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Soma

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(54) **RECHARGEABLE UNIVERSAL SERIAL BUS EXTERNAL GRAPHICS DEVICE AND METHOD**

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G06T 1/60 (2006.01)
G06F 13/38 (2006.01)

(52) **U.S. Cl.**
CPC ***G06F 13/385*** (2013.01)
USPC **345/520**; 345/530

(58) **Field of Classification Search**
USPC 710/2, 8; 345/505, 520, 530
See application file for complete search history.

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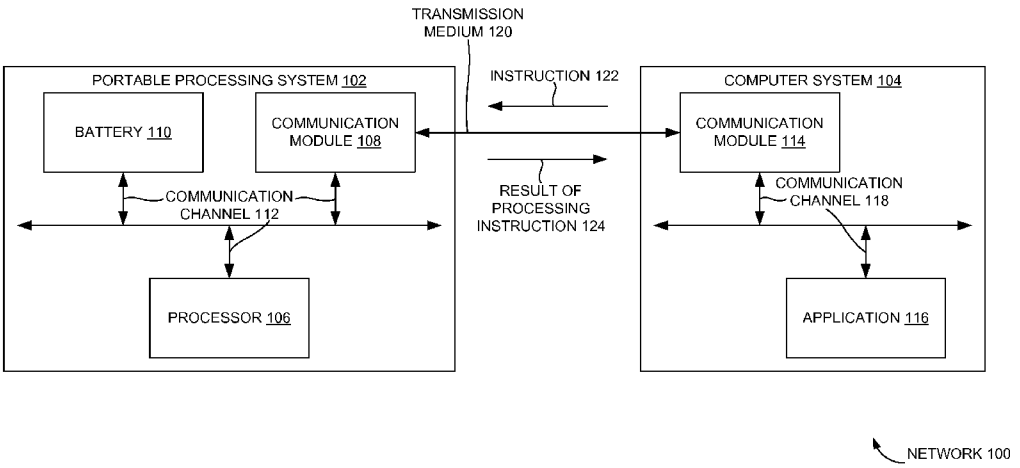
(57) **ABSTRACT**

A graphics processing device that is portable, reconfigurable and provides graphics processing for a computer system is provided. The graphics processing device includes a Universal Serial Bus (USB) interface coupled with the graphics processor and configured to be coupled with computer system. The graphics processing device further includes the USB interface configured to transfer a graphics instruction, originated by the computer system, to the graphics processor. The graphics processing device may further include a battery coupled with the graphics processor to partially power the graphics processor. The battery may be rechargeable. The graphics processor may be configured to process graphics instruction on behalf of the computer system. A portable processing system to provide processing for a computer system is also disclosed. The portable processing system may include a processor. The portable processing system may include a USB module coupled with processor and configured to be coupled with computer system.

20 Claims, 6 Drawing Sheets



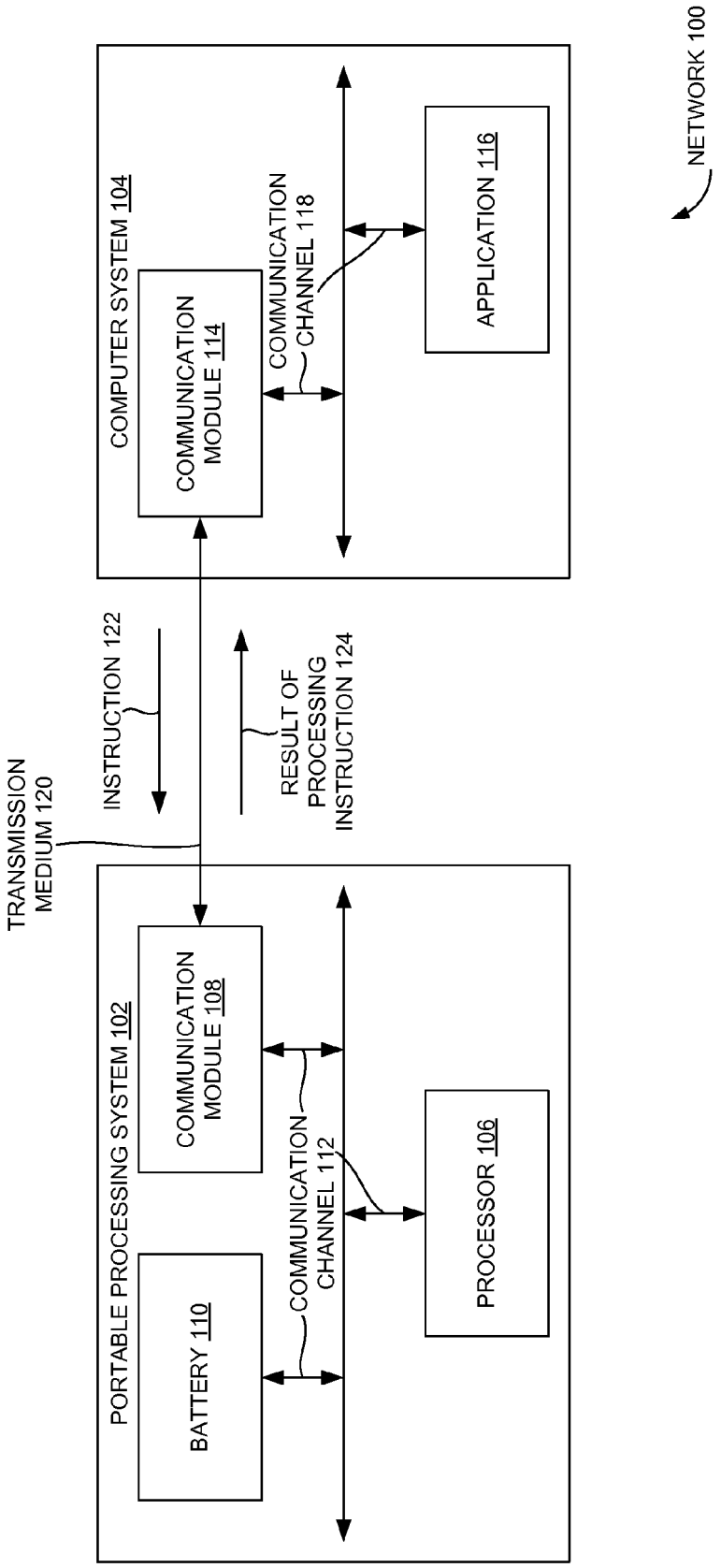

NETWORK 100
COMPUTER SYSTEM 104
COMMUNICATION MODULE 114
COMMUNICATION CHANNEL 118
APPLICATION 116
INSTRUCTION 122
RESULT OF PROCESSING INSTRUCTION 124
TRANSMISSION MEDIUM 120
PORTABLE PROCESSING SYSTEM 102
COMMUNICATION MODULE 108
BATTERY 110
COMMUNICATION CHANNEL 112
PROCESSOR 106

FIGURE 1

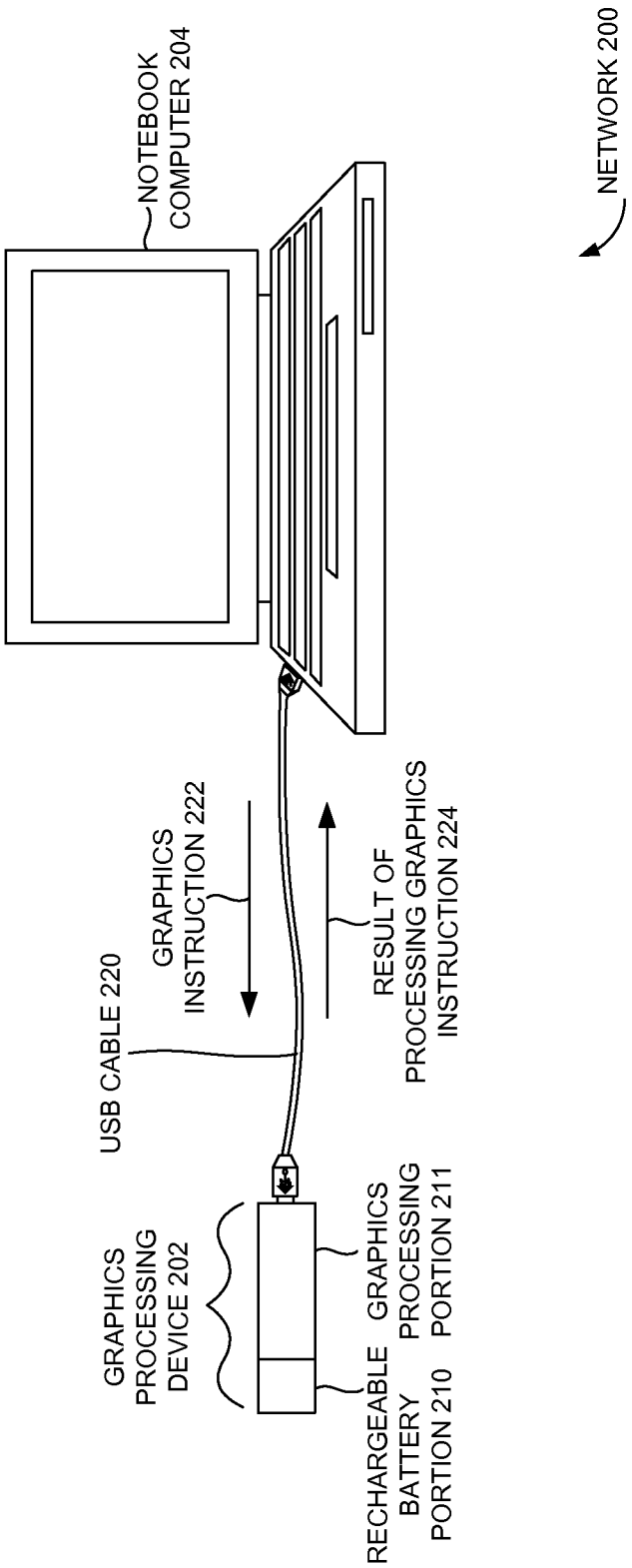

NOTEBOOK COMPUTER 204
NETWORK 200
GRAPHICS INSTRUCTION 222
RESULT OF PROCESSING GRAPHICS INSTRUCTION 224
USB CABLE 220
GRAPHICS PROCESSING DEVICE 202
GRAPHICS PROCESSING PORTION 211
RECHARGEABLE BATTERY PORTION 210

FIGURE 2

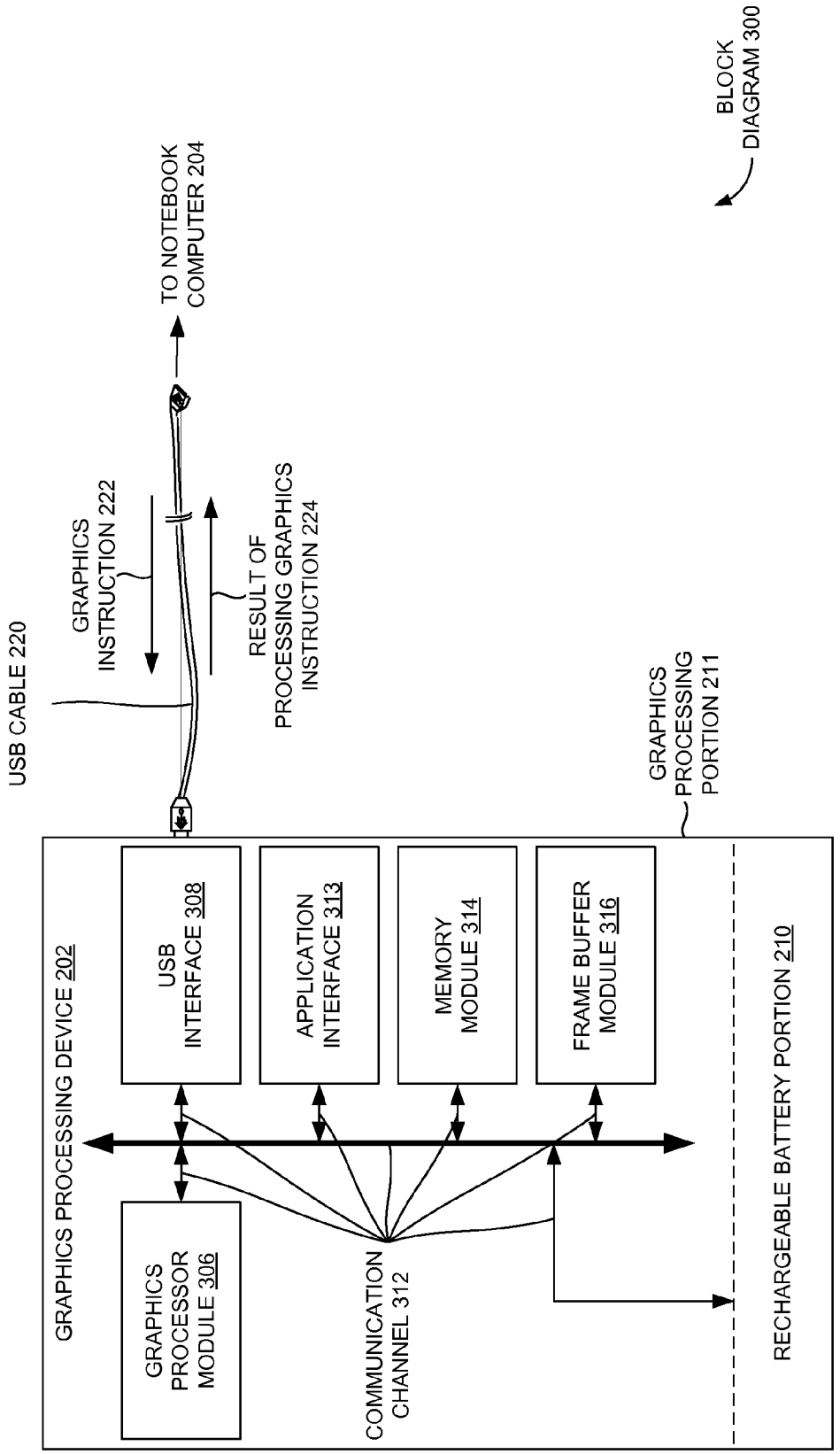

BLOCK DIAGRAM 300
TO NOTEBOOK COMPUTER 204
GRAPHICS INSTRUCTION 222
RESULT OF PROCESSING GRAPHICS INSTRUCTION 224
USB CABLE 220
GRAPHICS PROCESSING PORTION 211
GRAPHICS PROCESSING DEVICE 202
USB INTERFACE 308
APPLICATION INTERFACE 313
MEMORY MODULE 314
FRAME BUFFER MODULE 316
GRAPHICS PROCESSOR MODULE 306
COMMUNICATION CHANNEL 312
RECHARGEABLE BATTERY PORTION 210

FIGURE 3

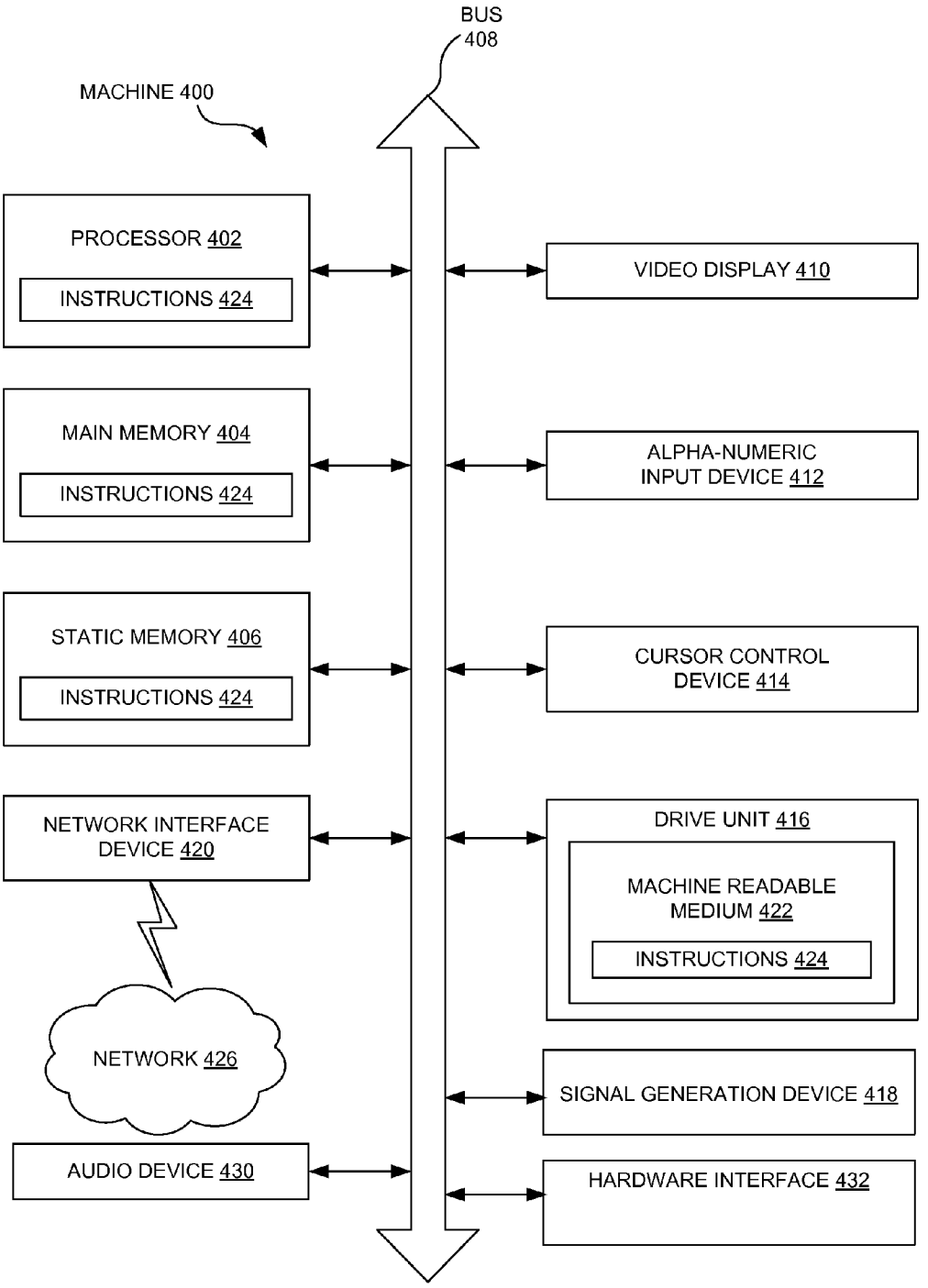

BUS
408
MACHINE 400
PROCESSOR 402
INSTRUCTIONS 424
MAIN MEMORY 404
INSTRUCTIONS 424
STATIC MEMORY 406
INSTRUCTIONS 424
NETWORK INTERFACE DEVICE 420
NETWORK 426
AUDIO DEVICE 430
VIDEO DISPLAY 410
ALPHA-NUMERIC INPUT DEVICE 412
CURSOR CONTROL DEVICE 414
DRIVE UNIT 416
MACHINE READABLE MEDIUM 422
INSTRUCTIONS 424
SIGNAL GENERATION DEVICE 418
HARDWARE INTERFACE 432

FIGURE 4

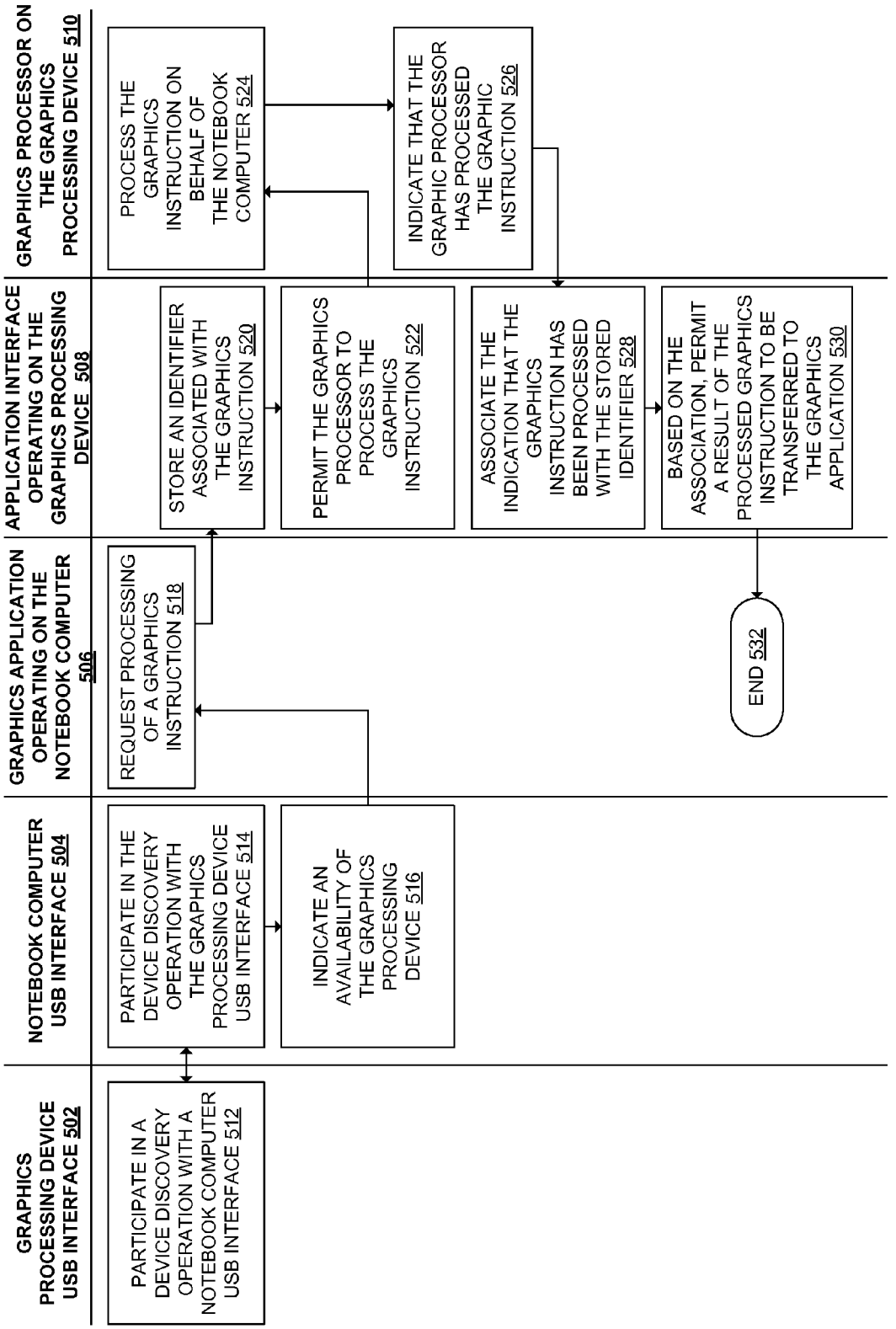

GRAPHICS PROCESSING DEVICE USB INTERFACE 502
NOTEBOOK COMPUTER USB INTERFACE 504
GRAPHICS APPLICATION OPERATING ON THE NOTEBOOK COMPUTER 506
APPLICATION INTERFACE OPERATING ON THE GRAPHICS PROCESSING DEVICE 508
GRAPHICS PROCESSOR ON THE GRAPHICS PROCESSING DEVICE 510
PARTICIPATE IN A DEVICE DISCOVERY OPERATION WITH A NOTEBOOK COMPUTER USB INTERFACE 512
PARTICIPATE IN THE DEVICE DISCOVERY OPERATION WITH THE GRAPHICS PROCESSING DEVICE USB INTERFACE 514
INDICATE AN AVAILABILITY OF THE GRAPHICS PROCESSING DEVICE 516
REQUEST PROCESSING OF A GRAPHICS INSTRUCTION 518
STORE AN IDENTIFIER ASSOCIATED WITH THE GRAPHICS INSTRUCTION 520
PERMIT THE GRAPHICS PROCESSOR TO PROCESS THE GRAPHICS INSTRUCTION 522
PROCESS THE GRAPHICS INSTRUCTION ON BEHALF OF THE NOTEBOOK COMPUTER 524
INDICATE THAT THE GRAPHIC PROCESSOR HAS PROCESSED THE GRAPHIC INSTRUCTION 526
ASSOCIATE THE INDICATION THAT THE GRAPHICS INSTRUCTION HAS BEEN PROCESSED WITH THE STORED IDENTIFIER 528
BASED ON THE ASSOCIATION, PERMIT A RESULT OF THE PROCESSED GRAPHICS INSTRUCTION TO BE TRANSFERRED TO THE GRAPHICS APPLICATION 530
END 532

FIGURE 5

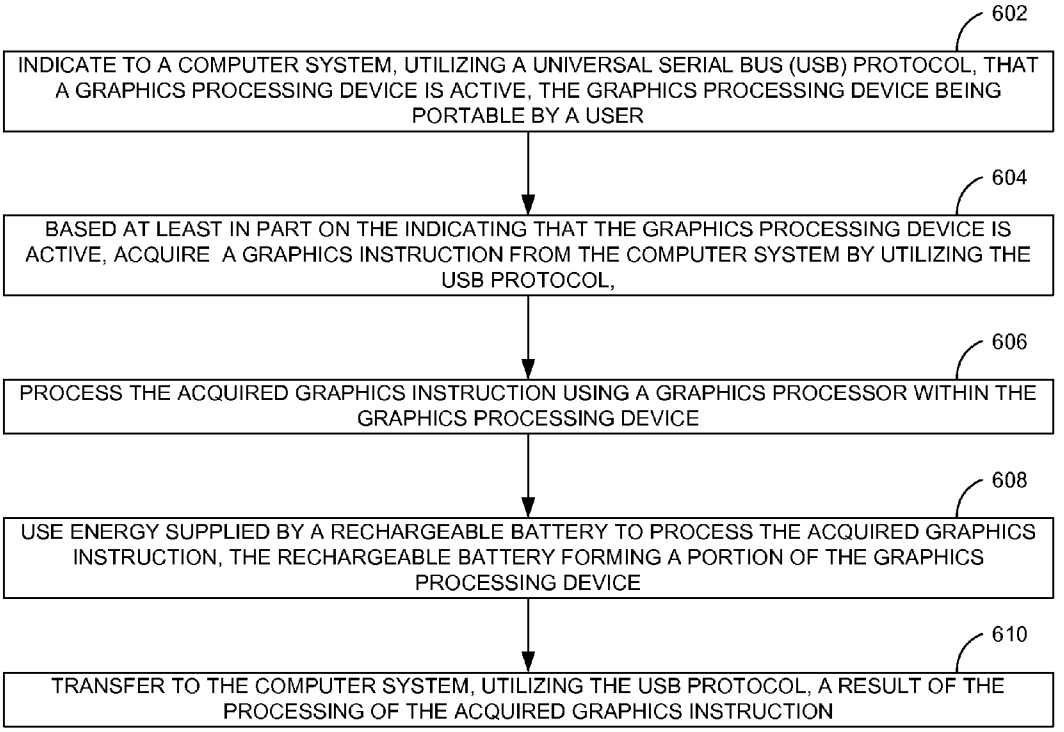

602
INDICATE TO A COMPUTER SYSTEM, UTILIZING A UNIVERSAL SERIAL BUS (USB) PROTOCOL, THAT A GRAPHICS PROCESSING DEVICE IS ACTIVE, THE GRAPHICS PROCESSING DEVICE BEING PORTABLE BY A USER
604
BASED AT LEAST IN PART ON THE INDICATING THAT THE GRAPHICS PROCESSING DEVICE IS ACTIVE, ACQUIRE A GRAPHICS INSTRUCTION FROM THE COMPUTER SYSTEM BY UTILIZING THE USB PROTOCOL,
606
PROCESS THE ACQUIRED GRAPHICS INSTRUCTION USING A GRAPHICS PROCESSOR WITHIN THE GRAPHICS PROCESSING DEVICE
608
USE ENERGY SUPPLIED BY A RECHARGEABLE BATTERY TO PROCESS THE ACQUIRED GRAPHICS INSTRUCTION, THE RECHARGEABLE BATTERY FORMING A PORTION OF THE GRAPHICS PROCESSING DEVICE
610
TRANSFER TO THE COMPUTER SYSTEM, UTILIZING THE USB PROTOCOL, A RESULT OF THE PROCESSING OF THE ACQUIRED GRAPHICS INSTRUCTION

FIGURE 6

RECHARGEABLE UNIVERSAL SERIAL BUS EXTERNAL GRAPHICS DEVICE AND METHOD

FIELD OF TECHNOLOGY

This disclosure relates generally to graphics acceleration technology. More particularly, this disclosure relates to a rechargeable universal serial bus external graphics device and method.

BACKGROUND

An external graphics device (e.g., an external graphics card) may consume a significant amount of power when coupled with a data processing system through a Peripheral Component Interconnect Express (PCI-e) slot. The significant amount of power may be consumed because the external graphics device may perform process incentive graphics tasks. Furthermore, the PCI-e slot may be slow when compared to other approaches.

SUMMARY

Disclosed are rechargeable universal serial bus external graphics device and method.

In one aspect, the rechargeable universal serial bus external graphics device referred to herein after as graphics processing device may be portable and may provide graphics processing for a computer system. The graphics processing device includes a graphics processor. The graphics processing device also includes a universal serial bus (USB) interface that is communicatively coupled with the graphics processor and is configured to be communicatively coupled with the computer system. In one or more embodiments, the USB interface may utilize a USB 3.0 protocol. The graphics processing device further includes the USB interface being further configured to transfer a graphics instruction, originated by the computer system, to the graphics processor. The graphics processor may be configured to process the graphics instruction on behalf of the computer system. The graphics processor may also be configured to transfer a result of processing the graphics instruction to the computer system, using the USB interface.

The graphics processing device may further include a battery coupled with the graphics processor, and configured to partially power the graphics processor to process the graphics instruction. The battery may be rechargeable. The battery may be a lithium ion battery. The battery may be user-attachable with the graphics processing device and user-detachable from the graphics processing device such that the battery is field replaceable. The graphics instruction associated with a graphics application may be operated by the computer system.

In another aspect, a portable processing system to provide processing for a computer system is disclosed. The portable processing system may include a processor. The portable processing system may also include a battery coupled with the processor and configured to provide power to the processor. The battery may be configured to at least partially power the processor to process the instruction. The battery may be user-detachable from the portable processing system and user-attachable with the portable processing system. The battery may be rechargeable. The battery may be a lithium ion rechargeable battery.

The portable processing system may also include a USB module communicatively coupled with the processor and

may be configured to be communicatively coupled with the computer system. The USB module may be configured to transfer an instruction, which was originated by the computer system, to the processor. The processor may be configured to process the instruction on behalf of the computer system. The processor may transfer a result of the processed instruction to the computer system, using the USB module. The processor may include a graphics processor, and the portable processing system may be configured to provide auxiliary graphics processing for the computer system. The instruction may include a graphics instruction associated with a graphics application operated by the computer system.

In yet another aspect, a graphics processing system includes a computer system. The computer system includes one or more system processors. The computer system also includes a memory coupled with one or more system processors. The computer system further includes a video display device configured to display graphical data generated by one or more system processors. The computer system furthermore includes a first USB interface coupled with one or more system processors, and an audio device configured to generate audio data generated by one or more system processors. The graphics processing system also includes a graphics processing device communicatively coupled with the computer system using a USB cable. The graphics processing device may include one or more graphics processors. The graphics processing device may also include a second USB interface communicatively coupled with one or more graphics processors and configured to communicatively couple the first USB interface with the second USB interface using the USB cable.

The second USB interface may be configured to receive a graphics instruction that is encoded by a USB 3.0 communication protocol from the computer system via the USB cable. The second USB interface may also be configured to provide the graphics instruction for one or more graphics processors. One or more graphics processors may be configured to process the graphics instruction on behalf of the computer system. The graphic processor may also be configured to transfer a result of the processed graphics instruction to the computer system, using the second USB interface. The graphics processing device may further include a rechargeable battery that may be removably coupled with one or more graphics processors and may be configured to be field replaceable. The rechargeable battery may be configured to partially power one or more graphics processors when one or more graphics processors process the graphics instruction. The graphics processors may include one or more multi-core processors.

In yet another aspect a method includes indicating to a computer system, that a graphics processing device is active. The computer system may be indicated by utilizing a Universal Serial Bus (USB) protocol. The graphics processing device may be portable by a user. The method also includes acquiring a graphics instruction from the computer system, based at least in part on the indicating that the graphics processing device is active. The graphics instruction may be acquired by utilizing the USB protocol. The method further includes processing the acquired graphics instruction using a graphics processor within the graphics processing device. The method furthermore includes using energy supplied by a rechargeable battery to process the acquired graphics instruction. The rechargeable battery may form a portion of the graphics processing device. The method furthermore includes transferring to the computer system, utilizing the USB protocol, a result of the processing of the acquired graphics instruction. In one or more embodiments, the acquiring of the graphics instruction utilizing the USB protocol may include acquiring the graphics instruction utilizing a USB 3.0

protocol. In one or more embodiments, transferring the result of the processing of the acquired graphics instruction includes utilizing the USB 3.0 protocol. In one or more embodiments, the energy in the rechargeable battery may be stored prior to the supplying the energy.

The methods and systems disclosed herein may be implemented in any means for achieving various aspects, and may be executed in a form of a machine-readable medium embodying a set of instructions that, when executed by a machine, cause the machine to perform any of the operations disclosed herein. Other features will be apparent from the accompanying drawings and from the detailed description that follows.

BRIEF DESCRIPTION OF THE DRAWINGS

The embodiments of this invention are illustrated by way of example and not limitation in the figures of the accompanying drawings, in which like references indicate similar elements and in which:

FIG. **1** is a block diagram, showing an example network including an example portable processing system and an example computing system, in accordance with an example embodiment.

FIG. **2** a block diagram, showing an example network including an example graphics processing device and a notebook computer, in accordance with an example embodiment.

FIG. **3** is a block diagram illustrating the example graphics processing device of FIG. **2**, in accordance with an example embodiment.

FIG. **4** is a block diagram showing an example machine, in accordance with an example embodiment.

FIG. **5** is an interaction diagram, illustrating example interactions involving components of an example graphics processing system, in accordance with an example embodiment.

FIG. **6** is a flow diagram showing an example method for providing graphics processing, in accordance with an example embodiment.

Other features of the present embodiments will be apparent from the accompanying drawings and from the detailed description that follows.

DETAILED DESCRIPTION

Example embodiments, as described below, may be used to provide a rechargeable universal serial bus external graphics device and method.

Although the present embodiments have been described with reference to specific example embodiments, it will be evident that various modifications and changes may be made to these embodiments without departing from the broader spirit and scope of the various embodiments.

FIG. **1** is a block diagram, showing an example network **100** including an example portable processing system **102** and an example computing system **104**, in accordance with an example embodiment. The example network **100** may include, but is not limited to a wired network or a wireless network. The example network **100** may be implemented with an appropriate communication protocol including, but not limited to a universal serial bus (USB), an internet protocol (IP), Wi-Fi, worldwide interoperability for microwave access (Wimax), a fibre channel over ethernet (FCoE), a wireless application protocol (WAP) or a combination therein. In one or more embodiments, the portable processing system **102** (e.g., a graphics processing system) may be configured to process one or more instructions on behalf of the computer system **104**. Examples of the computer system **104** may include, but is not limited to a desktop, a laptop, a handheld device, and/or a computer system that does not include a graphics processor. The computer system **104** may include one or more system processors (e.g., central processing unit (CPU) and/or a memory (e.g., random access memory (RAM), read only memory (ROM) coupled with one or more of the processors.

In one or more embodiments, the computer system **104** may also include a video display device configured to display graphical data generated by one or more system processors. The computer system may further include a first USB interface coupled with one or more system processors. Furthermore, the computer system may also include an audio device configured to generate audio data generated by one or more system processors. In one or more embodiments, the portable processing system **102** includes a processor **106** (e.g., a graphics processor). The processor **106** may be a general purpose processor or a special purpose processor. In one or more embodiments, the processor **106** may include a multicore processor. In one or more embodiments, the processor **106** may include, for example a graphics processor. In one or more embodiments, the portable processing system **102** may be configured to provide auxiliary graphics processing for the computer system **104**. In one or more embodiments, the portable processing system **102** further includes a battery **110** coupled with the processor **106** and configured to provide power to the processor **106**.

Further, in one or more embodiments, the portable processing system **102** also includes a communication module **108** (e.g., a USB module) communicatively coupled with the processor **106** and configured to be communicatively coupled with the computer system **104**. In one or more embodiments, the communication module **108** (e.g., a USB module) may utilize a USB 3.0 protocol to communicate with the computer system **104**. The communication module **108** may be configured to transfer an instruction **122** that was originated by the computer system **104**, to the processor **106**. The instruction **122** may include, for example a graphics instruction associated with a graphics application operated by the computer system **104**. The communication module **108** may also be configured to receive, process, and/or transmit data using one or more network communication protocols (e.g., IP, transmission control protocol (TCP), and the like). The communication module **108** may be further be configured to translate to/or from the network communication protocol of the processor **106**.

Examples of the network communication protocols may include, but are not limited to USB, Wi-Fi, WiMax, PCI-e, and the like. The processor **106** may be configured to process the instruction **122** on behalf of the computer system **104** and transfer a result of the processed instruction **124** to the computer system **104** through the communication module **108**. The communication module may include one or more interfaces (e.g., a USB interface). In an example embodiment, the portable processing system **102** may include a first interface and a second interface. Examples of the first interface may include, but not limited to a USB interface. The second interface (e.g. a USB interface) may be communicatively coupled with one or more of the processors (e.g., processor **106**). The second interface may be configured to communicatively couple the first interface with the second interface using a communication medium (e.g., a USB cable). In one or more embodiments, the battery **110** may be configured to partially power the processor **106** to process the instruction **122**.

Further, the second interface may be configured to receive a graphics instruction from the computer system **104**. The graphic instruction may be encoded by a communication

protocol (e.g. a USB 3.0) from the computer system **104**. Further, the second interface may also be configured to provide graphic instruction to the processor **106**. In one or more embodiments, the battery **110** may be user-detachable from the portable processing system **102** and/or user-attachable with the portable processing system **102**. The battery **110** may be rechargeable or non-rechargeable. The rechargeable battery may be further configured to partially power one or more of the processors when one or more of the processors processes an instruction (e.g. a graphic instruction) or when the computer system **104** fails to supply power to the portable processing system **102** (e.g., on event of power failure when the computer system **104** is devoid of a back-up power source).

Examples of the battery **110** may include, but is not limited to a lead acid battery, a nickel cadmium (NiCd) battery, nickel metal hydride (NiMH) battery, a lithium ion (Li-ion) battery, and lithium ion polymer (Li-ion polymer) rechargeable battery, and the like. Consider, for example, if an application **116** running on the computer system **104** requires the processing capabilities of the portable processing system **102**. The application **116** may include, for example, a graphics application including for example a video game, or other graphics application. A communication module **114** of the computer system **104** may interact with the application **116** through a communication channel **118**.

The communication module **114** may transfer a data associated with the application **116** to be processed through the portable processing system **102**, to the USB module **108** through the transmission medium **120**. The transmission medium **120** may include, for example, a USB cable, a data cable, a wireless network, and the like. The USB module **108** may transfer the data to be processed to the processor **106** through the communication channel **112** of the portable processing system **102**. The processor **106** may process the data and transfer a result of processing instruction **124** to the USB module **108**. The USB module **108** may transfer the result of processing instruction **124** to the communication module **114** of the computer system **104**.

FIG. **2** a block diagram, showing an example network **200** including an example graphics processing device **202** and a notebook computer **204**, in accordance with an example embodiment. The term graphics processing device **202** may be used interchangeably with the term rechargeable USB external graphics device. In one or more embodiments, the graphics processing device **202** is portable and provides graphics processing for a computer system **104**. The graphics processing device **202** includes a graphics processor. In one or more embodiments, the graphics processing device **202** may also include a USB interface (not shown) communicatively coupled with the graphics processor and may be configured to be communicatively coupled with the computer system **104**. For the purpose of illustration the detailed description may refer to the USB interface; however the scope of the graphics processing system disclosed herein is not limited to the USB interface but may be extended to include any known generic communication interface of a computing system. In one or more embodiments, the USB interface may further be configured to transfer a graphics instruction, originated by the computer system **104**, to the graphics processing device **202**.

In one or more embodiments, the USB interface may utilize a USB 3.0 protocol to transfer data. The graphics instruction associated with a graphics application may be operated by the computer system **104**. The graphics processor may be configured to process the graphics instruction on behalf of the computer system. The graphics processor may also be configured to transfer a result of processing the graphics instruction to the computer system **104**, using the USB interface. The graphics processing device **202** may further include a battery coupled with the graphics processor, and configured to at least partially power the graphics processor to process the graphics instruction. In one or more embodiments, the battery may be rechargeable and may be housed in a rechargeable battery portion **210** of the graphics processing device **202**. The battery may be a lithium ion battery. The battery may be user-attachable with the graphics processing device and/or user-detachable from the graphics processing device such that the battery is field replaceable. The battery may be recharged by using power from the computer system **104** (e.g., notebook computer **204**). The graphics processor may be housed in a graphics processing portion **211** of the graphics processing device **202**.

FIG. **3** is a block diagram illustrating the example graphics processing device **202** of FIG. **2**, in accordance with one or more embodiments. In the example embodiment of FIG. **3**, the graphics processing device **202** may have a modular architecture allowing disintegration of one or more functional modules within the graphics processing device **202**. The functional modules may include, but is not limited to, a graphics processor module **306**, a memory module **314**, a frame buffer module **316**, and the like. The modularization allows replacement of the functional modules and customization of the graphics processing device **202** to upgrade functionalities of the graphics processing device **202**. Further, replaceability of the functional modules allows upgrading individual functional modules without the need to replace whole of the graphics processing device **202**. The replaceability of the functional modules also allows mix and match of various components (e.g., processor, memory, and the like) of the functional modules. In one or more embodiments, the modular architecture may be implemented using one or more standard interfaces between modules that allow specification of a desired inter-modular behavior, verification that the behavior is as designed, and predictability that the correct behavior will always occur.

In one or more embodiments, an open interface standard may be implemented in the graphics processing device **202** to strengthen compatibility and interoperability of the functional modules from different vendors. In one or more embodiments, the modular architecture may be implemented by separately mounting different functional modules at different sections of a motherboard and by interconnecting the different sections through one or more physical interfaces. In one or more embodiments, the motherboard may have one or more base sockets to receive pins on the functional modules and to provide interconnection between the various functional modules. Each functional module may be an integrated circuit and may house one or more of a processor circuitry, a memory circuitry, and a similar desired circuitry to provide a desired functionality. Each functional module may have a separate base socket to allow replacement of the functional modules.

In one or more embodiments, the graphics processor module **306** may include a graphics processor and a communication interface to allow communication among the replaceable functional modules of the graphic processing device. The modularization renders the functional modules to be replaceable and thereby renders the graphics processing device **202** to be reconfigurable without the need to replace whole of the graphics processing device **202**. The graphics processing device **202** could be, for example, an external graphics card. In one or more embodiments, the memory module **314** may include a memory (e.g., double data rate three synchronous

dynamic random access memory (DDR3 SDRAM™)) and/or an interface to allow communication with other functional modules of the graphic processing device **202**. In one or more embodiments, the memory may also include an operating system (e.g., Android™, Linux™, Microsoft®'s Windows™) of the graphics processing device **202** resident therein. Also, in one or more embodiments, the frame buffer module **316** may include a frame buffer and/or an interface to allow communication with other functional modules of the graphic processing device **202**.

If one or more processing capabilities of the graphics processing device **202** need to be enhanced, one or more of the functional modules in the graphics processing device **202** can be replaced with one or more new processing modules with required processing capabilities (e.g., a faster processing capability) without removing the whole of the graphics processing device **202**. For example, a 2 gigabyte (GB) memory chip of the graphics processing device may be removably mounted on the motherboard of the graphics processing device **202**. If the memory of the graphics processing device needs to be enhanced to a 4 GB memory due to requirements of a graphics application to be processed through the graphics processing device **202**, then the 2 GB memory chip may be replaced with a 4 GB memory chip. The pins of the 4 GB memory chip may match the pins of the 2 GB memory chip so as to mount the 4 GB memory chip on a base socket where the 2 GB memory chip was previously mounted, without having to replace the whole of the graphics processing device **202** for up gradation.

Further, it may be economically feasible from the perspective of a user to replace one or more of the functional modules within the graphics processing device **202** instead of replacing whole of the graphics processing device **202**, whenever a need to upgrade the capabilities of graphics processing device **202** arises. In addition, in one or more embodiments, the graphics processing device **202** may also include a USB interface **308** to allow the graphics processing device **202** to communicate with a computer system (e.g. notebook computer **204**) through a USB cable **220**. In one or more embodiments, a graphics instruction **222** may be transferred from the notebook computer **204** to the graphics processing device **202** through the USB cable **220**. The USB interface **308** may be configured to receive the graphics instruction **222** and communicate the received instruction to the graphics processor module **306** through a communication channel **312**. The graphics processor module may process the graphics instruction and a result **224** of the processing may be transferred to the computer system (e.g. notebook computer **204**) through the USB cable **220** as illustrated in FIG. **3**.

In one or more embodiments, the graphics processing device **202** may further include an application interface **313**. The application interface **313** may facilitate the processing of instructions (e.g., graphical instruction) on behalf of a computer system (e.g., the notebook computer **204**) requesting auxiliary processing from a portable processing system (e.g., the graphics processing device **202**). Although the example application interface **313** is shown to be located on the graphics processing device **202** in FIG. **3**, the example application interface **313** may be located elsewhere (e.g., external to the graphics processing device **202**) without departing from the claimed subject matter. In an example embodiment, the application interface **313** may be located on the notebook computer **204**.

In some example embodiments, the graphics processing device **313** and the notebook computer device **204** may share in facilitating the processing of instructions. In some example embodiments, some or all of the functionality of the application interface **313** may be provided external to the graphics processing device **202** and/or the computer system **104** (e.g., notebook computer **204**). In one or more embodiments, the graphics processing device **202** of FIG. **2** may periodically indicate to the notebook computer **204** of FIG. **2**, that the graphics processing device **302** is activated to process graphics instructions on behalf of the notebook computer **204** of FIG. **2**. In various example embodiments, the graphics processing device **202** may use the USB interface **308** of FIG. **3** and the USB cable **220** of FIG. **2**, to indicate the active state. In an example embodiment, subsequent to indicating the active state of the graphics processing device **202**, the application interface **313** of FIG. **3** may receive a processing request from the notebook computer **204** of FIG. **2**. In an example embodiment, the application interface **313** of FIG. **3** may coordinate the processing of a graphics instruction by the graphics processor **306**. In some example embodiments, the application interface **313** of FIG. **3** may be implemented with software (e.g., drivers) or in other example embodiments with hardware, and in yet further embodiments, the application interface **313** may be implemented using a combination of hardware and software. The operation of the application interface **313** is discussed in further detail below with respect to FIG. **5**.

FIG. **4** is a block diagram showing an example machine **400**, in accordance with an example embodiment. In one or more embodiments, the machine **400** is an example form of a computer system **104**, within which a set of instructions, for causing the machine **400** to perform any one or more of the methodologies discussed herein, may be executed. In various embodiments, the machine **400** may operate as a standalone device and/or may be connected (e.g., networked) to other machines. In a networked deployment, the machine **400** may operate in the capacity of a server and/or a client machine in server-client network environment, and/or as a peer machine in a peer-to-peer (or distributed) network environment. The machine **400** may be a personal computer (PC), a tablet PC, a set-top box (STB), a Personal Digital Assistant (PDA), a cellular telephone, a web appliance, a network router, switch and/or bridge, an embedded system and/or any machine capable of executing a set of instructions (sequential and/or otherwise) that specify actions to be taken by the machine **400**. Further, while only a single machine is illustrated, the term "machine" shall also be taken to include any collection of machines that individually and/or jointly execute a set (or multiple sets) of instructions to perform any one and/or more of the methodologies discussed herein.

The example computer system **104** includes a processor **402** (e.g., a central processing unit (CPU) a graphics processing unit (GPU) and/or both), a main memory **404** and a static memory **406**, which communicate with each other via a bus **408**. The computer system **104** may further include a video display unit **410** (e.g., a liquid crystal display (LCD) and/or a cathode ray tube (CRT)). The computer system **104** also includes an alphanumeric input device **412** (e.g., a keyboard), a cursor control device **414** (e.g., a mouse), a disk drive unit **416**, a signal generation device **418** (e.g., a speaker) and a network interface device **420**. The disk drive unit **416** includes a machine-readable medium **422** on which is stored one or more sets of instructions (e.g., software **424**) embodying any one or more of the methodologies and/or functions described herein.

The software **424** may also reside, completely and/or at least partially, within the main memory **404** and/or within the processor **402** during execution thereof by the computer system **104**, the main memory **404** and the processor **402** also constituting machine-readable media. The software **424** may

further be transmitted and/or received over a network **426** via the network interface device **420**. Further, in one or more embodiments, the machine **400** may also include an audio device **430** configured to generate audio data generated by the processor **402**. In one or more embodiments, the machine **400** may also include a hardware interface (e.g. a USB interface) for communicatively coupling one or more peripheral devices (e.g. a graphics processing device **202**) with the machine **400**.

While the machine-readable medium **422** is shown in an example embodiment to be a single medium, the term "machine-readable medium" should be taken to include a single medium and/or multiple media (e.g., a centralized and/or distributed database, and/or associated caches and servers) that store one or more sets of instructions. The term "machine-readable medium" shall also be taken to include any medium that is capable of storing, encoding and/or carrying a set of instructions for execution by the machine and that cause the machine to perform any one or more of the methodologies of the various embodiments. The term "machine-readable medium" shall accordingly be taken to include, but not be limited to, solid-state memories, optical and magnetic media, and carrier wave signals.

FIG. **5** is an interaction diagram, illustrating example interactions involving components of an example graphics processing system. As illustrated in FIG. **5**, at step **512**, a user interface **502** of a graphics processing device **202** in the example graphics processing system participates in a device discovery operation with a USB interface **504** of a notebook computer. During the device discovery, the graphics processing device **202** may indicate to a computer system **104**, that the graphics processing device **202** is active. In one or more embodiments, the graphics processing device **202** may be portable by a user and the indication may be made using a USB protocol. For example, referring to FIG. **2**, the graphics processing device **202** may indicate to the notebook computer **204** that the graphics processing device **202** is active and ready to process graphics instructions (e.g., on behalf of the notebook computer **204**).

In one or more embodiments, in step **514**, the USB interface **504** of the notebook computer participates in device discovery with the user interface **512** of the graphics processing device. For example, referring again to FIG. **2**, the graphics processing device **202** of FIG. **2** may provide the indication that the graphics processing device **202** is active to the notebook computer **204** over the USB cable **220**. Further in step **516**, the USB interface **504** of the notebook computer indicates availability of the graphics processing device to the notebook computer. In one or more embodiments, at step **518**, a graphics application **506** running in the notebook computer requests processing a graphics instruction through an application interface **508**.

For example, referring to FIG. **3**, when a graphics instruction **222** needs to be processed through the graphics processing device **202** on behalf of the notebook computer **204**, the notebook computer transfers the graphics instruction **222** through the USB cable **220** to the USB interface **308** of the graphics processing device **202**. The graphics instruction **222** may then be transferred to the application interface **313** that mediates between the graphics processor module **306** and the notebook computer **204**. At step **520**, the application interface **508** stores an identifier associated with the graphics instruction. Referring to FIG. **3** again, the identifier may be stored in, for example, the memory within the memory module **314** of the graphics processing device **202**. Further, at step **522**, the application interface **508** permits graphics processor to process the graphics instruction.

Furthermore at step **524**, a graphics processor **510** coupled to the notebook computer **204** processes the graphics instruction on behalf of the notebook computer **204**. Furthermore, on completion of processing, at step **526**, the graphics processor **510** indicates that the graphics processor **510** has processed the graphics instruction. At step **528**, on receiving the indication from the graphics processor **510**, the application interface **508** associates the indication that the graphics instruction has been processed with the stored identifier. Furthermore, at step **530**, the application interface **508**, permits a result of the processed graphics instruction to be transferred to the graphics application based on the association of the indication. The process ends at step **532**.

FIG. **6** is a flow diagram showing an example method for providing graphics processing, in accordance with an example embodiment.

In one or more embodiments, operation **602** may involve indicating to a computer system, that a graphics processing device is active. In an example embodiment, the graphics processing device may be portable by a user and the indication may be made using a USB protocol. For example, referring to FIG. **2**, the graphics processing device **202** may indicate to the notebook computer **204** that the graphics processing device **202** is active and ready to process graphics instructions (e.g., on behalf of the notebook computer **204**). In an example embodiment, the graphics processing device **202** of FIG. **2** may provide the indication to the notebook computer **204** of FIG. **2** over the USB cable **220** of FIG. **2**. In one or more embodiments, operation **604** may involve acquiring, a graphics instruction from the computer system, based at least in part on the indicating that the graphics processing device is active.

The acquisition may be made using the USB protocol. In one or more embodiments, the graphics instruction may be acquired utilizing a USB 3.0 protocol. For example, referring to FIG. **3**, when the graphics instruction **222** needs to be processed, the graphics instruction **222** may be transferred from the notebook computer **204** to the graphics processor module **306** of the graphics processing device **202** through the USB interface **308** using the USB cable **220**. The graphics processor module **306** may acquire the graphics instruction **222** and may decode and process graphics instruction **222**.

In one or more embodiments, operation **606** may involve processing the acquired graphics instruction using a graphics processor within the graphics processing device. In one or more embodiments, operation **608** may involve using energy supplied by a rechargeable battery to process the acquired graphics instruction, the rechargeable battery forming a portion of the graphics processing device. For example, referring to FIG. **3**, if the notebook computer **204** fails to power the graphics processing device **202** due to a sudden power failure during processing of the graphics instruction **222** in the graphics processing device **202**, then the graphics processing device **202** may utilize energy from the battery **110** and continue to process the graphics instruction **222**.

The battery **110** may be rechargeable battery. In one or more embodiments, the energy may be stored in the rechargeable battery prior to the supplying of the energy. Examples of the rechargeable battery may include, but is not limited to, a lead acid battery, a nickel cadmium (NiCd) battery, nickel metal hydride (NiMH) battery, a lithium ion (Li-ion) battery, and lithium ion polymer (Li-ion polymer) rechargeable battery, and the like. In one or more embodiments, operation **610** may involve transferring to the computer system, a result of the processing of the acquired graphics instruction.

In one or more embodiments, the result of the processing of the acquired graphics instruction may be transferred to the

computer system (e.g. the notebook computer **202**) using a USB protocol including, for example a USB 3.0 protocol. For example, referring to FIG. **3**, once the graphics processor module **306** completes processing the graphics instruction **222**, the graphics processor module **306** may indicate the completion of processing to the application interface **313** of the graphics processing device **202**. The application interface **313** may associate an indication on an identifier associated with the graphics instruction **222**, indicating that the graphics instruction **222** has been processed. On indicating, a result of processing the graphics instruction **224** may be transferred from the graphics processor module **306** to the USB interface **306**. The application interface **313** may then permit the result of the graphics processing **224** to be transferred to the notebook computer **204** from the USB interface **306** over the USB cable **220**.

Although the present embodiments have been described with reference to specific example embodiments, it will be evident that various modifications and changes may be made to these embodiments without departing from the broader spirit and scope of the various embodiments. For example, the various devices and modules described herein may be enabled and operated using hardware circuitry, firmware, software or any combination of hardware, firmware, and software (e.g., embodied in a machine readable medium). For example, the various electrical structure and methods may be embodied using transistors, logic gates, and electrical circuits (e.g., application specific integrated (ASIC) circuitry and/or in Digital Signal Processor (DSP) circuitry).

In addition, it will be appreciated that the various operations, processes, and methods disclosed herein may be embodied in a machine-readable medium and/or a machine accessible medium compatible with a computer system and may be performed in any order (e.g., including using means for achieving the various operations). Accordingly, the specification and drawings are to be regarded in an illustrative rather than a restrictive sense.

What is claimed is:

1. A portable graphics card of a data processing device, comprising:

a graphics processor;

an application interface;

a battery; and

a Universal Serial Bus (USB) interface communicatively coupled with the graphics processor,

the USB interface being configured to transfer a graphics instruction from the data processing device to the application interface, the data processing device being external to the portable graphics card,

the graphics processor and the application interface together being configured to:

in response to receiving the graphics instruction at the application interface, store in memory, by the application interface, an identifier associated with the graphics instruction,

process, by the graphics processor, the graphics instruction on behalf of the data processing device to perform a process intensive task through the portable graphics card,

provide, by the graphics processor to the application interface, an indication of completion of processing the graphics instruction,

associate, by the application interface, the indication of completion of processing the graphics instruction with the identifier stored in the memory, and

in response to associating the indication of completion with the identifier stored in the memory, transfer a result of processing the graphics instruction to the data processing device using the USB interface, and

the battery being configured to at least partially power the graphics processor to process the graphics instruction,

wherein the portable graphics card is implemented with a modular architecture to allow for at least one of upgrading and replacement of individual functional modules thereof without a need to entirely replace the portable graphics card, the replacement of the individual functional modules being facilitated through a capability to mix and match components of the individual functional modules, and the modular architecture being configured to utilize standard interfaces between the individual functional modules.

2. The graphics card of claim **1**, wherein the USB interface utilizes a USB 3.0 protocol.

3. The graphics card of claim **1**, wherein the graphics instruction is associated with a graphics application executing on the data processing device.

4. The graphics card of claim **1**, wherein the battery is rechargeable.

5. The graphics card of claim **1**, wherein the battery is a lithium ion battery.

6. The graphics card of claim **1**, wherein the battery is user-attachable with the graphics card and user-detachable from the graphics card such that the battery is field replaceable.

7. A data processing system comprising:

a data processing device;

a portable external graphics card including a graphics processor, an application interface, and a battery configured to provide power to the graphics processor, the portable external graphics card being external to the data processing device, and the portable external graphics card being implemented with a modular architecture to allow for at least one of upgrading and replacement of individual functional modules thereof without a need to entirely replace the portable external graphics card, the replacement of the individual functional modules being facilitated through a capability to mix and match components of the individual functional modules, and the modular architecture being configured to utilize standard interfaces between the individual functional modules; and

a USB module communicatively coupled with the graphics processor and configured to be communicatively coupled with the data processing device, the USB module being configured to transfer an instruction originating from the data processing device to the application interface, and

the graphics processor and the application interface together being configured to:

in response to receiving the instruction at the application interface, store in memory, by the application interface, an identifier associated with the instruction,

process, by the graphics processor, the instruction on behalf of the data processing device to perform a process intensive task through the portable graphics card,

provide, by the graphics processor to the application interface, an indication of completion of processing the instruction,

associate, by the application interface, the indication of completion of processing the instruction with the identifier stored in the memory, and

in response to associating the indication of completion with the identifier stored in the memory, transfer a

result of the processed instruction to the data processing device using the USB module.

8. The data processing system of claim **7**, wherein the portable external graphics card is configured to provide auxiliary graphics processing for the data processing device.

9. The data processing system of claim **7**, wherein the instruction includes a graphics instruction associated with a graphics application executing on the data processing device.

10. The data processing system of claim **7**, wherein the battery is configured to at least partially power the processor to process the instruction.

11. The data processing system of claim **7**, wherein the battery is user-detachable from the portable external graphics card and user-attachable with the portable external graphics card.

12. The data processing system of claim **7**, wherein the battery is rechargeable.

13. The data processing system of claim **7**, wherein the battery is a lithium ion rechargeable battery.

14. The data processing system of claim **7**, wherein the USB module utilizes a USB 3.0 protocol.

15. A graphics processing system comprising:

a data processing device comprising:

one or more system processors,

a memory coupled with the one or more system processors,

a video display device configured to display graphical data generated by the one or more system processors,

a first USB interface coupled with the one or more system processors, and

an audio device configured to generate audio data generated by the one or more system processors; and

a portable graphics card external to the data processing device and communicatively coupled with the data processing device using a USB cable, the portable graphics card being implemented with a modular architecture to allow for at least one of upgrading and replacement of individual functional modules thereof without a need to entirely replace the portable graphics card, the replacement of the individual functional modules being facilitated through a capability to mix and match components of the individual functional modules, the modular architecture being configured to utilize standard interfaces between the individual functional modules, and the portable graphics card including:

one or more graphics processors,

an application interface,

a rechargeable battery that is removably coupled with the one or more graphics processors and is configured to be field replaceable, the rechargeable battery being further configured to at least partially power the one or more graphics processors when the one or more graphics processors processes a graphics instruction, and

a second USB interface communicatively coupled with the one or more graphics processors and configured to communicatively couple the first USB interface with the second USB interface using the USB cable,

the second USB interface being configured to receive a graphics instruction that is encoded by a USB 3.0 communication protocol from the data processing device via the USB cable and to provide the graphics instruction to the application interface, and

the one or more graphics processors and the application interface together being configured to:

in response to receiving the graphics instruction at the application interface, store in a second memory, by the application interface, an identifier associated with the graphics instruction,

process, by the one or more graphics processors, the graphics instruction on behalf of the data processing device to perform a process intensive task through the portable graphics card,

provide, by the one or more graphics processors to the application interface, an indication of completion of processing the graphics instruction,

associate, by the application interface, the indication of completion of processing the graphics instruction with the identifier stored in the second memory, and

in response to associating the indication of completion with the identifier stored in the second memory, transfer a result of the processed graphics instruction to the data processing device using the second USB interface.

16. The graphics processing system of claim **15**, wherein the one or more graphics processors include at least one multi-core processor.

17. A method comprising:

implementing a portable graphics card with a modular architecture to allow for at least one of upgrading and replacement of individual functional modules thereof without a need to entirely replace the portable graphics card;

facilitating the replacement of the individual functional modules of the portable graphics card through a capability to mix and match components of the individual functional modules;

utilizing standard interfaces for communication between the individual functional modules of the portable graphics card;

indicating to a data processing device, utilizing a Universal Serial Bus (USB) protocol, that the portable graphics card is active, the portable graphics card being portable by a user and external to the data processing device;

acquiring, utilizing the USB protocol, a graphics instruction from the data processing device, based at least in part on the indication that the portable graphics card is active, wherein an identifier associated with the acquired graphics instruction is stored in memory in response to acquiring the graphics instruction;

processing the acquired graphics instruction using a graphics processor within the portable graphics card to perform a process intensive task through the portable graphics card on behalf of the data processing device, wherein, upon completion of processing the acquired graphics instruction, an indication of completion of processing the acquired graphics instruction is associated with the identifier stored in the memory;

providing a rechargeable battery within the portable graphics card;

using energy supplied by the rechargeable battery to process the acquired graphics instruction; and

in response to associating the indication of completion with the identifier stored in the memory, transferring to the data processing device, utilizing the USB protocol, a result of the processing of the acquired graphics instruction.

18. The method of claim **17**, wherein the acquiring of the graphics instruction utilizing the USB protocol includes acquiring the graphics instruction utilizing a USB 3.0 proto-

col, and the transferring of the result of the processing of the acquired graphics instruction includes utilizing the USB 3.0 protocol.

19. The method of claim **17**, comprising:

storing the energy in the rechargeable battery prior to the supplying of the energy.

20. The method of claim **17**, wherein the battery is a lithium ion rechargeable battery.

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