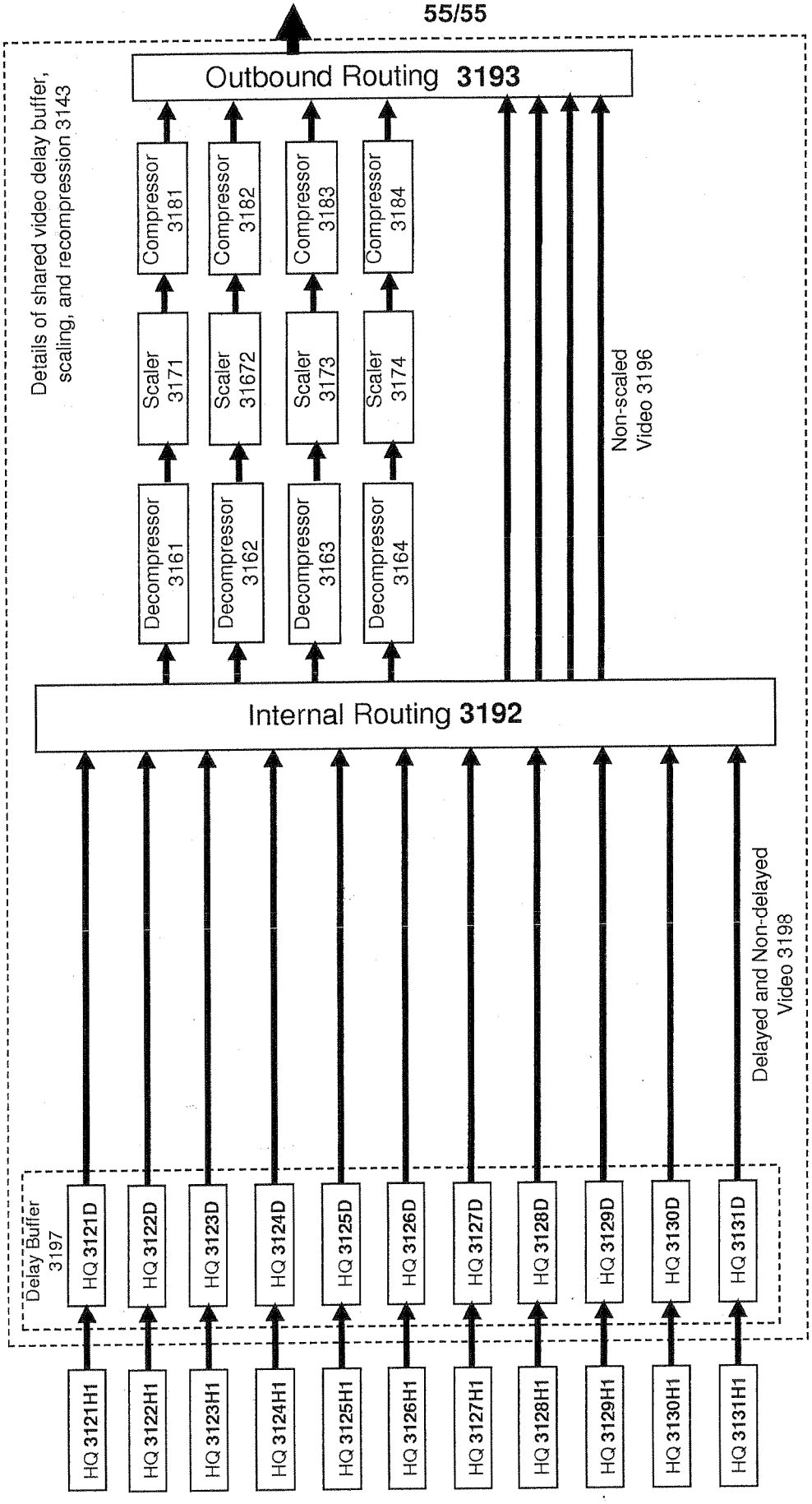

Outbound Routing 3193
Details of shared video delay buffer, scaling, and recompression 3143
Compressor 3181
Compressor 3182
Compressor 3183
Compressor 3184
Scaler 3171
Scaler 31672
Scaler 3173
Scaler 3174
Decompressor 3161
Decompressor 3162
Decompressor 3163
Decompressor 3164
Non-scaled Video 3196
Internal Routing 3192
Delay Buffer 3197
HQ 3121D
HQ 3122D
HQ 3123D
HQ 3124D
HQ 3125D
HQ 3126D
HQ 3127D
HQ 3128D
HQ 3129D
HQ 3130D
HQ 3131D
Delayed and Non-delayed Video 3198
HQ 3121H1
HQ 3122H1
HQ 3123H1
HQ 3124H1
HQ 3125H1
HQ 3126H1
HQ 3127H1
HQ 3128H1
HQ 3129H1
HQ 3130H1
HQ 3131H1

Fig. 31h