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(54) **METHOD AND SYSTEM FOR INTEGRATING ETHERNET AND MULTIMEDIA FUNCTIONS INTO A LAN SYSTEM**

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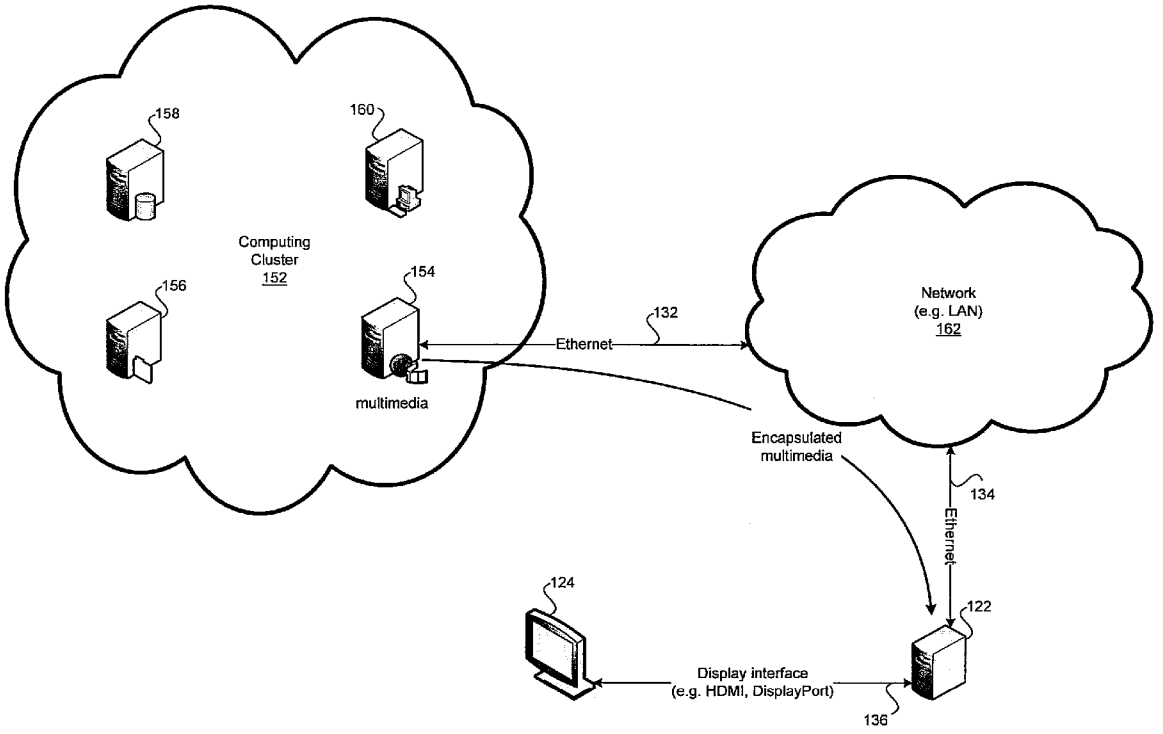
(52) **U.S. Cl.** **370/403**

(57) **ABSTRACT**

Aspects of a method and system for Ethernet and multimedia functions into a LAN subsystem are provided. In this regard, an integrated network interface which may comprise one or more Ethernet interfaces, and one or more high definition (HD) multimedia interfaces may be enabled to transmit and/or receive HD multimedia content over a network. Audio/Video Bridging and/or Audio/Video Bridging extensions may be utilized for the transmission and/or reception of HD multimedia content over a network. The integrated network interface may be enabled to transmit and/or receive physical layer signals adhering to protocols such as Ethernet and DisplayPort and may be configurable to select the type of signals to be transmitted or received. In this regard, aspects of the invention may enable converting Ethernet frames to DisplayPort micro-packets and visa-versa.



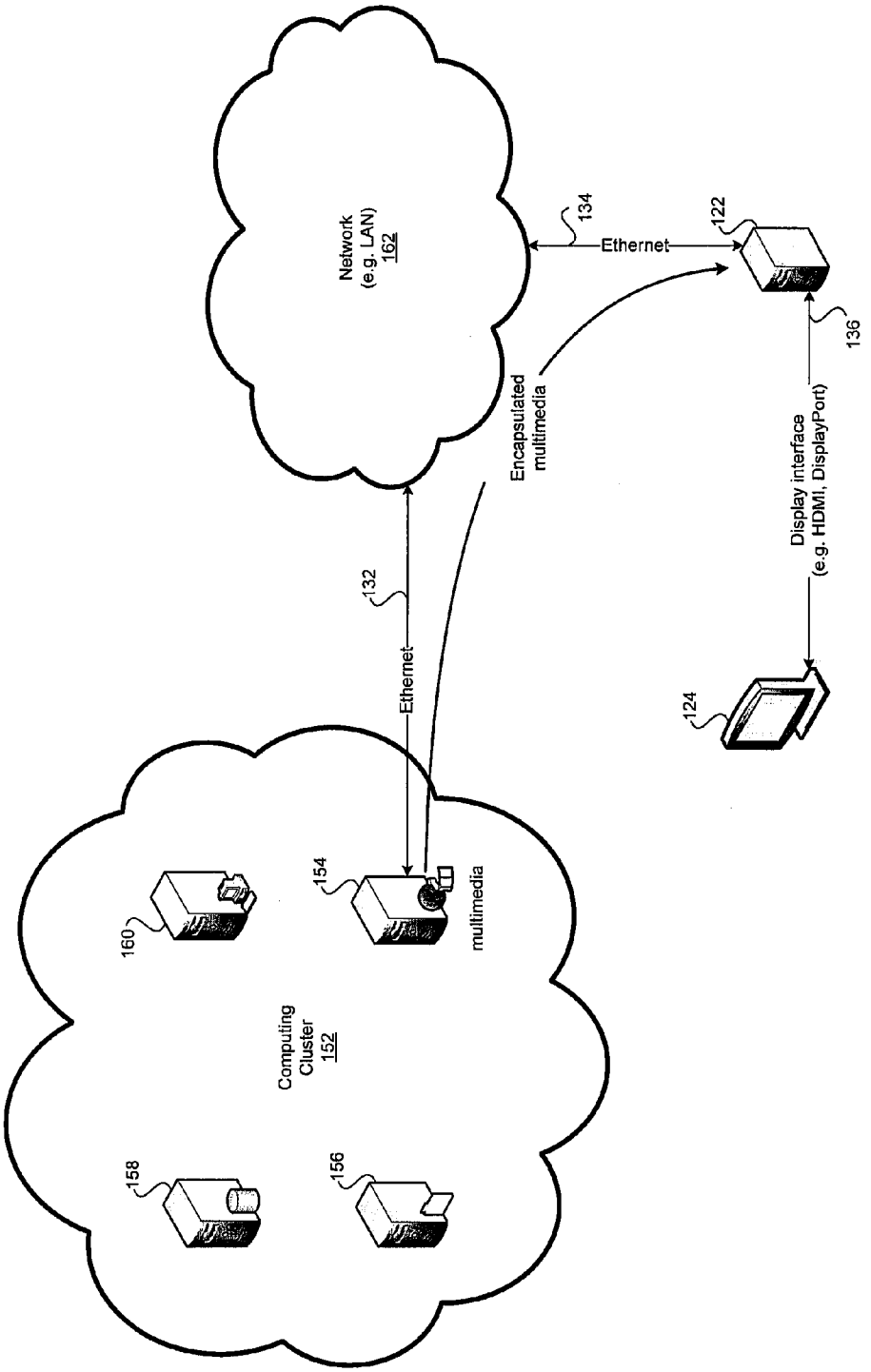

Network
(e.g. LAN)
162
134
Ethernet
122
136
Encapsulated
multimedia
Display interface
(e.g. HDMI, DisplayPort)
132
Ethernet
124
154
multimedia
160
Computing
Cluster
152
158
156

FIG 1A

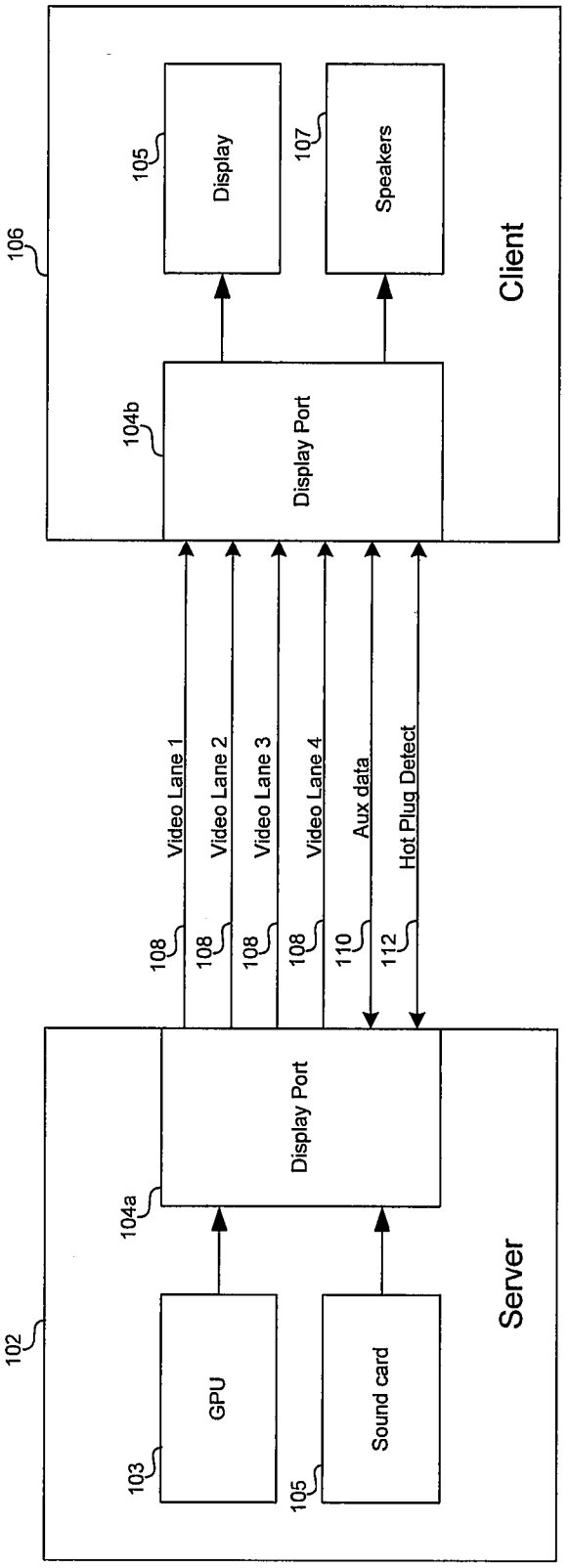

Server
102
GPU
103
Sound card
105
Display Port
104a
Video Lane 1
Video Lane 2
Video Lane 3
Video Lane 4
Aux data
Hot Plug Detect
108
108
108
108
110
112
Client
106
Display
105
Speakers
107
Display Port
104b

FIG 1B

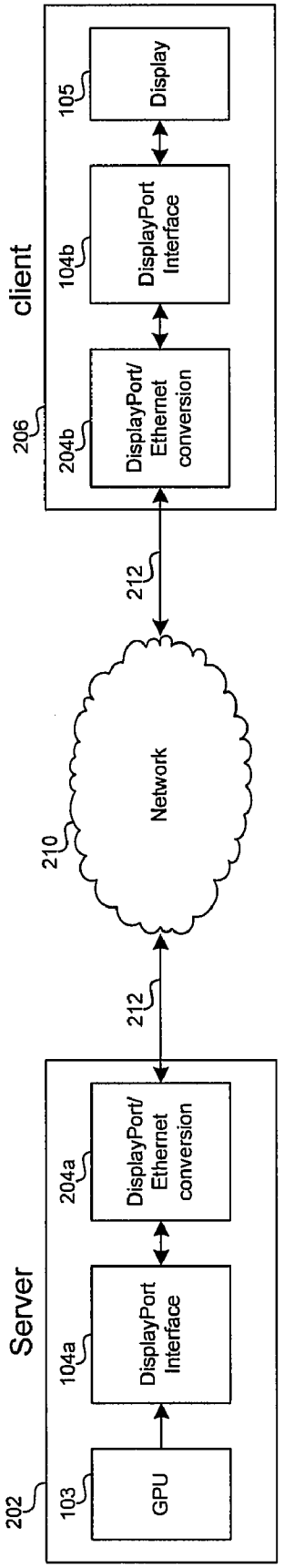

Server
202
GPU
103
DisplayPort Interface
104a
DisplayPort/ Ethernet conversion
204a
212
Network
210
212
client
206
DisplayPort/ Ethernet conversion
204b
DisplayPort Interface
104b
Display
105

FIG 2

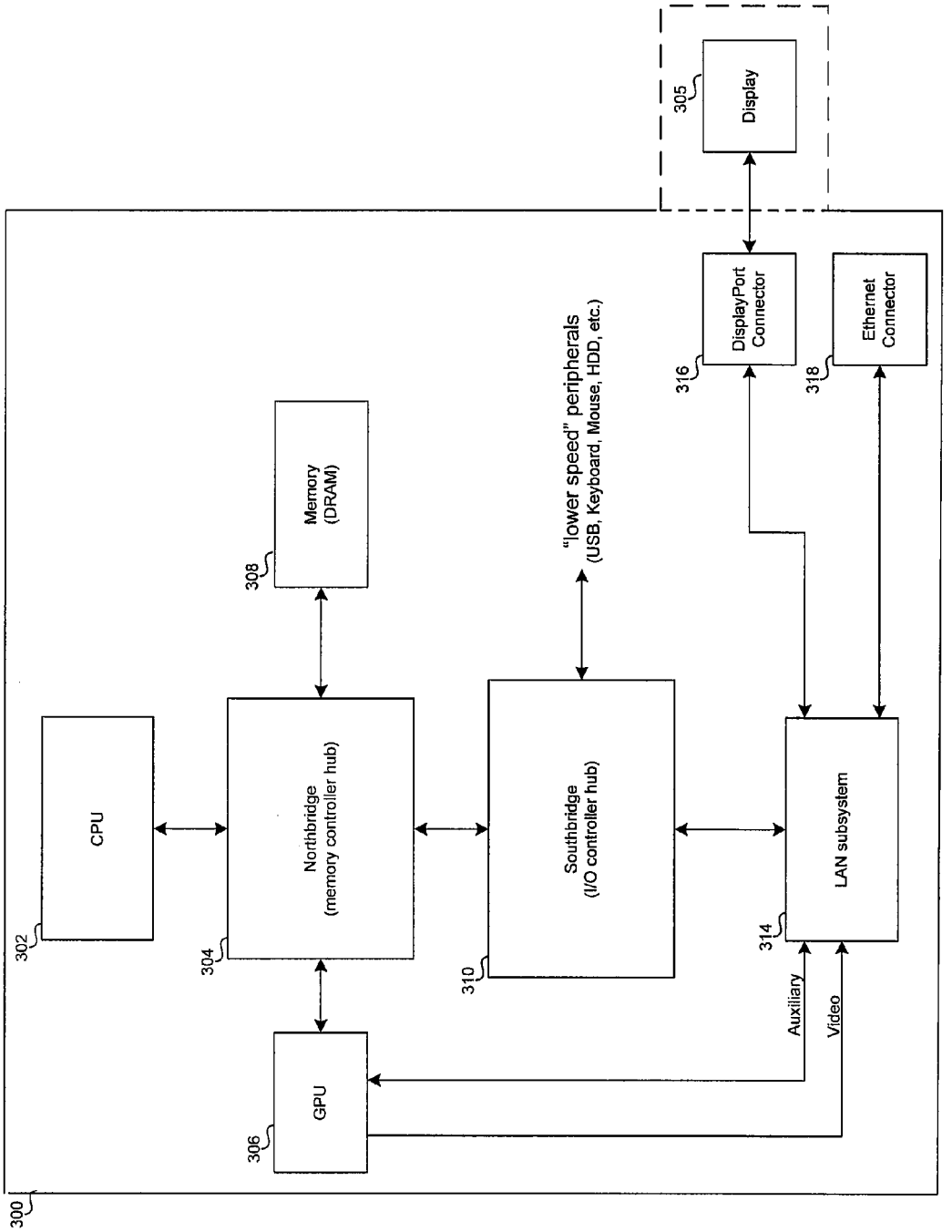

300
305
Display
316
DisplayPort Connector
318
Ethernet Connector
"lower speed" peripherals
(USB, Keyboard, Mouse, HDD, etc.)
308
Memory (DRAM)
302
CPU
304
Northbridge (memory controller hub)
310
Southbridge (I/O controller hub)
314
LAN subsystem
306
GPU
Auxiliary
Video

FIG 3

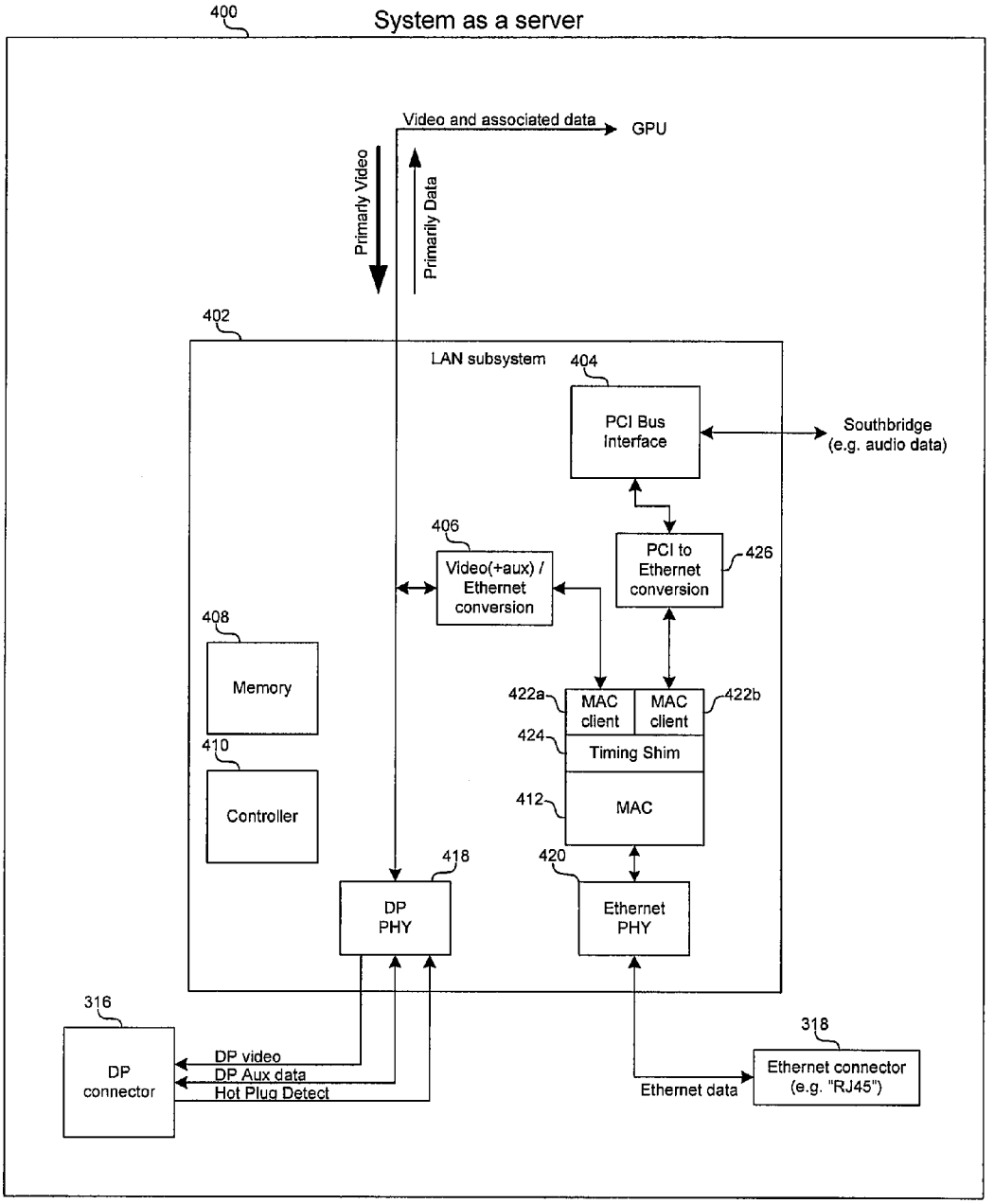

400
System as a server
Video and associated data
GPU
Primarily Video
Primarily Data
402
LAN subsystem
404
PCI Bus Interface
Southbridge (e.g. audio data)
406
Video(+aux) / Ethernet conversion
PCI to Ethernet conversion
426
408
Memory
410
Controller
422a
MAC client
MAC client
422b
424
Timing Shim
412
MAC
418
DP PHY
420
Ethernet PHY
316
DP connector
DP video
DP Aux data
Hot Plug Detect
318
Ethernet connector (e.g. "RJ45")
Ethernet data

FIG 4A

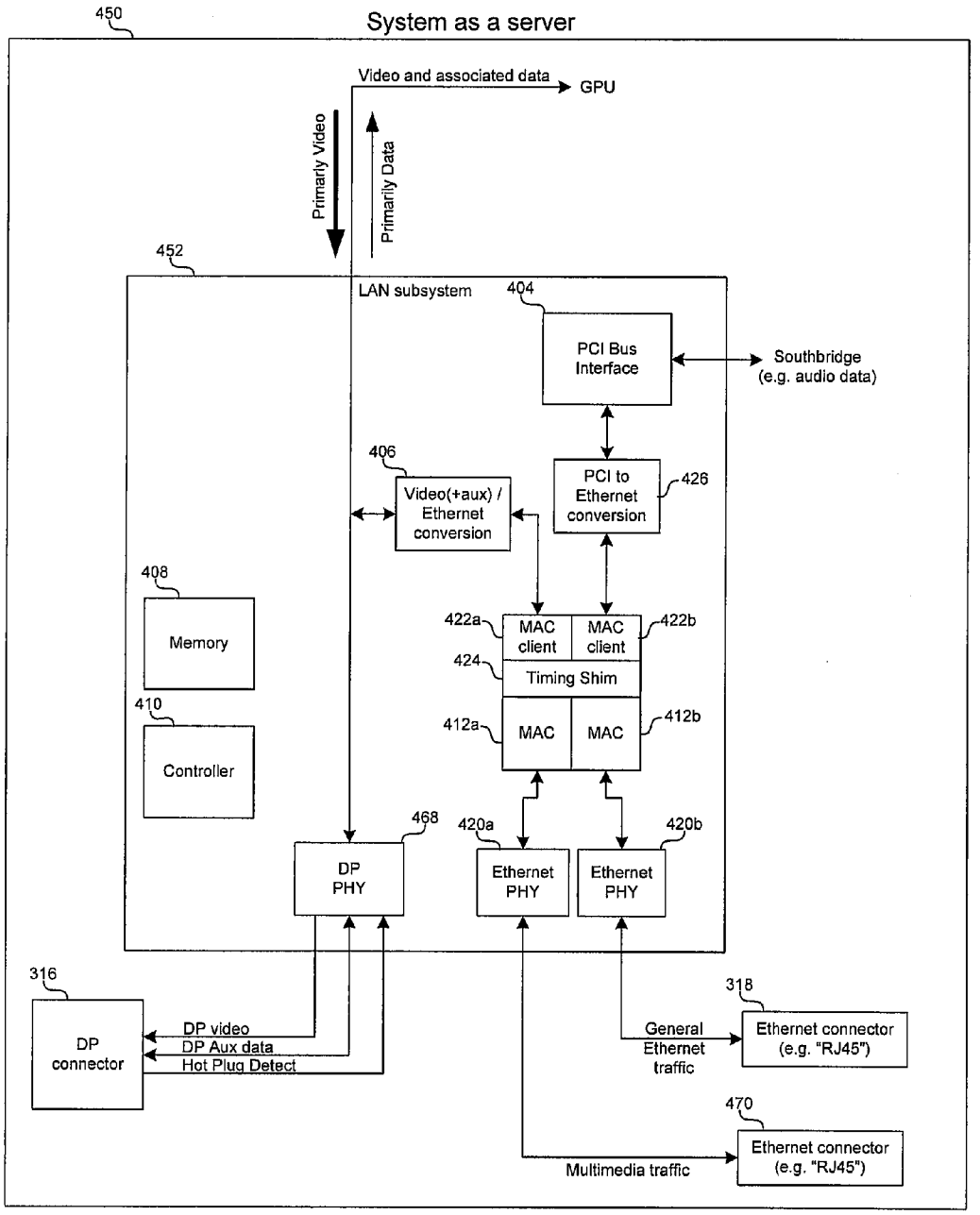

450
System as a server
Video and associated data
GPU
Primarily Video
Primarily Data
452
LAN subsystem
404
PCI Bus Interface
Southbridge (e.g. audio data)
406
Video(+aux) / Ethernet conversion
PCI to Ethernet conversion
426
408
Memory
422a
MAC client
MAC client
422b
424
Timing Shim
410
Controller
412a
MAC
MAC
412b
468
420a
420b
DP PHY
Ethernet PHY
Ethernet PHY
316
DP connector
DP video
DP Aux data
Hot Plug Detect
318
General Ethernet traffic
Ethernet connector (e.g. "RJ45")
470
Multimedia traffic
Ethernet connector (e.g. "RJ45")

FIG 4B

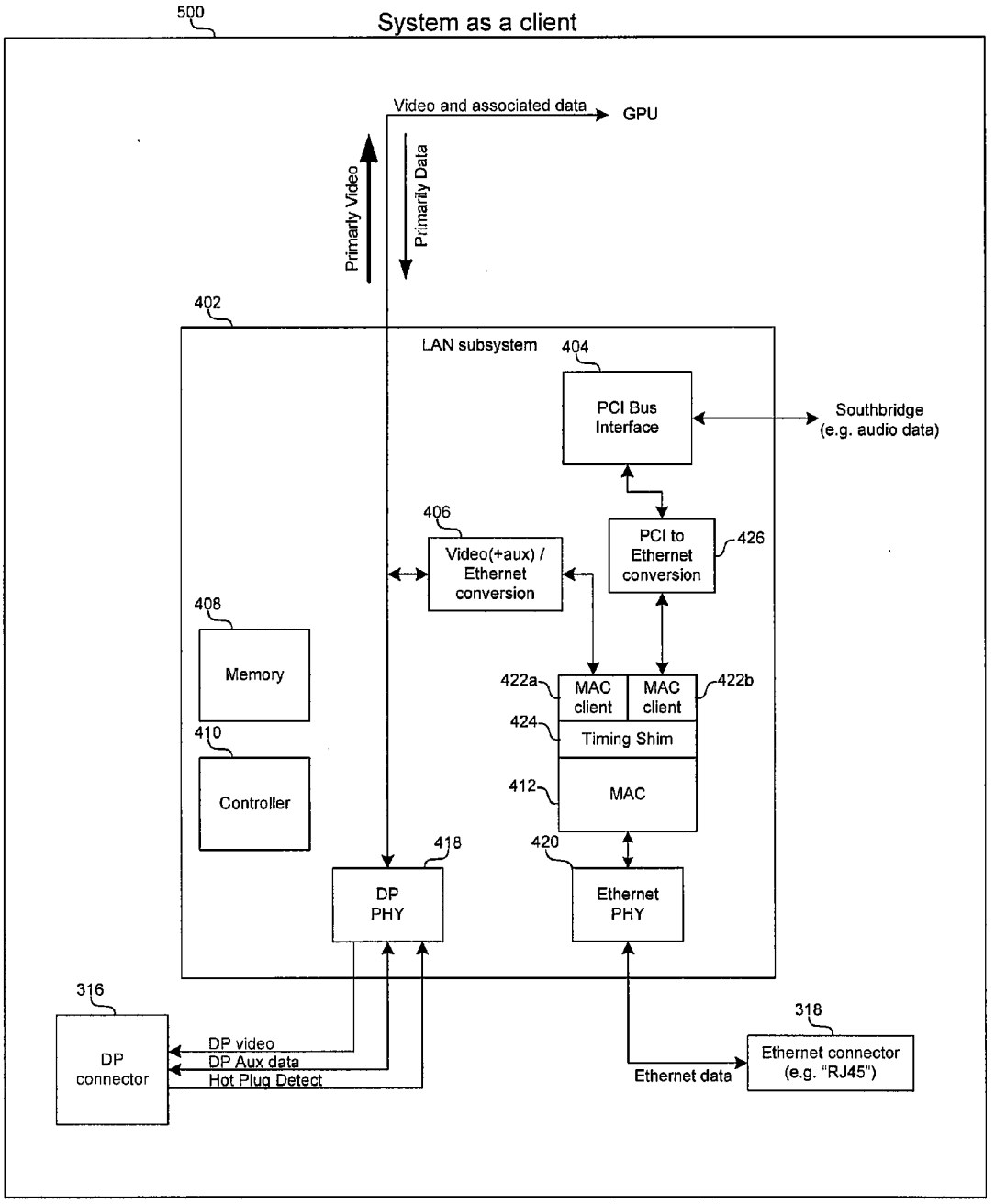

500
System as a client
Video and associated data
GPU
Primarily Video
Primarily Data
402
LAN subsystem
404
PCI Bus Interface
Southbridge (e.g. audio data)
406
Video(+aux) / Ethernet conversion
PCI to Ethernet conversion
426
408
Memory
410
Controller
422a
MAC client
MAC client
422b
424
Timing Shim
412
MAC
418
DP PHY
420
Ethernet PHY
316
DP connector
DP video
DP Aux data
Hot Plug Detect
318
Ethernet connector (e.g. "RJ45")
Ethernet data

FIG 5A

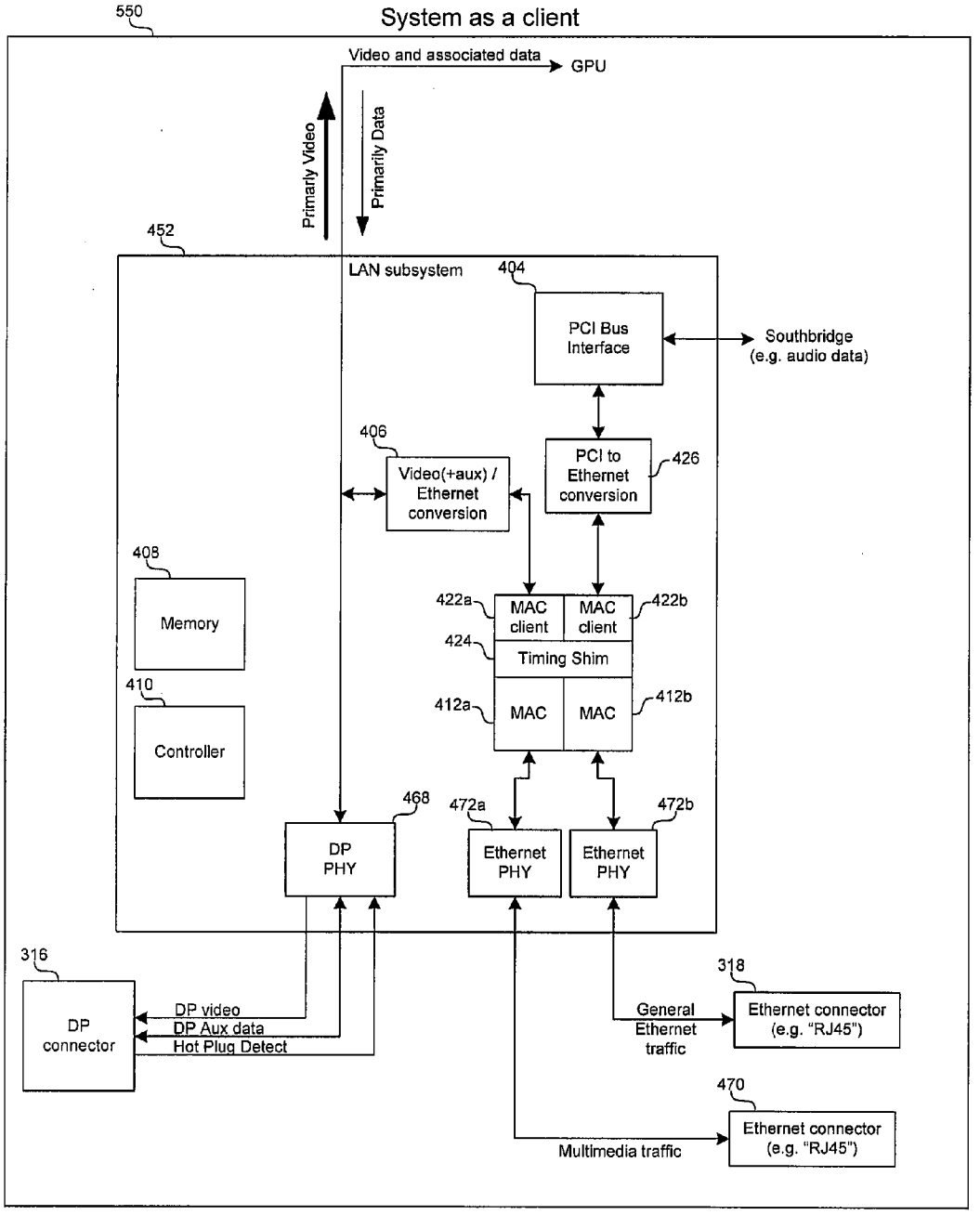

550
System as a client
Video and associated data
GPU
Primarily Video
Primarily Data
452
LAN subsystem
404
PCI Bus Interface
Southbridge (e.g. audio data)
406
Video(+aux) / Ethernet conversion
PCI to Ethernet conversion
426
408
Memory
410
Controller
422a
MAC client
MAC client
422b
424
Timing Shim
412a
MAC
MAC
412b
468
DP PHY
472a
Ethernet PHY
Ethernet PHY
472b
316
DP connector
DP video
DP Aux data
Hot Plug Detect
318
General Ethernet traffic
Ethernet connector (e.g. "RJ45")
470
Multimedia traffic
Ethernet connector (e.g. "RJ45")

FIG 5B

METHOD AND SYSTEM FOR INTEGRATING ETHERNET AND MULTIMEDIA FUNCTIONS INTO A LAN SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS/INCORPORATION BY REFERENCE

[0001] This patent application makes reference to, claims priority to and claims benefit from U.S. Provisional Patent Application Ser. No. 60/917,870 filed on May 14, 2007.

[0002] The above stated application is hereby incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

[0003] Certain embodiments of the invention relate to signal processing. More specifically, certain embodiments of the invention relate to a method and system for integrating Ethernet and multimedia functions into a LAN subsystem.

BACKGROUND OF THE INVENTION

[0004] The generation and rendering of high end graphics often involves the movement of large quantities of data. Frequently the data is stored in a server, from which it may be accessed by users at computer workstations via a network. Once the data is received at the computer workstation, the graphics may be displayed on an attached video monitor. In many cases the video monitor is physically separate and has been conventionally attached to the computer workstation via an analog interface, such as a video graphics array (VGA) interface, or a digital interface such as a digital visual interface (DVI). In a typical configuration, an interface in the computer workstation is connected to a compatible interface in the video monitor via an interstitial connector, such as a cable.

[0005] The ever increasing amount of multimedia content, and in particular, high quality multimedia content is presenting a number of challenges to designers and administrators of computing platforms and network alike. For example, bandwidth, hardware, and the isochronous nature of multimedia file transfers are all factors limiting the quality and availability of the multimedia content. In this regard a number of standards have been developed for transporting high quality multimedia data for presentation. For example, the digital video interface (DVI) and High Definition Multimedia Interface (HDMI) represent two of the most widely adopted and utilized display interfaces. However, DVI and HDMI each have a number of drawbacks which Video electronics Standards Association (VESA) has attempted to address with the newly emerging DisplayPort (DP) standard. In this regard, DP may offer, for example, increased bandwidth and more advanced copy protection as compared to DVI or HDMI.

[0006] Display Port is a digital interface standard, which enables a computer workstation to send graphics and video data to a video monitor, or multimedia display device, via a Display Port interface. In this regard, the Display Port interface standard may describe a point-to-point interface, which is capable of transmitting data from a device connected at one end of a connecting cable to a device connected at the other end of the connecting cable. The graphics and/or video data communicated across the Display Port interface may be sent in mini-packets as described in applicable standards. The mini-packets may contain information comprising instructions on how to render the graphics and/or video data on the video display screen, for example. The mini-packets may be sent via a plurality of data paths referred to as "lanes". In an exemplary Display Port interface, there may be four (4) such lanes.

[0007] In addition to supporting unidirectional data traffic from the workstation to the computer monitor (or other attached video display device), the Display Port standard may also enable the bidirectional transfer of data. For example, the Display Port standard may allow for the exchange of encryption keys to enable the transfer of encrypted digital data across the Display Port interface. This capability may enable protection of digital content transferred across the Display Port interface. In addition, the bidirectional traffic capability of the Display Port interface may enable communication of computer mouse and/or keyboard data to the computer workstation. For example, mouse clicks to specific regions on the screen, or keyboard responses to the screen display may result in the generation of data across the Display Port interface in the direction of the video display device to the computer workstation.

[0008] Further limitations and disadvantages of conventional and traditional approaches will become apparent to one of skill in the art, through comparison of such systems with some aspects of the present invention as set forth in the remainder of the present application with reference to the drawings.

BRIEF SUMMARY OF THE INVENTION

[0009] A system and/or method is provided for integrating Ethernet and multimedia functions into a LAN subsystem, substantially as shown in and/or described in connection with at least one of the figures, as set forth more completely in the claims.

[0010] These and other advantages, aspects and novel features of the present invention, as well as details of an illustrated embodiment thereof, will be more fully understood from the following description and drawings.

BRIEF DESCRIPTION OF SEVERAL VIEWS OF THE DRAWINGS

[0011] FIG. **1**A is a diagram illustrating an exemplary system for transfer of high definition multimedia data across a network, in accordance with an embodiment of the invention.

[0012] FIG. **1**B is block diagram illustrating a DP interface, in connection with an embodiment of the invention.

[0013] FIG. **2** is a diagram illustrating an exemplary network enabled to communicate HD multimedia content over a network, in accordance with an embodiment of the invention.

[0014] FIG. **3** is a diagram illustrating an exemplary system enabled to transmit and/or receive DP, Ethernet, and/or Ethernet with AVB datastreams, in accordance with an embodiment of the invention.

[0015] FIG. **4**A is a block diagram illustrating an exemplary LAN subsystem of a multimedia server, in accordance with an embodiment of the invention.

[0016] FIG. **4**B is a block diagram illustrating an exemplary LAN subsystem of a multimedia server, in accordance with an embodiment of the invention.

[0017] FIG. **5**A is a block diagram illustrating an exemplary LAN subsystem of a multimedia client, in accordance with an embodiment of the invention.

[0018] FIG. **5**B is a block diagram illustrating an exemplary LAN subsystem of a multimedia client, in accordance with an embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0019] Certain embodiments of the invention may be found in a method and system for integrating Ethernet and multimedia functions into a LAN subsystem. Various aspects of the invention may extend the point-to-point limitation of conventional display interfaces, to enable transfer of high definition (HD) multimedia data across a network, such as a local area network (LAN). For example, a computer graphics server located in a computing cluster may be able to transfer HD multimedia data across a network, to a destination computing device, for example. The destination computing device may then transfer the received HD multimedia data to one or more multimedia display devices via one or more point-to-point connections between the destination computing device and the attached multimedia display devices. In this regard, various embodiments of the invention may support high performance graphics within low-cost destination computing devices without requiring costly high performance graphics processing hardware and/or software.

[0020] Aspects of the invention may comprise an integrated network interface, which may comprise one or more Ethernet interfaces, and one or more high definition (HD) multimedia interfaces to enable transmission and/or reception of HD multimedia content over a network. Audio/Video Bridging and/or Audio/Video Bridging extensions may be utilized for the transmission and/or reception of multimedia content. Exemplary HD multimedia interfaces may comprise DVI, HDMI, and DisplayPort. The integrated network interface may be enabled to transmit and/or receive physical layer signals adhering to protocols such as Ethernet and DisplayPort. Additionally, the integrated network interface may be configurable to select the type of signals to be transmitted or received. In this regard, aspects of the invention may enable packetization of multimedia content into, for example, Ethernet frames and/or DisplayPort micro-packets. Also, aspects of the invention may enable extracting HD multimedia content from DisplayPort micro-packets and/or Ethernet frames. Similarly, aspects of the invention may enable converting Ethernet frames to DisplayPort micro-packets and visa-versa. In various embodiments of the invention, an integrated network interface may be enabled to transmit and/or receive HD multimedia content over a network via a first connector; and transmit and/or receive general Ethernet traffic over a network via a second connector. In other various embodiments of the invention, an integrated network interface may be enabled to transmit and/or receive HD multimedia content and/or general Ethernet traffic over a single connector.

[0021] FIG. **1**A is a diagram illustrating an exemplary system for transfer of HD multimedia data across a network, in accordance with an embodiment of the invention. Referring to FIG. **1**A, there is shown a computing cluster **152**, a network **162**, a computing device **122** and a multimedia monitor **124**. The computing cluster **152** may comprise a multimedia server **154**, a file server **156**, a database server **158** and a network management server **160**.

[0022] The computing cluster **152** may comprise a plurality of servers, each of which may perform one or more specific tasks, or execute one or more specific applications. Each server may store data which may be accessible to users at computing devices **122**, which are attached to the network **162**. The servers within the computer cluster **152** may communicate with each other, and/or with the network **162** via Ethernet interfaces. The video server **154** may store computer graphics data in addition to storing video, audio and/or multimedia programs. The multimedia monitor **124** may enable the rendering and display of visual images comprising video and/or graphics, for example.

[0023] The video server **154** may comprise hardware and/or software, which enables processing of graphics, video, audio and/or multimedia data. The computer multimedia, graphics, video, and/or audio (collectively referred to herein as multimedia) stored at the video server **154** may be accessible via the network **162**. The file server **156** may store one or more files. The file server **156** may be utilized, for example, to store files from various users. The database server **158** may store one or more database programs, applications and/or files. The network management server **160** may store information pertaining to the configuration and/or availability of various network communications devices and/or interfaces. The network management server **160** may utilize a protocol such as the simple network management protocol (SNMP). The computing device **122** and multimedia monitor **124** may communicate via a display interface such as DVI, HDMI, or DisplayPort. The computing device **122** may communicate with the network **162** via an Ethernet interface.

[0024] In an exemplary operation, the video server **154** may encapsulate HD multimedia data in one or more Ethernet frames. The format of the Ethernet frames may be specified in applicable standards, such as IEEE 802 standards. The Ethernet frames may contain an address (for example, in a destination address field within the Ethernet frames), which indicates that the Ethernet frames are to be transported across the network **162**, and delivered to the computing device **122**. The Ethernet frames may comprise a designation (for example, in an EtherType field of the Ethernet frames), which indicates that the Ethernet frame is being utilized to encapsulate HD multimedia in a particular format. Exemplary formats may comprise, for example, HDMI and DisplayPort. The Ethernet frames may also comprise a traffic class identifier, which may enable the network **162** to provide services in accordance with Audio/video Bridging and/or Audio/Video Bridging extensions (any combination of which is referred to herein as "AVB"). These services may comprise prioritized transport of the Ethernet frames across the network **162** to enable the time duration for transport across the network **162** to meet latency targets associated with the specified traffic class.

[0025] The video server **154** may transport the Ethernet frames via an Ethernet interface connector **132** to the network **162**. The Ethernet frames may subsequently be transported from the network **112** to the computing device **122** via an Ethernet interface connector **134**. An exemplary Ethernet interface connector may be a category 5 cable.

[0026] Upon receipt of the Ethernet frames, the computing device **122** may determine (for example, based on an identifier in the EtherType field of the received Ethernet frames) that the received Ethernet frames contain HD multimedia content. The computing device **122** may extract the multimedia content and may send it to the multimedia monitor **124** via the display interface connector **136**. The display interface connector **136** may enable physical connection between the computing device **122** and the multimedia monitor **124** via a point-to-point connection. The HD multimedia content may then be rendered for display at the multimedia monitor **124**.

[0027] In various embodiments of the invention, point-to-point oriented traffic, which may not be network aware or contain a means of network identification (such as a network destination address, for example) may be encapsulated in Ethernet frames at a centralized server (such as a video server **154**), and transported across a network **162** (such as a LAN, for example). The point-to-point oriented traffic may comprise HD multimedia content such as Display Port micro-packets, or even raw data generated by an application program. The encapsulated traffic may be de-encapsulated at a network destination device (such as the computing device **122**) and delivered to a destination multimedia device (such as the multimedia monitor **124**). Thus, in various embodiments of the invention, from the perspective of the application (s), which enable the generation of the point-to-point oriented traffic (such as Display Port, for example), the centralized server (such as the video server **154**) may transport the point-to-point oriented traffic to the destination multimedia device **124** across a network **162** as though the multimedia device **124** were directly attached to the centralized server via a Display Port interface.

[0028] In various embodiments of the invention, the tasks required of the computing device **122** may comprise reception of Ethernet frames via the Ethernet interface connector **134**, determination that the Ethernet frames may contain encapsulated HD multimedia content, extraction of the HD multimedia content from the Ethernet frames, and transfer of the content to the multimedia monitor **124** via the display interface connector **136**. In this regard, the video server **154** may generate instructions for rendering the video data on the multimedia monitor **124** within the Display Port mini-packets instead of requiring that this task be performed within the computing device **122**. Thus, various embodiments of the invention may enable the computing device **122** to be a "thin client" device, which may not require high performance hardware and/or software capabilities to enable the generation of multimedia content for high performance video and/or graphics applications. This in turn may enable the rendering of high performance video and/or graphics on multimedia monitors **124** which are attached to low cost computing devices **122**.

[0029] FIG. **1**B is block diagram illustrating a DisplayPort (DP) system, in connection with an embodiment of the invention. In this regard, DisplayPort is an exemplary display interface that may be utilized for conveying HD multimedia data. Referring to FIG. **1**B there is shown a server **102** and a client **106**, each comprising a DP interface **104**. Although, only a single client is shown, it may be possible for a server to transmit DP data to multiple clients.

[0030] The server **102** may comprise suitable logic circuitry, and/or code that may enable generating and/or outputting HD multimedia data. In this regard, the server **102** may comprise a graphics processing unit (GPU) **103** which may generate video data and convey the video data to the DP interface **104***a*. Similarly, the server **102** may comprise a sound card **105** which may generate audio data and convey the audio data to the DP interface **104***a*. Accordingly, the DP interface **104***a* may encapsulate the data into multimedia DP micro-packets and may transmit the micro-packets on one or more of the lanes **108** and **110**. In this regard, the DisplayPort micro-packets may contain instructions and/or information, in micro-packet headers for example, to enable rendering of the multimedia data at the client **106**.

[0031] The client **106** may comprise suitable logic circuitry, and/or code that may enable rendering and/or presenting multimedia data. In this regard, the server **102** may comprise a display **105** which may be enabled to receive video data from the DP interface **104***b* and present the video information to a user. Similarly, the server **102** may comprise speakers **107** which may be enabled to receive audio data from the DP interface **104***b* and present the audio information to a user. Accordingly, the DP interface **104***b* may de-packetize and/or reformat received DP micro-packets and may output audio/video data in a format suitable for rendering or presentation by the display **105** and/or the speakers **107**. In this regard, instructions and/or control data contained in the DP micro-packets may be utilized for the rendering/presentation of the multimedia data.

[0032] Each of the video lanes **108** may comprise a physical link, such a twisted pair. The number of lanes utilized for any given multimedia content may depend on factors such as resolution, bits per pixel (bpp), and bits per component (bpc). Additionally, each of the lanes may operate at a link rate of 1.62 Gbps or 2.7 Gbps.

[0033] The auxiliary data lane **110** may comprise a physical link, such a twisted pair. The auxiliary lane **110** may be utilized to initialize and/or setup a link between the server **102** and the client **106**. The auxiliary lane **110** may also carry remote control command data and/or other control data to/from the client **106**. For example, the auxiliary lane may carry keyboard and/or mouse commands form the client **106** to the server **102**. Additionally, the auxiliary lane may carry audio data from the server **102** to the client **106**.

[0034] The hot plug detect lane **112** may comprise a physical link, such a twisted pair, the hot plug detect lane **112** may enable the server to detect the connection of a client. Additionally, the hot plug detect lane **112** may enable the client to signal a loss of synchronization or connection to the server.

[0035] In operation, the system **100** may be limited in terms of distance between the server **102** and client **106** due to limitations of the DP interface. Additionally, incorporating the DP interface **104***a*, and **104***b* into the server **102** and the client **106** may be infeasible with existing platforms and technology due to cost and/or space constraints, for example. Furthermore, DisplayPort may possess limited or no network awareness. In this regard, DisplayPort was designed to carry Audio/Video traffic via an interstitial connector over relatively short distances.

[0036] FIG. **2** is a diagram illustrating an exemplary network enabled to communicate HD multimedia content over a network, in accordance with an embodiment of the invention. In this regard, FIG. **2** depicts an exemplary embodiment wherein the HD multimedia content is in the form of DisplayPort micro-packets. Referring to FIG. **2** there is shown a server **202** and a client **206** which may exchange DP traffic via the network **210**. Although only a single client **206** is illustrated in FIG. **2**, aspects of the invention may enable carrying multimedia content from a server to multiple clients.

[0037] The server **202** may comprise suitable logic circuitry, and/or code that may enable generating and/or outputting HD multimedia data. In this regard, the server **202** may be similar to the server **102** of FIG. **1**, but may additionally comprise a DP/Ethernet conversion block **204***a*. In various embodiments of the invention, the server **202** may comprise a computing device such as desktop computer or a laptop computer.

[0038] The DP/Ethernet conversion block **204***a* may comprise suitable logic, circuitry, and/or code that may enable conversion of a DP datastream to an Ethernet datastream. In

this manner, a DP datastream may be transmitted across the network **210** to the client **206**. In various embodiments of the invention, the server **202** may comprise a computing device such as desktop computer or a laptop computer. Additionally, the display **105** may be integrated into the client **206** or may comprise a collocated monitor connected via a point-to-point connection.

[0039] The client **206** may comprise suitable logic circuitry, and/or code that may enable rendering and/or presenting multimedia data. In this regard, the client **206** may be similar to the client **106** of FIG. **1**, but may additionally comprise an Ethernet/DP conversion block **208**.

[0040] The DP/Ethernet conversion block **204***b* may comprise suitable logic circuitry, and/or code that may enable receiving an Ethernet datastream, and converting the Ethernet datastream to a DP datastream. In this regard, the Ethernet/DP conversion block **204***b* may enable exchanging a DP datastream with the server **202** via the network **210**.

[0041] The network **210** may comprise one or more physical links and/or network hardware devices. In an exemplary embodiment of the invention the network **210** may comprise one or more Ethernet switches which may be AVB enabled, and/or one or more unshielded twisted pair cables with 8 position 8 conductor (8P8C) modular connectors on either end.

[0042] In an exemplary operation, the display **105** may be detected by the DP interface **104***b* and the appropriate DisplayPort configuration data (DPCD) may be encapsulated into a DP datastream and conveyed to the DP/Ethernet conversion block **204***b*. The DP datastream containing the DPCD may thus be converted into an Ethernet datastream and transmitted into the network **210**. Upon arriving at the DP/Ethernet conversion block **204***a*, the Ethernet datastream comprising the DPCD may be converted back to a DP datastream and passed to the DP interface **104***a*. In this manner, a DP connection may be established across the network **210** as if the DP interfaces **104***a* and **104***b* were communicating directly with each other. However, DP is intended as a point to point interface and requires the exchange of time sensitive synchronous and isochronous data. Consequently, converting the DP data stream to an Ethernet datastream and transmitting it across a network with uncertain bandwidth and/or latency may result in the DP interfaces being unable to process the DPCD and/or establish a reliable DP connection. Similarly, even if a DP connection is established over the network **210**, network bandwidth and/or latencies may result in poor video quality at the client **105**.

[0043] Accordingly, AVB may be utilized by the server **202** and the client **206** to establish a network path over which a DP connection may exist. In this regard, prior to establishing a DP connection and/or prior to transmission of data over that connection, an AVB protocol such as IEEE 802.1AS may be utilized to synchronize the client **206** and the server **202**. Additionally, an AVB protocol such as IEEE 802.1Qat may be utilized to reserve resources across the network **210**. Also, nodes comprising the reserved path may implement IEEE 802.1Qav to govern forwarding and queuing of the time sensitive data. In this manner, AVB may enable timing synchronization and a guarantee of bandwidth and/or latencies for transmitting HD multimedia content across a network.

[0044] After synchronization, and establishment of a DP connection, the server **202** may begin transmission of multimedia data into the network **210**. For example, the GPU **103** may generate an elementary video stream and may convey the stream to the DP interface **104***a*. The DP interface **104***a* may receive the elementary video stream and may packetize it into a DP datastream. Accordingly, the DP micro-packets and associated control/auxiliary data may be conveyed to the Ethernet/DP conversion block **204***a* which may convert the DP datastream to an Ethernet datastream and may transmit the Ethernet datastream onto a first link **212** comprising the network path reserved via AVB. The Ethernet datastream may be received at the client **206** and may be converted back to a DP datastream by the DP/Ethernet conversion block **204***b*. Subsequently, the DP datastream may be conveyed to the DP interface **104***b* which may, in turn, convey to DP datastream to the display **105** for rendering and/or presentation to a user.

[0045] In various embodiments of the invention, the tasks required of the client **206** may comprise reception of Ethernet datastreams, determination that the Ethernet datastreams may contain encapsulated DisplayPort micro-packets, de-encapsulation of the DisplayPort micro-packets, and transfer of the de-encapsulated Display Port micro-packets to the display **105** via the Display Port interface **104***b*. In this regard, the video server **202** may generate instructions for rendering the video data on the display **105** within the Display Port mini-packets instead of requiring that this task be performed within the client **206**. Thus, various embodiments of the invention may enable the client **206** to be a "thin client" device, which is not required to comprise high performance hardware and/or software capabilities to enable the generation of Display Port mini-packets for high performance video and/or graphics applications. This in turn may enable the rendering of high performance video and/or graphics on displays, such as the display **105**, which are attached to low cost clients **206**.

[0046] FIG. **3** is a diagram illustrating an exemplary system enabled to transmit and/or receive DP and/or Ethernet datastreams, in accordance with an embodiment of the invention. Referring to FIG. **3** the system **300** may comprise a CPU **302**, a northbridge **304**, a graphics processing unit **306**, a memory block **308**, a southbridge **310**, a LAN subsystem **314**, a DP connector **316**, and an Ethernet connector **318**.

[0047] The CPU **302** may comprise suitable logic, circuitry, and/or code that may enable processing data and/or controlling operations of the system **300**. In this regard, the CPU **302** may be enabled to provide control signals to the various other blocks comprising the system **300**. The CPU **302** may also enable execution of applications programs and/or code. The applications programs and/or code may enable generation of video and/or audio. The CPU **302** may also enable the retrieval of stored video and/or audio. The CPU **302** may be accessed via the northbridge **304**.

[0048] The GPU **306** may comprise suitable logic, circuitry, and/or code that may enable generating, rendering, [de]compressing, [en/de]crypting, or otherwise manipulating graphics information. The GPU may be enabled to output HD video content to the LAN subsystem **314**. In this regard, the HD video content may, for example, comprise raw pixel data, DisplayPort packets, or data formatted according to DVI or HDMI standards.

[0049] In various embodiments of the invention the CPU and/or GPU may, for example, each comprise one or more processing elements and/or circuits, or may be integrated into a single processor and/or circuit. In this manner, operations performed by the CPU and/or GPU may be partitioned in a variety of ways without deviating from the scope of the present invention.

[0050] The northbridge **304** may comprise suitable logic, circuitry, and/or code that may enable the handling of "high speed" data transfers in the system **300**. For example, the northbridge **304** may handle data transfers between the CPU **302**, the memory block **308**, and the GPU **306**.

[0051] The display **305** may comprise suitable logic, circuitry, and/or code that may enable rendering and/or presentation of video to a user. In this regard, the display **305** may be enabled to receive a DP datastream and render/present the data contained in the DP datastream. In various embodiments of the invention, the display **305** may be enabled to modify, format, or otherwise manipulate the video prior to displaying it. In various embodiments of the invention, the display **305** may be integrated into the system **300** or may be an external display connected to the system **300** via a connecting cable.

[0052] The memory **308** may comprise suitable logic, circuitry, and/or code that may enable storage of data. For example, the memory **308** may be enabled to store video data which may be transferred to/from the GPU via the northbridge **304**. The memory **308** may additionally store data, for example, configuration data and/or state variables utilized in controlling/configuring the various blocks of the system **300**.

[0053] The southbridge **310** may comprise suitable logic, circuitry, and/or code that may enable handling of "lower speed" communications in the system **300**. For example, the southbridge **310** may handle communications between the northbridge **304**, the LAN subsystem **314** and lower speed peripherals such as a sound card, a hard disk drive, a universal serial bus, a keyboard, and/or a mouse.

[0054] The LAN subsystem **314** may comprise suitable logic, circuitry, and/or code that may enable transmission and/or reception of DisplayPort and/or Ethernet data. The LAN subsystem **314** may interface to one or more networks. The LAN subsystem **314** may comprise PHY layer functions and MAC layer functions. In this regard, the LAN subsystem **314** may enable packetization/de-packetization of Ethernet and/or DP datastreams. Also, the LAN subsystem may enable coordination of communications between the system **300** and one or more remote systems. In this regard, the LAN subsystem may enable utilization of AVB. Additionally, the LAN subsystem may be enabled to convert data bits to physical signals and outputting the symbols onto one or more physical links. Similarly, the LAN subsystem may be enabled to receive symbols via a physical link, convert them into bits of data, and assemble the bits into protocol data units (e.g. Ethernet frames and/or DP micro-packets). In this regard, exemplary physical links may include twisted pair cables and/or wireless channels. Additionally, the LAN subsystem **314** may enable transmission and/or reception of Ethernet frames at various transfer rates, such as 10 Mbps, 100 Mbps, 1,000 Mbps (or 1 Gbps), 10 Gbps, 40 Gbps, 100 Gbps, and/or non-standard transfer rates such as 2.5 Gbps and 5 Gbps, for example. In various embodiments of the invention, the LAN subsystem **314** may comprise one or more chips, be implemented on one or more die, be implemented on a motherboard, or in numerous other forms without deviating from the scope of the invention.

[0055] The DisplayPort connector **316** may enable physical connection to a DisplayPort physical link which may comprise at least conductors for each of the 4 lanes in the Display Port interface and for an auxiliary (AUX) lane. The 4 video lanes may enable the transmission or reception of Display Port mini-packets containing video data, while the AUX lane may enable transmission and reception of audio signals, control signals, input from peripheral devices such as keyboards and/or mice, and encryption keys. In various embodiments of the invention, the DisplayPort connector **316** may connect the system **300** to a display **305**. Although up to 4 lanes are utilized, the invention is not so limited. Accordingly, more than 4 lanes may be utilized without departing from the scope of various embodiments of the invention.

[0056] The Ethernet connector **318** may enable physical connection to an Ethernet Physical link which may comprise, for example, one or more twisted pairs. The Ethernet connector **318** may enable physical connection via an 8P8C modular connector such as a RJ-45 connector, for example. In various embodiments of the invention, the Ethernet connector **318** may provide a physical connection to enable communication of general Ethernet traffic, and/or multimedia traffic utilizing AVB between the system **300** and a remote system. In various embodiments of the invention, a single Ethernet connector **318** may be utilized for Ethernet and DP traffic in which case the DP connector **316** may be absent. In various other embodiments of the invention, a single DP connector **316** may be utilized for Ethernet and DP traffic in which case the DP connector **318** may be absent.

[0057] In various embodiments of the invention, the system **300** may also be enabled to convert between multimedia formats. For example, the system **300** may be enabled to receive HDMI data via the Ethernet connector **318**, convert the data to DP, and transmit the DP data via the DP connector **316**.

[0058] In an exemplary transmit operation, the system **300** may represent a server, such as the server **202** of FIG. **2** and may transmit data via an Ethernet and/or a DisplayPort connection. For example, the GPU **306** may output a video stream to the LAN subsystem **314**. The LAN subsystem **314** may packetize the video stream into an Ethernet datastream and/or a DP datastream. In various embodiments of the invention, the LAN subsystem **314** may convert DP datastreams to Ethernet datastreams similar to the DP/Ethernet conversion block **204**A of FIG. **2**. Additionally, the LAN subsystem **314** may convert the Ethernet and/or DP datastreams to physical symbols and may output the physical symbols via the DP connector **316** and/or the Ethernet connector **318**. In another example, audio and/or combined audio/video may be transmitted in a similar manner.

[0059] In an exemplary receive operation, the system **300** may represent a client, such as the client **204** of FIG. **2**, and may receive data via an Ethernet and/or a DisplayPort connection. In this regard, the LAN subsystem **314** may receive physical symbols via the DP connector **316** and/or the Ethernet connector **318**, and may convert these symbols to bits of data. Additionally, the LAN subsystem **314** may assemble the data into Ethernet and/or DP datastreams accordingly. A DP datastream received via the DP connector **316** may comprise auxiliary data associated with a DP connection to the display **305**. In this regard, the LAN subsystem may convey the auxiliary data to an appropriate block comprising the system **300** (e.g. the GPU **306**) or may convert the DP datastreams to an Ethernet datastream for transmission to a remote system. An Ethernet datastream received via the Ethernet connector **318** may comprise a DP datastream encapsulated in an Ethernet datastream. In this regard, the LAN subsystem **314** may extract and/or reconstruct the DP datastream from the Ethernet datastream. In this manner, the LAN subsystem may be similar to the DP/Ethernet conversion block **204***b* of FIG. **2**. Accordingly, the DP datastream may be output to the display

305 via the DP connector **316**. The display **305** may render or otherwise manipulate the video data contained in the DP datastream for presentation to a user. In another exemplary embodiment of the invention, audio and/or combined audio/video may be received and presented in a similar manner.

[0060] FIG. **4**A is a block diagram illustrating an exemplary LAN subsystem of a multimedia server, in accordance with an embodiment of the invention. Although the system **400** in FIG. **4**A is illustrated functioning as a server, the invention may not be so limited and in this regard, various embodiments of the invention the system **400** may also be enabled to function as a client. Referring to FIG. **4**A, the system **400** may comprise a LAN subsystem **402**. The LAN subsystem **402** may comprise a PCI bus interface **404**, a video/Ethernet conversion block **406**, a PCI/Ethernet conversion block **426**, MAC clients **422***a* and **422***b*, timing shim **424**, a memory **408**, a controller **410**, a time stamp block **414**, a MAC **412**, a DisplayPort PHY **418**, and an Ethernet PHY **420**.

[0061] The PCI bus interface **404** may comprise suitable logic, circuitry, and/or code that may enable transmitting and/or receiving data via a PCI (Peripheral Component Interconnect) bus. In this regard, data from, for example, the southbridge **310** of FIG. **3**, may be communicated to a network via the LAN system **402**. Accordingly, a PCI bus may provide a means for conveying data received via an Ethernet or DP connection to the various components comprising the server **400**. Although a PCI bus is used for illustration, any standardized or proprietary bus may be utilized for communication between the server **400** and the LAN subsystem **402** without deviating form the scope of various embodiments of the invention.

[0062] The Video/Ethernet conversion block **406** may comprise suitable logic, circuitry, and/or code that may enable converting multimedia and associated auxiliary data from an Ethernet payload format. Video and associated auxiliary data received by the video/Ethernet conversion block **406** from a GPU, for example, may be packetized, depacketized, encapsulated, decapsulated, or otherwise processed so as to be formatted as one or more Ethernet payloads. Similarly, Ethernet payloads received from a MAC client, for example, may be packetized, depacketized, encapsulated, decapsulated, or otherwise processed so as to be formatted as one or more video or multimedia streams. For example, DP micro-packets, raw video, and/or raw audio/video may be extracted and/or reconstructed from one or more Ethernet payloads. Similarly, video/Ethernet conversion block **406** may receive packetized video data and/or audio data, such as a DisplayPort stream, and may encapsulate and/or format the data into one or more Ethernet payloads. In some instances, audio may be synchronized to video and may be routed via the GPU. In these instances, both audio and video may be formatted into Ethernet payloads by the video/Ethernet conversion block **406**. In various embodiments of the invention, the video/Ethernet conversion block **406** may receive control signals and/or data from the controller **410**. Additionally, in various embodiments of the invention the Video/Ethernet conversion block **406** may store data to and/or read data from the memory **408**. In various embodiments of the invention, the Video/Ethernet conversion block **406** may be implemented in one or more physical and/or functional blocks. In this regard, various functions implemented by the Video/Ethernet conversion block **406** may be shared and/or separated physically and/or functionally without deviating from the scope of the invention

[0063] The PCI/Ethernet conversion block **426** may comprise suitable logic, circuitry, and/or code that may enable converting data received to and/or from an Ethernet payload format. In this regard, audio data, for example, received via a PCI bus may be formatted as one or more Ethernet payloads. Similarly, one or more Ethernet payloads may be formatted for transmission via a PCI bus.

[0064] In various exemplary embodiments of the invention, the video/Ethernet conversion block **406**, the PCI/Ethernet conversion block **404**, or other blocks comprising the LAN subsystem **400** may be enabled to perform compression and/or de-compression of video and/or audio content prior to and/or subsequent to packetization, depacketization, encapsulation, decapsulation.

[0065] The MAC clients **422***a* and **422***b* may each comprise suitable logic, circuitry, and/or code that may enable reception of Ethernet payloads from the video/Ethernet conversion block **406** and/or the PCI/Ethernet conversion block **426** and may enable encapsulating the Ethernet payloads in one or more Ethernet frames. Additionally, the MAC clients **422***a* and **422***b* may be enabled to receive Ethernet frames from the MAC **412** and may enable decapsulation of the Ethernet frames to extract Ethernet payloads which may comprise multimedia, auxiliary, control, or general Ethernet data. In this regard, Ethernet payloads may be formatted and/or encapsulated according to one or more protocols. For example Ethernet payloads may comprise DP micro-packets and/or IP datagrams. In this regard, other protocols may be utilized for the packetization and/or conveyance of data without deviating from the scope of the present invention. In an exemplary embodiment of the invention, multimedia data destined for a remote client may be first packetized into DP micro-packets. Subsequently, the DP micro-packets may be directly encapsulated into Ethernet frames. In another embodiment of the invention, the DP micro-packets may be encapsulated into one or more IP datagrams which may, in turn, be encapsulated into Ethernet Frames. Also, priority and quality of service properties of higher layer protocols may be mapped to physical layer via AVB. In various embodiments of the invention, the MAC clients **422***a* and **422***b* may receive control signals and/or data from the controller **410**. Additionally, in various embodiments of the invention the MAC clients **422***a* and **422***b* may store data to and/or read data from the memory **408**. In various embodiments of the invention, the MAC clients **422***a* and **422***b* may be implemented in one or more physical and/or functional blocks. In this regard, various functions implemented by the MAC clients **422***a* and **422***b* may be shared and/or separated physically and/or functionally without deviating from the scope of the invention.

[0066] The timing shim **424** may comprise suitable logic, circuitry and/or code that may enable reception of Ethernet frames the MAC clients **422***a* and **422***b*. The timing shim **424** may append time synchronization information, such as a time stamp, to the Ethernet frames. The time stamp shim **424** may, for example, append a time stamp when the EtherType field indicates that the Ethernet frame is to utilize AV Bridging capabilities for transport across a network. In various embodiments of the invention, the Video/Ethernet conversion block **406** may receive control signals and/or data from the controller **410**. Additionally, in various embodiments of the invention the Video/Ethernet conversion block **406** may store data to and/or read data from the memory **408**. In various embodiments of the invention, the Video/Ethernet conversion block **406** may be implemented in one or more physical

and/or functional blocks. In this regard, various functions implemented by the Video/Ethernet conversion block **406** may be shared and/or separated physically and/or functionally without deviating from the scope of the invention.

[0067] The memory **408** may comprise suitable logic, circuitry, and/or code that may enable storage of data. In this regard, the memory **408** may enable buffering received data. Additionally, the memory **408** may enable storage of state variable or other information utilized to control the operations of the LAN subsystem **402**.

[0068] The controller **410** may comprise suitable logic, circuitry, and/or code that may enable operations of the LAN subsystem **402**. In this regard, the controller **410** may be enabled to process data and/or provide control signals/information to enable and/or control operation of the various blocks comprising the LAN subsystem **402**.

[0069] The MAC **412** may comprise suitable logic, circuitry, and or code that may enable providing addressing and/or access control to a network and may enable the transmission of the Ethernet frames via a network. In this regard, the MAC **412** may be enabled to buffer, prioritize, or otherwise coordinate the transmission and/or reception of data via the Ethernet connector **318** and associated physical link. The MAC **412** may be enabled to perform additional packetization, depacketization, encapsulation, and decapsualtion of data. The MAC **412** may enable generation of header information within the Ethernet frames, which enable the utilization of AVB within a network for transport of the Ethernet frames. The MAC **412** may also enable traffic shaping of transmitted Ethernet frames by determining time instants at which Ethernet frames may be transmitted to a network. The MAC **412** may also enable generation of header information within the Ethernet frames, which utilize conventional Ethernet services. The conventional Ethernet services may not utilize traffic shaping and/or AVB, for example.

[0070] The DisplayPort PHY **418** may comprise suitable logic, circuitry, and/or code that may enable transmission and/or reception of data bits over a physical medium. The DisplayPort PHY **418** may be implemented in one or more physical and/or functional blocks. In this regard, various functions implemented by the DisplayPort PHY **418** may be shared and/or separated physically and/or functionally without deviating from the scope of the invention. The DisplayPort PHY **418** may be enabled to convert between digital values and analog symbols impressed on the physical medium. In an exemplary embodiment of the invention, the physical medium may comprise twisted pair or coaxial cabling, and the transmitted symbols may be as defined by DisplayPort protocols. In this regard, DisplayPort PHY **418** may enable DisplayPort physical layer functionality.

[0071] In an exemplary transmit operation, data conveyed to the DP PHY **418** via, for example, a graphics processor or an audio processor, may be packetized into one or more DP micro-packets and may be converted to physical symbols and transmitted onto a physical medium via the DP connector **316**. In this manner, audio, video, and/or control/auxiliary data may be transmitted to a local multimedia client or other multimedia rendering device, for example.

[0072] In an exemplary receive operation, symbols received via the DP connector **316** may be converted to digital values and assembled into DP micro-packets before being conveyed up to a another block, such as a GPU or audio processor, comprising the system **400**. In this manner, DP micro-packets comprising control/auxiliary data, for example, received from a local multimedia client via the DP connector **316** may be de-packetized and the control/auxiliary data may be provided to, for example, the GPU.

[0073] The Ethernet PHY **420** may comprise suitable logic, circuitry, and/or code that may enable transmission and/or reception of data bits over a physical medium. The Ethernet PHY **420** may be implemented in one or more physical and/or functional blocks. In this regard, various functions implemented by the Ethernet PHY **420** may be shared and/or separated physically and/or functionally without deviating from the scope of the invention. The Ethernet PHY **420** may be enabled to convert between digital values and analog symbols impressed on the physical medium. Accordingly, received symbols may be converted to digital values and assembled into Ethernet frames before being conveyed up to the MAC **412**. Data received from the MAC **412** may be converted to physical symbols and transmitted onto a physical medium. In an exemplary embodiment of the invention, the physical medium may comprise twisted pair or coaxial cabling, and the transmitted symbols may be as defined by Ethernet protocols. In this regard, the Ethernet PHY **420** may enable Ethernet physical layer functionality.

[0074] In an exemplary transmit operation, data conveyed to the MAC client **422***a* or **422***b* via, for example, the video/Ethernet conversion block **406** or the PCI/Ethernet conversion block **426**, may be packetized into one or more Ethernet Frames. Subsequently, the frames may be conveyed to the MAC **412** which, in turn, may convey the frames to the DP PHY **420**. The DP PHY **420** may be convert the data to physical symbols and transmit the symbols onto a physical medium via the Ethernet connector **318**. In this manner, multimedia and/or general data may be transmitted to a remote client over a network. Ethernet frames may comprise headers which identify a network path over which they are to be transmitted. In this regard, AVB may be utilized to ensure timely delivery of the frames. Additionally, headers comprising the Ethernet frames may comprise information which may be utilized to extract/reconstruct the multimedia and/or general data from the Ethernet datastream.

[0075] In an exemplary receive operation, symbols received via the Ethernet connector **318** may be converted to digital values and assembled into Ethernet frames before being conveyed up to a another block, such as the video/Ethernet conversion block **406** or the PCI/Ethernet conversion block **426**. In this manner, Ethernet frames comprising control/auxiliary data received from a remote client via the Ethernet connector **318** may be extracted/reconstructed and the control/auxiliary data may be provided to, for example, a GPU or audio processor. Ethernet frames may comprise headers which identify a network path from which they are received. In this regard, AVB may be utilized to ensure timely delivery of the frames. Additionally, headers comprising the Ethernet frames may comprise information which may be utilized to extract/reconstruct the multimedia and/or general data from the Ethernet datastream.

[0076] In various embodiments of the invention logic, circuitry, and/or code may be shared between the DP PHY **418** and the Ethernet PHY **420**. For example, one or more line drivers may be configurable to output Ethernet or DP compliant physical layer signals. The DP PHY **418** and/or the Ethernet PHY **420** may thus be programmably configured to enable DP and/or Ethernet functionality. In this regard, one or

more control signals from, for example the controller **410** or the MAC **412**, may be communicated to the DP PHY **418** and/or the Ethernet PHY **420**.

[0077] FIG. **4**B is a block diagram illustrating an exemplary LAN subsystem of a multimedia server, in accordance with an embodiment of the invention. Although the system **450** in FIG. **4**B is illustrated as functioning as a server, the invention is not so limited, and in this regard, the system **450** may also be enabled to function as a client. Referring to FIG. **4**B, the system **450** may be similar to the system **400** of FIG. **4**A, but may comprise two MACs **412***a* and **412***b* and two Ethernet PHYs **472***a* and **472***b*. In this manner, the system **450** may support an additional connection via an Ethernet connector **470**. In various embodiments of the invention, various blocks comprising the server **450** and/or the LAN subsystem **452** may be scaled-up versions of the blocks comprising the server **400** and/or the LAN subsystem **402** in order to enable the additional Ethernet connection. Moreover, in various embodiments of the invention, the systems may be further scaled to support an increase number of connections. Additionally, the system **450** may be enabled to convert between multimedia formats. For example, the system **450** may be enabled to receive, for example, HDMI data via one of the connectors **318** or **370**, convert the HDMI data to DP, and output the data via the connector **316**.

[0078] The two Ethernet PHYs **412***a* and **412***b* may be enabled o transmit/receive via the additional Ethernet connector **470**. For example, PHY **412***a* may support an Ethernet connection for the transmission of multimedia data utilizing AVB and Ethernet PHY **412***b* may support an Ethernet connection for the transmission of general and/or non-AVB data. In this regard, the LAN subsystem **452** may support embodiments in which separate physical ports for standard Ethernet, multimedia over Ethernet, and DisplayPort traffic are desired.

[0079] The Ethernet connector **470** may be similar to or the same as the Ethernet connector **318**. In this regard, the Ethernet connector **470** may enable a second Ethernet connection to the LAN subsystem **452**. In one embodiment of the invention, general Ethernet traffic may be transmitted and/or received via the connector **318** and multimedia traffic may be received via the connector **470**. In this manner, multimedia data, packetized into Ethernet frames, may be transmitted to a local or remote client via the connector **470**. Moreover a DP datastream converted to one or more Ethernet datastreams may be transmitted and/or received via the connector **470**. In this regard, AVB may be utilized for the traffic transmitted/received via the connector **470**. Thus, the connector **470** may enable a DP connection over a network, as described in FIG. **2**, between the system **450** and a remote client, while the connector **318** may handle traditional Ethernet traffic between the system **450** and a remote system.

[0080] FIG. **5**A is a block diagram illustrating an exemplary LAN subsystem of a multimedia client, in accordance with an embodiment of the invention. Although the system **500** in FIG. **5**A is acting as a client, it is not limited in this regard and in various embodiments the system **500** may also act as a server. Referring to FIG. **5**A, the system **500** may be similar to the system **400** of FIG. **4**A.

[0081] In operation, a DP connection may be established between a remote server, such as the server **400**, and a display local to the system **500**. Accordingly, the system **500** may be enabled to receive an Ethernet datastream, extract/reconstruct a DP datastream from the received Ethernet datastream, and transmit the DP datastream to a local display via the DP connector **316** or other appropriate block(s) comprising the system **400**. In this regard, the system **500** may receive an Ethernet datastream from a remote server which may be transmitting a DP datastream to a display that is local to the system **500**.

[0082] In one embodiment of the invention, DP micro-packets may be extracted and/or reconstructed directly from received Ethernet frames. Accordingly, the MAC client **422***a* may extract/reconstruct Ethernet payloads from received Ethernet Frames and convey the payloads to the video/Ethernet conversion block **406** and/or the PCI/Ethernet conversion block **426**. In this regard, the video/Ethernet conversion block **406** and/or the PCI/Ethernet conversion block **426** may extract and/or reconstruct the DP micro-packets, and/or audio/video comprising the DP micro-packets, from the Ethernet payloads and convey the multimedia data to an appropriate block(s) comprising the system **500** (e.g. memory or CPU). Additionally, the video/Ethernet conversion block **406** may convey extracted DP micro-packets to the DP PHY **418** for conversion to DP physical layer symbols and transmission via the DP connector **316** to a local display.

[0083] In another embodiment of the invention, The Ethernet payloads may comprise IP datagrams. Accordingly, the PCI/Ethernet conversion block **426** and/or the video/Ethernet conversion block **406** may be enabled to determine whether the IP datagrams comprise general Ethernet traffic, or whether the IP datagrams comprise a DP datastream. In this regard, the video/Ethernet conversion block **406** may be enabled to extract/reconstruct multimedia data from the IP datagrams and convey the video data to an appropriate block (s) comprising the system **500** (e.g. memory or CPU). Additionally, the video/Ethernet conversion block **406** may convey the micro-packets to the DP PHY **418** for conversion to DP physical layer symbols and transmission via the DP connector **316** to the local display. Similarly, the PCI/Ethernet conversion block **426** may be enabled to extract general traffic and/or audio data from the IP datagrams and convey the data to the PCI bus interface **404**.

[0084] Ethernet frames and/or data comprising the Ethernet frames may be encrypted and the system **500** may be enabled to decrypt the frames and/or data. For example, the system **500** may be enabled to decrypt MACsec secured Ethernet frames, IPsec secured datagrams, and/or video protected utilizing high-bandwidth digital content protection (HDCP).

[0085] FIG. **5**B is a block diagram illustrating an exemplary LAN subsystem of a multimedia client, in accordance with an embodiment of the invention. It should be noted that although the system **550** in FIG. **5**B is acting as a client, it is not limited in this regard and in various embodiments the system **550** may also act as a server. Referring to FIG. **5**B, the system **550** may be similar to the system **450** of FIG. **4**B. Accordingly, in various embodiments of the invention, various blocks comprising the server **550** and/or the LAN subsystem **552** may be scaled-up versions of the blocks comprising the server **500** and/or the LAN subsystem **502** in order to enable the additional Ethernet connection. Moreover, in various embodiments of the invention, the systems may be further scaled to support an increase number of connections.

[0086] The two Ethernet PHYs **412***a* and **412***b* may be enabled o transmit/receive via the additional Ethernet connector **470**. For example, PHY **412***a* may support an Ethernet connection for the transmission of multimedia data utilizing AVB and Ethernet PHY **412***b* may support an Ethernet connection for the transmission of general and/or non-AVB data.

In this regard, the LAN subsystem **452** may support embodiments in which separate physical ports for standard Ethernet, multimedia over Ethernet, and DisplayPort traffic are desired.

[0087] The Ethernet connector **470** may be similar to or the same as the Ethernet connector **318**. In this regard, the Ethernet connector **470** may enable a second Ethernet connection to the LAN subsystem **452**. In one embodiment of the invention, general Ethernet traffic may be transmitted and/or received via the connector **318** and multimedia traffic may be received via the connector **470**. In this manner, multimedia data, packetized into Ethernet frames, may be transmitted to a local or remote client via the connector **470**. Moreover a DP datastream converted to one or more Ethernet datastreams may be transmitted and/or received via the connector **470**. In this regard, AVB may be utilized for the traffic transmitted/received via the connector **470**. Thus, the connector **470** may enable a DP connection over a network, as described in FIG. **2**, between the system **450** and a client, while the connector **318** may handle traditional Ethernet traffic between the system **450** and a remote system.

[0088] Aspects of the invention may comprise an integrated network interface, such as the LAN subsystem **452**, which may comprise one or more Ethernet interfaces, and one or more high definition (HD) multimedia interfaces to enable transmission and/or reception of HD multimedia content over a network. Audio/Video Bridging and/or Audio/Video Bridging extensions may be utilized for the transmission and/or reception of multimedia content. Exemplary HD multimedia interfaces may comprise DVI, HDMI, and DisplayPort. The integrated network interface may be enabled to transmit and/or receive physical layer signals adhering to protocols such as Ethernet and DisplayPort. Additionally, the integrated network interface may be configurable to select the type of signals to be transmitted or received. In this regard, aspects of the invention may enable packetization of multimedia content into, for example, Ethernet frames and/r DisplayPort micro-packets. Also, aspects of the invention may enable extracting HD multimedia content from DisplayPort micro-packets and/or Ethernet frames. Similarly, aspects of the invention may enable converting Ethernet frames to DisplayPort micro-packets and visa-versa. In various embodiments of the invention, a integrated network interface may be enabled to transmit and/or receive HD multimedia content over a network via a first connector; and transmit and/or receive general Ethernet traffic over a network via a second connector.

[0089] Another embodiment of the invention may provide a machine-readable storage, having stored thereon, a computer program having at least one code section executable by a machine, thereby causing the machine to perform the steps as described herein for integrating Ethernet and DP functions into a LAN subsystem.

[0090] Accordingly, the present invention may be realized in hardware, software, or a combination of hardware and software. The present invention may be realized in a centralized fashion in at least one computer system, or in a distributed fashion where different elements are spread across several interconnected computer systems. Any kind of computer system or other apparatus adapted for carrying out the methods described herein is suited. A typical combination of hardware and software may be a general-purpose computer system with a computer program that, when being loaded and executed, controls the computer system such that it carries out the methods described herein.

[0091] The present invention may also be embedded in a computer program product, which comprises all the features enabling the implementation of the methods described herein, and which when loaded in a computer system is able to carry out these methods. Computer program in the present context means any expression, in any language, code or notation, of a set of instructions intended to cause a system having an information processing capability to perform a particular function either directly or after either or both of the following: a) conversion to another language, code or notation; b) reproduction in a different material form.

[0092] While the present invention has been described with reference to certain embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted without departing from the scope of the present invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the present invention without departing from its scope. Therefore, it is intended that the present invention not be limited to the particular embodiment disclosed, but that the present invention will include all embodiments falling within the scope of the appended claims.

What is claimed is:

1. A system for communication, the system comprising:
an integrated network interface that comprises one or more HD multimedia interfaces, wherein said integrated network interface enables transmission and/or reception of HD multimedia content over a network.

2. The method according to claim **1**, wherein said integrated network interface comprises one or more Ethernet interfaces.

3. The system according to claim **2**, wherein AVB enables said transmission and/or reception of said HD multimedia content over said network via said one or more Ethernet interfaces and said one or more HD multimedia interfaces.

4. The system according to claim **1**, wherein said HD multimedia interfaces comprise one or more of DisplayPort, HDMI, and DVI.

5. The system according to claim **1**, wherein said integrated network interface enables transmission and/or reception of Ethernet physical layer symbols and DisplayPort physical layer symbols.

6. The system according to claim **2**, wherein said integrated network interface is configurable to select said Ethernet and/or HD multimedia interfaces for transmission and/or reception of data.

7. The system according to claim **1**, wherein said integrated network interface enables packetization of HD multimedia data into Ethernet frames.

8. The system according to claim **1**, wherein said integrated network interface enables de-packetization of Ethernet frames to extract HD multimedia data.

9. The system according to claim **1**, wherein said integrated network interface enables the packetization of HD multimedia data into DisplayPort micro-packets.

10. The system according to claim **1**, wherein said integrated network interface enables the de-packetization of DisplayPort micro-packets to extract HD multimedia data.

11. The system according to claim **1**, wherein said integrated network interface enables conversion of Ethernet frames to DisplayPort mini-packets.

12. The system according to claim **1**, wherein said integrated network interface enables conversion of DisplayPort micro-packets to Ethernet frames.

13. The system according to claim **1**, wherein said integrated network interface comprises a first Ethernet interface utilized to transmit and/or receive general Ethernet traffic and a second Ethernet interface utilized to transmit and/or receive HD multimedia traffic utilizing AVB.

14. The system according to claim **1**, wherein said integrated network interface comprises one or more physical connectors for transmission and/or reception of Ethernet data and said HD multimedia data.

15. The system according to claim **1**, wherein said integrated network interface is enabled to convert data formatted for a first HD multimedia interface into data formatted for a second HD multimedia interface.

16. A method for communication, the method comprising:
transmitting and/or receiving of HD multimedia content over a network utilizing an integrated network interface that comprises one or more HD multimedia interfaces.

17. The method according to claim **16**, wherein said integrated network interface comprises one or more Ethernet interfaces.

18. The method according to claim **16**, wherein AVB enables said transmission and/or reception of said HD multimedia content over said network via said one or more Ethernet interfaces and said one or more HD multimedia interfaces.

19. The method according to claim **16**, wherein said HD multimedia interfaces comprise one or more of DisplayPort, HDMI, and DVI.

20. The method according to claim **16**, comprising transmission and/or reception of Ethernet physical layer symbols and DisplayPort physical layer symbols via said integrated network interface enables.

21. The method according to claim **16**, comprising configuring said integrated network interface to select said Ethernet and/or HD multimedia interfaces for transmission and/or reception of data.

22. The method according to claim **16**, comprising packetizing said HD multimedia content into Ethernet frames.

23. The method according to claim **16**, comprising depacketizing Ethernet frames to extract said HD multimedia content.

24. The method according to claim **16**, comprising packetizing said HD multimedia content into DisplayPort micro-packets.

25. The method according to claim **16**, comprising depacketizing DisplayPort micro-packets to extract said HD multimedia content.

26. The method according to claim **16**, comprising converting Ethernet frames to DisplayPort mini-packets to enable said transmission and/or reception of multimedia content.

27. The method according to claim **16**, comprising converting DisplayPort mini-packets to Ethernet frames to enable said transmission and/or reception of multimedia content.

28. The method according to claim **16**, wherein said integrated network interface comprises a first Ethernet interface utilized to transmit and/or receive general Ethernet traffic and a second Ethernet interface utilized to transmit and/or receive HD multimedia traffic utilizing AVB.

29. The method according to claim **16**, wherein said integrated network interface comprises one or more physical connectors for transmission and/or reception of Ethernet data and said HD multimedia data.

30. The method according to claim **16**, wherein said integrated network interface is enabled to convert data formatted for a first HD multimedia interface into data formatted for a second HD multimedia interface.

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