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Ginosar

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(54) **COMPUTING DEVICE CAPABLE OF INSTANT-ON AND NON-INSTANT ON MODES OF OPERATION**

(75) Inventor: **Ran Ginosar**, Beaverton, OR (US)

(73) Assignee: **Intel Corporation**, Santa Clara, CA (US)

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Related U.S. Application Data

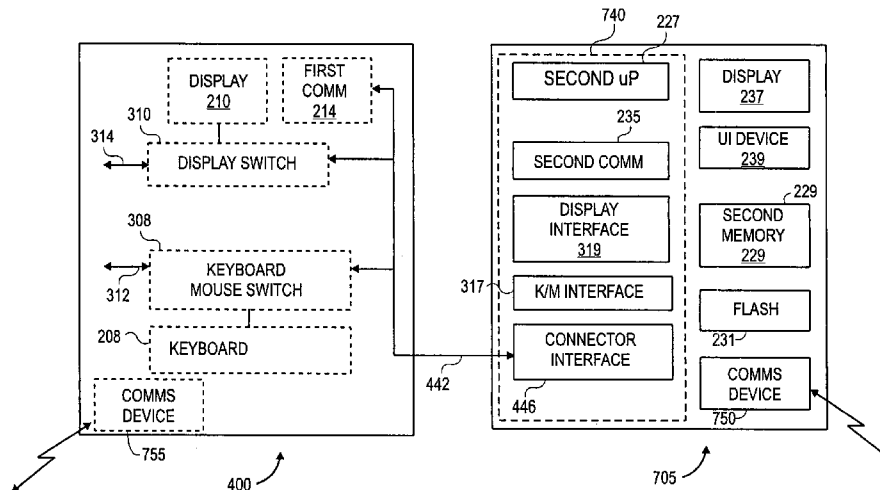(63) Continuation of application No. 09/404,486, filed on Sep. 23, 1999, now Pat. No. 6,931,474.

(51) **Int. Cl.**
G06F 13/00 (2006.01)

(52) **U.S. Cl.** **710/316**; 710/306; 710/36; 710/41; 710/16; 710/302

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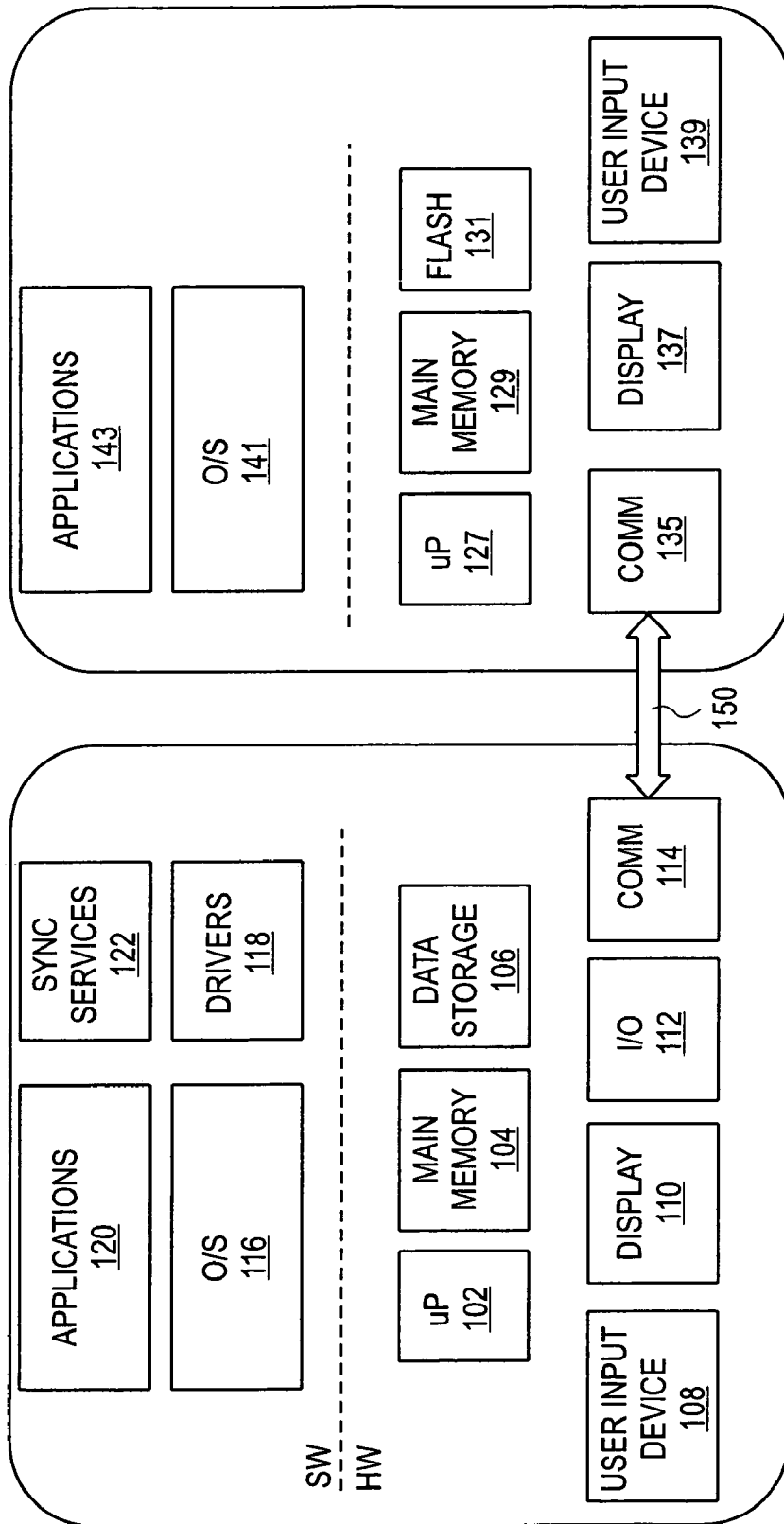See application file for complete search history.

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Primary Examiner—John R. Cottingham
Assistant Examiner—Raymond N Phan
(74) *Attorney, Agent, or Firm*—James S. Finn

(57) **ABSTRACT**

A single, dual form computing device is provided that incorporates the functionality of a laptop computer with that of a handheld or palm-size computing device, and allows each functionality to be selectively employed. The dual form computing device operates in one of two modes. While operating in a first "instant on" mode, the dual form computing device provides functionality similar to that of a handheld device, whereby a lengthy bootstrap process and operating system load is not required. While operating in a second "non-instant on" mode, the dual form computing device operates substantially like a laptop computer. Additionally, the dual form computing device is equipped to share input and output devices independent of the operation mode it functions in.

17 Claims, 8 Drawing Sheets
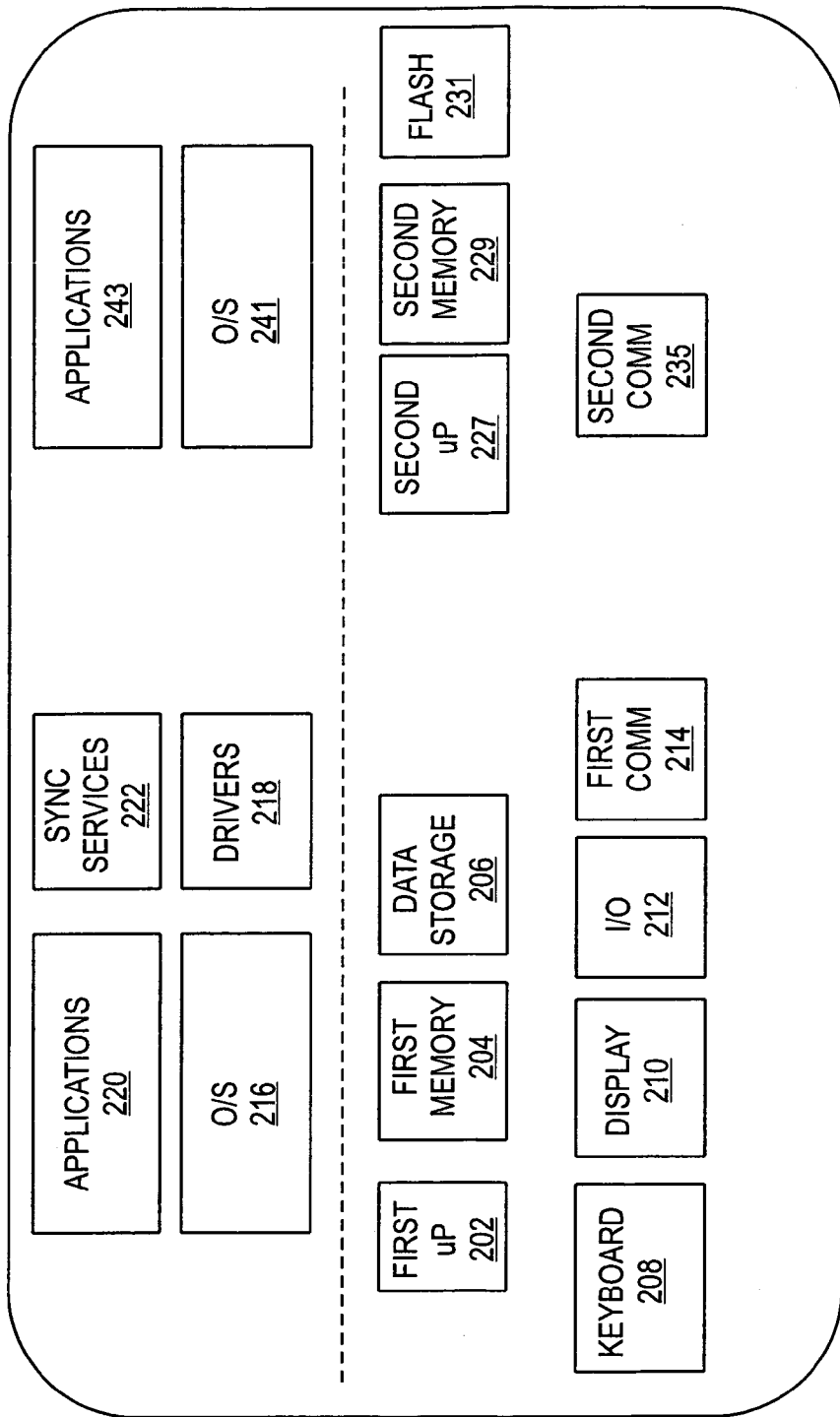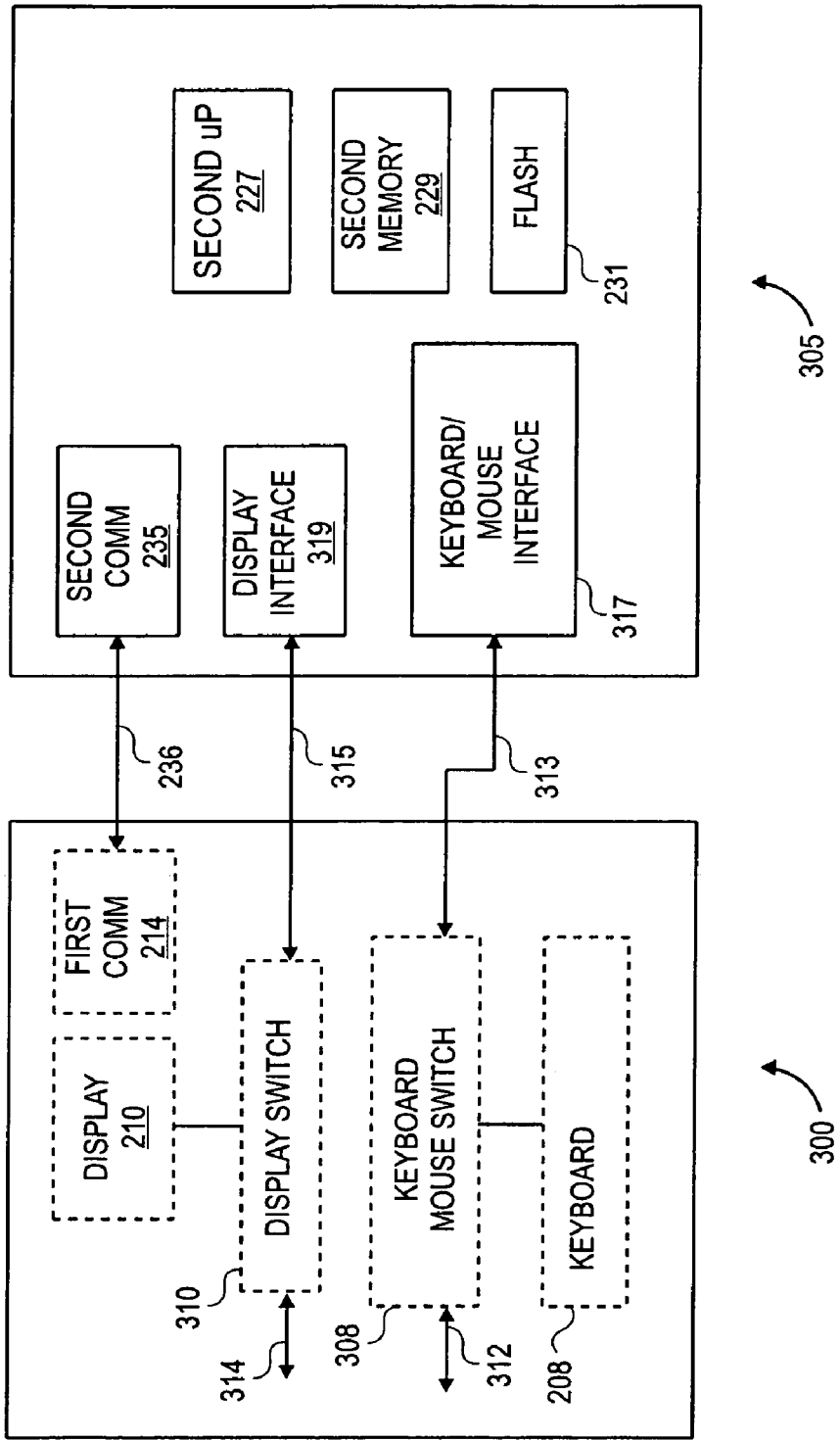
FIG. 1
(PRIOR ART)

APPLICATIONS 243

O/S 241

FLASH 231

SECOND MEMORY 229

SECOND uP 227

SECOND COMM 235

APPLICATIONS 220

SYNC SERVICES 222

O/S 216

DRIVERS 218

DATA STORAGE 206

FIRST MEMORY 204

FIRST uP 202

I/O 212

DISPLAY 210

FIRST COMM 214

KEYBOARD 208

200

FIG. 2

FIG. 3

FIG. 4

SECOND MEMORY 229

SECOND uP 527

DISPLAY 210

DISPLAY SWITCH 510

540

500

FIRST uP 502

KEYBOARD / MOUSE SWITCH 508

KEYBOARD 208

FIRST MEMORY 204
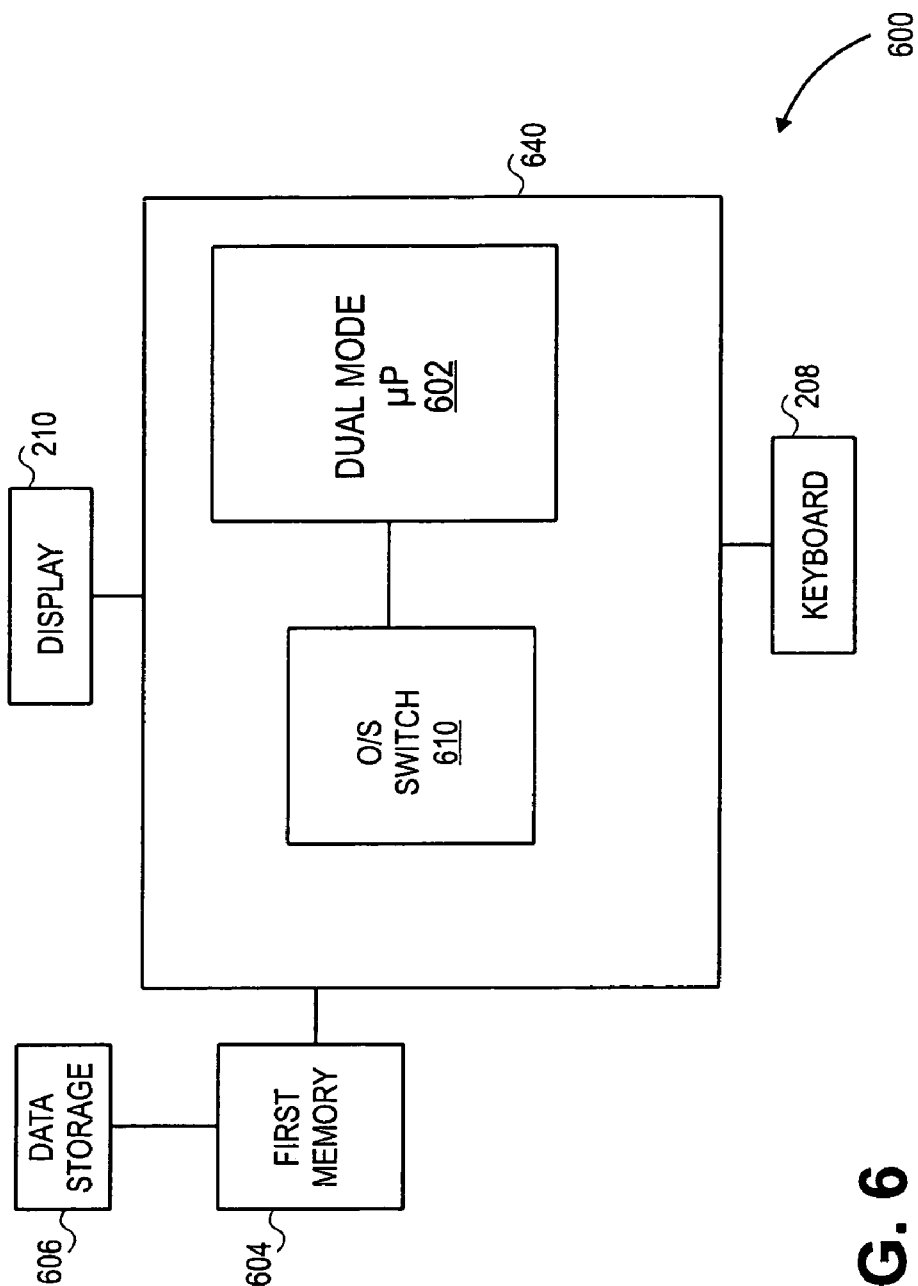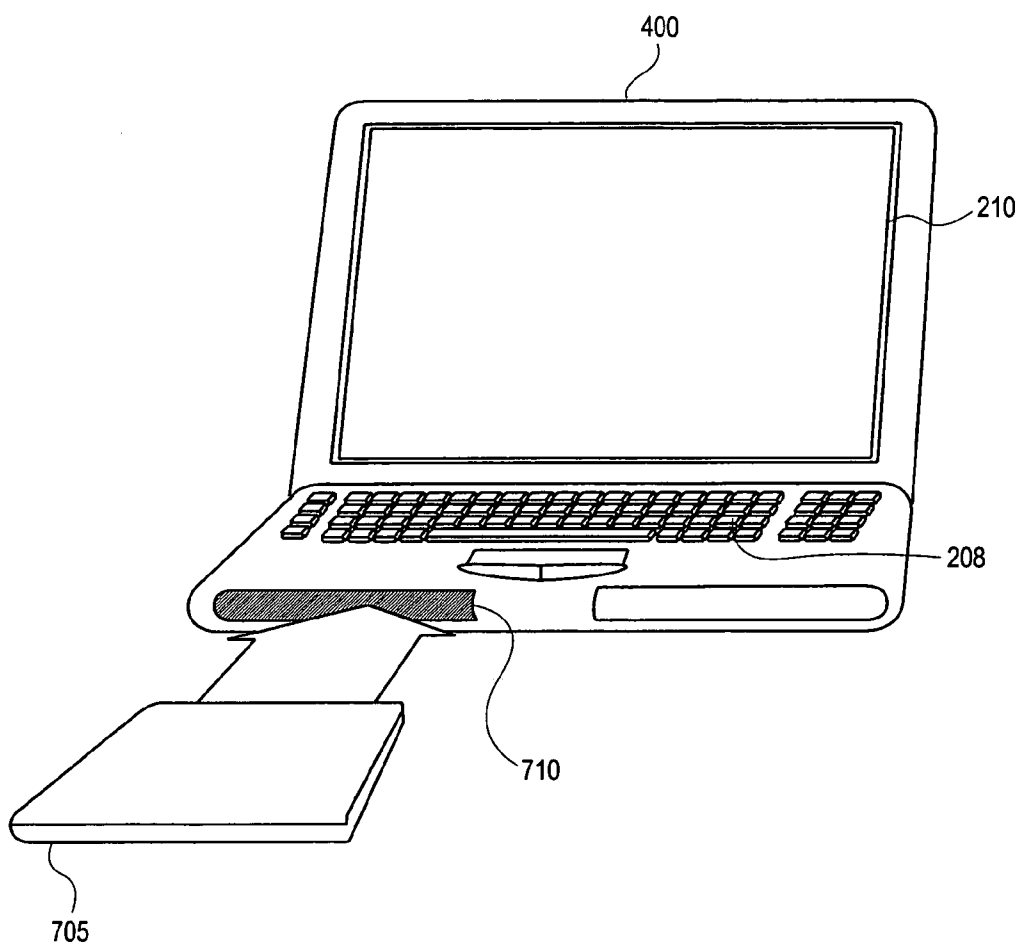
FIG. 5

FIG. 6

400

210

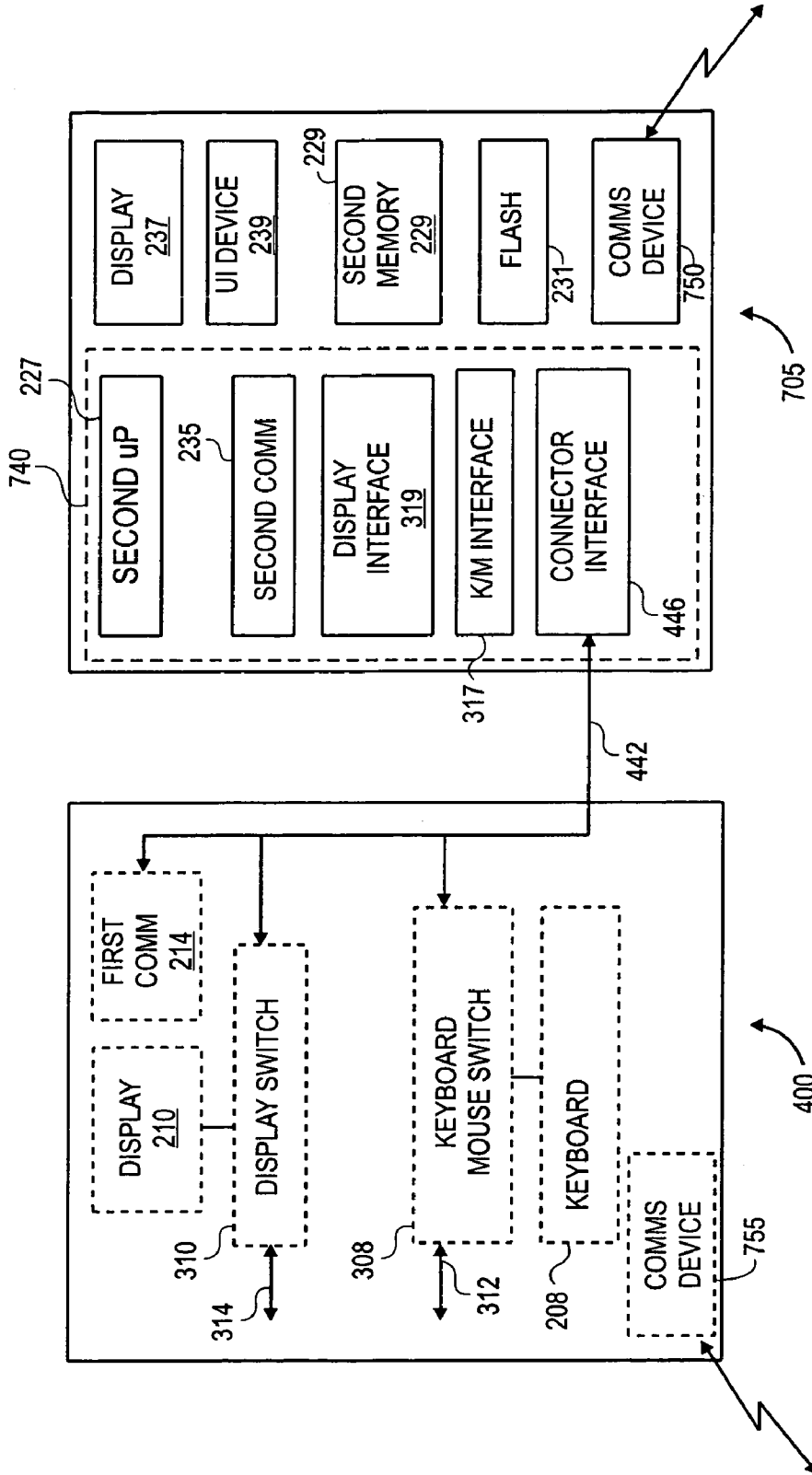208

710

705
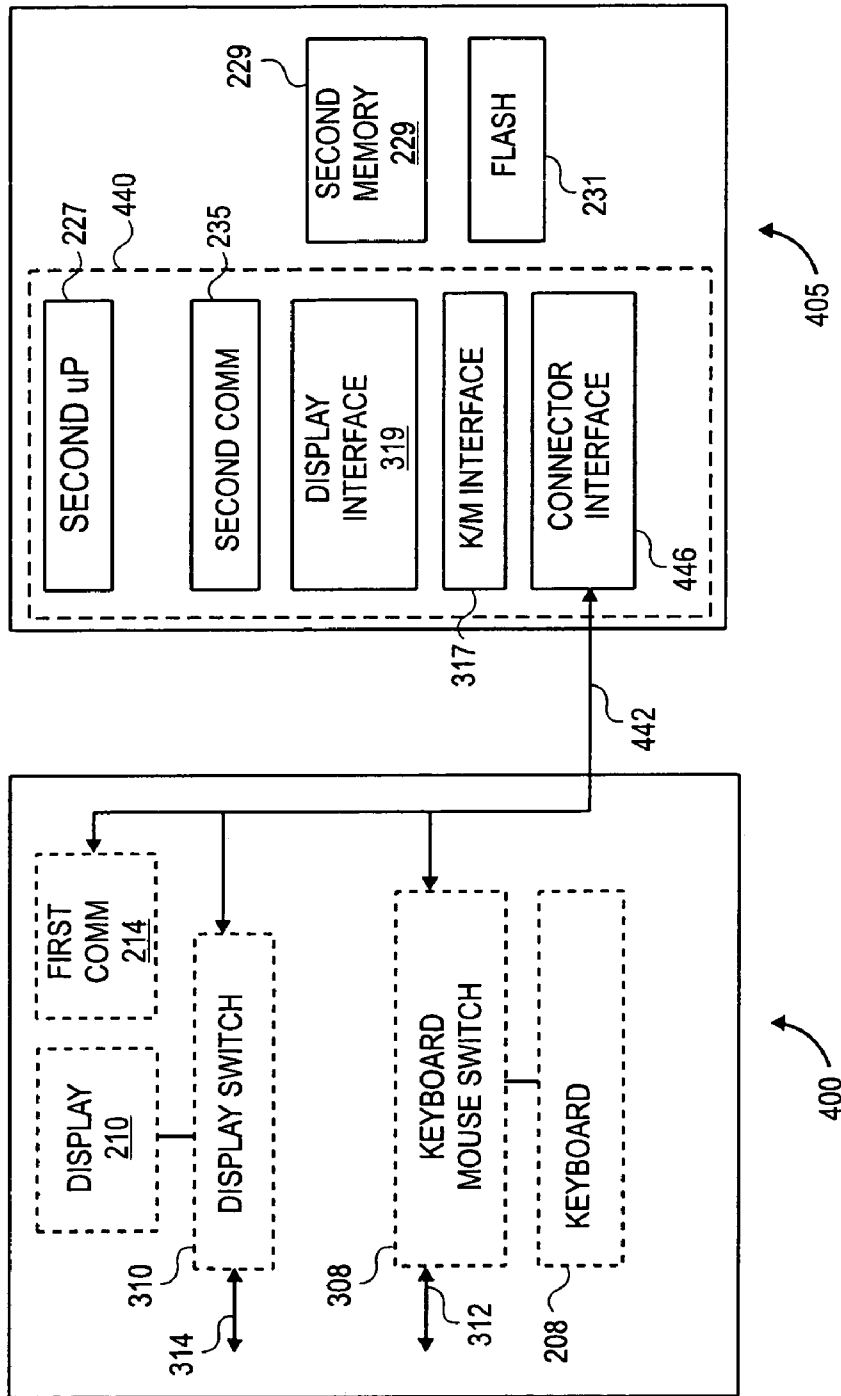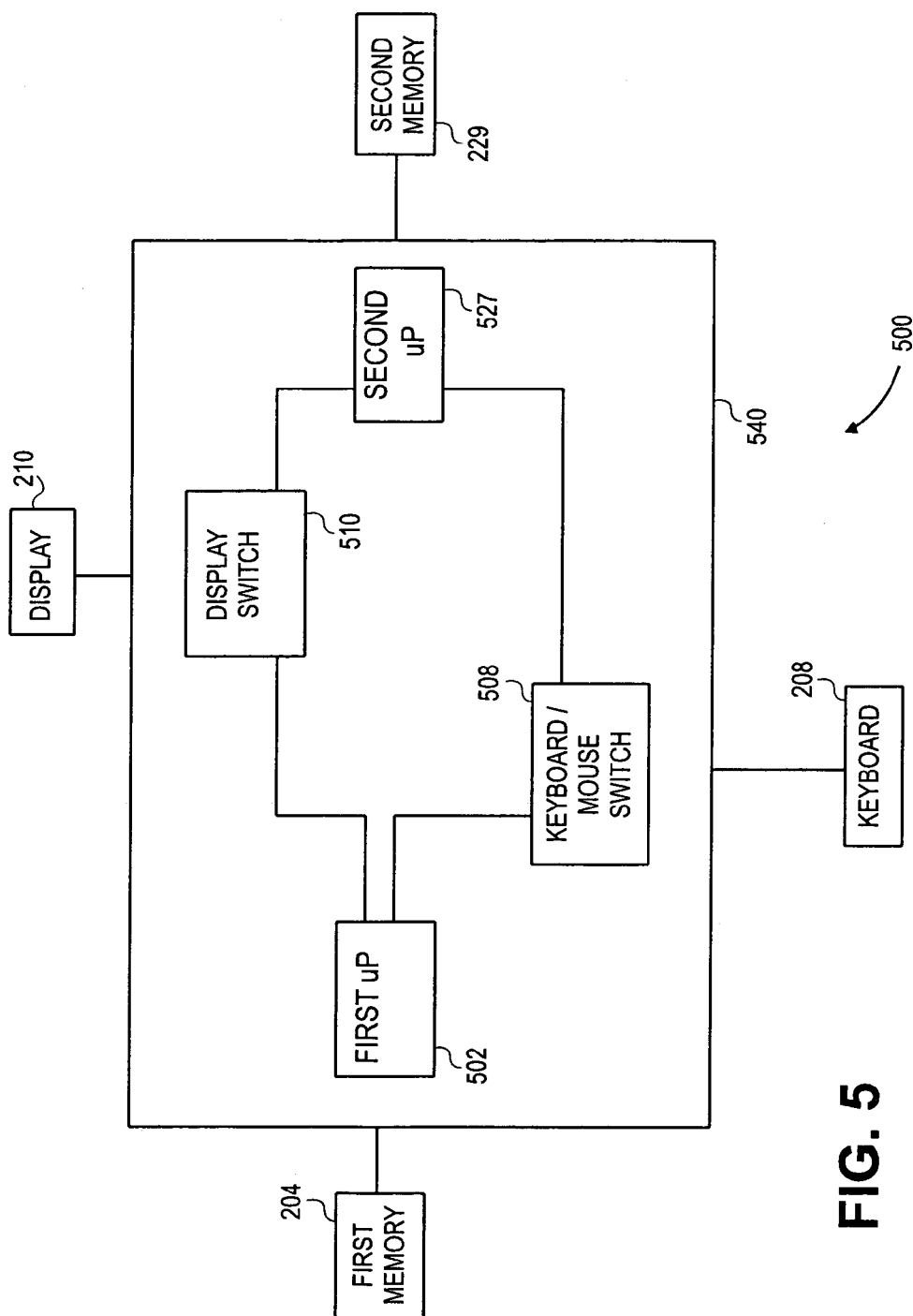
FIG. 7

FIG. 8

1

COMPUTING DEVICE CAPABLE OF INSTANT-ON AND NON-INSTANT ON MODES OF OPERATION

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation of U.S. patent application Ser. No. 09/404,486, entitled, "DUAL-FUNCTION COMPUTING SYSTEM", filed Sep. 23, 1999, now U.S. Pat. No. 6,931,474 which is a Continuation-In-Part of a U.S. patent application entitled "A Dual-Form Low Power/instant On Computing Device," filed Sep. 21, 1999.

BACKGROUND

1. Field of the Invention

The present invention relates to the field of computing in general and, in particular, to a dual form low power/instant on and high performance/non-instant on computing device.

2. Background Information

Desktop computing devices have typically provided the most processing power and largest data storage capabilities available on the market for the least amount of money. At least, that is true when compared to other computing devices such as laptop or notebook computers. It has only been recently, with the proliferation of low cost computing components such as processors, memory, and magnetic storage devices, however, that laptop computers have been able to approach the price versus performance barrier that desktop computers have traditionally defined. The slightly higher price that an equivalently equipped laptop computer demands over its desktop counterpart is considered by some to be an acceptable tradeoff when such factors as portability are factored in.

Unfortunately, price is sometimes less of a concern than expected battery life when it comes to potential laptop purchasers. Today, the average battery life expectancy for a laptop computer tends to be only 2 to 4 hours, thereby limiting the time and distance one may travel without recharging the battery. Additionally, the battery life expectancy of a laptop tends to be inversely proportional to the number of peripheral devices, such as CD/DVD-ROM drives, MODEMS, and various PC cards connected to the laptop. As the number of peripheral devices connected to the laptop increases, the resulting battery life of the laptop can be expected to decrease.

Most recently, a new genre of low power portable computing devices have entered the market. These portable devices, sometimes referred to as handhelds, or palm-size computers, are typically smaller and more lightweight than laptop computers, have a battery life expectancy that far surpasses that of laptops, and provide "instant on" access to programs and data, rather than requiring an extended operating system load time upon startup as do laptops. Typically, when these handheld devices are powered-on, a microprocessor contained within the device immediately begins to execute operating system instructions and applications stored within a read only memory (ROM) and/or random access memory (RAM) device. Since these instructions do not need to be loaded from a relatively slow data storage device, such as a hard disk drive, prior to execution by the microprocessor, startup time is decreased and battery life increased. Unfortunately, however, as convenient as these handheld devices may seem, they do have some drawbacks. Whereas desktop and laptop computers provide an abundance of data storage space, handheld devices remain lim-

2

ited in the amount of data that may be stored within the device. External data transfer cables may be used to transfer data between a handheld computing device and an external data storage device, however, such transfer mechanisms tend to be awkward and time consuming.

Similarly, handheld devices typically require specially compiled versions of applications software and operating systems that may only provide limited functionality as compared to a version generally available for laptops, e.g. Microsoft WINDOWS CE vs. WINDOWS 98.

Additionally, because of their reduced size, handheld devices typically contain smaller video displays as compared to laptops, and such displays may or may not provide color display capability. Furthermore, not all handheld devices contain keyboards, and those that do, often implement reduced size micro-keyboards or keypads, rather than the larger size keyboards available on most laptops.

Some users have the need for both a low power handheld computing device as well as a high performance laptop computer depending upon their particular circumstances. For example, when traveling in an airplane, a person may prefer to use a handheld computing device due to the long battery life. Likewise, a person may prefer to use a handheld computing device during a business meeting, where the use of a laptop computer may not be convenient. On the other hand, a high performance laptop computer may be preferable in situations where a user may have a large amount of data to input and has access to a power outlet. For example, a business person may use a laptop as their office computer, but may also choose to use a handheld computing device for use during travel and/or meetings. Such a user is therefore burdened with both the cost and inconvenience of two devices.

Therefore, what is needed is a single portable computing device that incorporates the advantages of both laptops and handheld devices, while overcoming the limitations of each found within the prior art.

SUMMARY OF THE INVENTION

An apparatus is provided with a first plurality of electronic components defining an instant on computing device for use in a first instant on mode of operation. The apparatus is further provided with a second plurality of electronic components, including a plurality of input and output devices defining a non-instant on computing device for use in a second non-instant on mode of operation. The apparatus is further provided with one or more switching mechanisms coupled to the input and output devices and to selected ones of the first and second plurality of electronic components to enable the input and output devices to be available for use in the first instant on, as well as the second non-instant on modes of operation.

In one embodiment, the first plurality of components define a hand-held computing device, such as a palm-top computer, while the second plurality of components define a laptop computer, which has a receptacle that receives the hand-held device. When the hand-held device is inserted into the receptacle, the one or more switching mechanisms make the input and output devices of the laptop computer available to the hand-held device for use in the instant on mode. When the hand-held device is not in the receptacle, however, it operates normally, using its own display and user input device.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is illustrated by way of example, and not by way of limitation in the FIGS. of the accompanying drawings in which like reference numerals refer to similar elements.

FIG. **1** is an architectural block diagram illustrating a conventional handheld computing device connected to a conventional laptop computer.

FIG. **2** is a block diagram illustrating a dual form computing device architecture according to one embodiment of the present invention.

FIG. **3** is a block diagram illustrating an add-on card implementation of a dual form computing device according to one embodiment of the present invention.

FIG. **4** is a block diagram illustrating a system-on-a-chip implementation of a dual form computing device according to one embodiment of the present invention.

FIG. **5** is a block diagram illustrating an integrated circuit (IC) implementation of a dual form computing device according to one embodiment of the of the present invention.

FIG. **6** is a block diagram illustrating one embodiment of the dual form computing device of the present invention including a single, dual mode microprocessor.

FIG. **7** is a schematic, pictorial illustration showing insertion of a hand-held computer into a receptacle in a laptop computer, according to one embodiment of the present invention.

FIG. **8** is a block diagram illustrating implementation of the embodiment of FIG. **7**.

DETAILED DESCRIPTION

A dual form instant on and non-instant on computing device is disclosed. In the following description, for purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the invention. It will be apparent, however, to one skilled in the art that the invention can be practiced without these specific details. In other instances, structures and devices are shown in block diagram form in order to avoid obscuring the invention.

Reference in the specification to "one embodiment" or "an embodiment" means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the invention. The appearances of the phrase "in one embodiment" in various places in the specification are not necessarily all referring to the same embodiment.

FIG. **1** is a block diagram illustrating a conventional handheld computing device connected to a conventional laptop computer. Referring to FIG. **1**, laptop computer **100** represents a general purpose portable computing device including microprocessor **102**, main memory **104**, data storage device **106**, user input device **108**, display device **110**, input/output port **112**, and communication device **114**. Microprocessor **102** represents various processors known in the art to process data signals. Main memory **104** represents a volatile data storage device, such as dynamic random access memory (DRAM), that stores instructions and/or data to be processed by microprocessor **102**. Data storage device **106** represents a non-volatile data storage device, such as a disk drive, CD-ROM, equipped to store large amounts of data for an extended period of time.

User input device **108** represents a "full function" or "full size" input device, such as a "full size" keyboard, mouse, or trackball that is equipped to convert user input into elec-

tronic data signals to be processed by microprocessor **102**. Display device **110** represents a "full size" video display device, such as a 15" thin film transistor (TFT), active matrix or the like, for displaying information to a user. Communication device **114** represents an input/output communications device equipped to transfer data to and from laptop computer **100**, such as a parallel interface, and I/O **112** represents additional input and output ports also equipped to transmit data to and from laptop computer **100**.

In a conventional laptop boot sequence, laptop computer **100** will typically perform a power-on self test (POST) when power is applied. The POST routine comprises code typically stored in a non-volatile memory such as ROM (not shown) that verifies the integrity and configuration of laptop computer **100**. Once the POST routine has completed successfully, laptop computer **100** begins to load operating system **116** from data storage device **106** into main memory **104** to be executed by microprocessor **102**. Operating system **116** comprises instructions that when processed by microprocessor **102**, manages the resources of laptop computer **100** enabling it to function in a conventional manner. As operating system **116** is loaded, various device drivers **118** may also be loaded. Device drivers **118** represent various instructions and data that when executed, facilitate access to the corresponding devices by operating system **116** and applications **120**. Once operating system **116** and device drivers **118** (if any) have been loaded and executed, applications **120** may also be loaded and executed.

Handheld computing device **125** is shown coupled to laptop computer **100** by external cable **150**. Handheld computing device **125** represents a handheld or palm-sized, limited function computing device, and includes microprocessor **127**, main memory **129**, flash memory **131**, communication device **135**, display device **137**, user input device **139**, operating system **141**, and applications **143**.

Microprocessor **127** represents various processors known in the art to process data signals. Main memory **129** and flash memory **131** each represent memory storage devices that store instructions and/or data that may be executed by microprocessor **127**. Main memory **129** may comprise volatile RAM and/or nonvolatile ROM, whereas flash memory **131** may comprise a nonvolatile memory device that can be erased and reprogrammed.

Communication device **135** represents an input/output communications device equipped to transfer data to and from handheld computing device **125**, such as a parallel interface. User input device **139** represents an input device, such as a stylus or reduced size keyboard, that is equipped to convert user input into electronic data signals to be processed by microprocessor **127**. Display device **137** represents a small display device, such as a 4" liquid crystal display (LCD), for displaying data to a user.

In addition to various hardware components, handheld computing device **125** also contains various software components including operating system **141** and applications **143**. Operating system **141** comprises instructions that when processed by microprocessor **127**, manage the resources of computing device **125** to function in a conventional manner. Operating system **141** represents any one of the various operating systems available for use with handheld computing device **125**, including for example, WINDOWS CE' from Microsoft Corporation of Redmond, Wash. Operating system **141** provides system services for applications **143** to access the various hardware components described above.

Applications **143** may include various utility and data processing software programs that have been specially designed for handheld computing device **125**, or have been

recompiled to function with microprocessor **127**. Often, applications **143** represent pared-down versions of application software commonly available for full-sized computing devices. Such pared-down, "light" or "pocket" versions typically contain only a subset of the functions available in the larger, more ubiquitous versions of the software. Both applications **143** and operating system **141** may reside in flash memory **131** and/or main memory **129** to be executed in place by microprocessor **127**.

When operating conventionally, handheld computing device **125** functions in a low power, "instant on" manner, whereby when it is powered-on, microprocessor **127** executes instructions representing operating system **141** and applications **143** directly from main memory **129** and flash memory **131**. In such a manner, handheld computing device **125** is able to bypass a long bootstrap and operating system load by executing operating instructions in place rather than loading the instructions into RAM from a comparatively slow data storage device, such as data storage device **106**, prior to execution. In addition, handheld computing device **125** is able to bypass a long bootstrap and operating system load partially because operating system **141** contains only a small portion of the code typically contained within operating systems used by larger, more robust, and more complex computing devices, such as laptop computer **100**.

Additionally, when operating conventionally, handheld computing device **125** also functions in a low power mode, whereby microprocessor **127** operates at low frequency and supply voltage levels, executes a simple operating system that does not incur heavy overhead, and employs and powers only a limited set of peripheral I/O devices. In comparison, laptop computer **100** operates under greater power requirements, but may also achieve greater performance due to a higher operational frequency and voltage, in addition to executing a more complicated operating system.

Once handheld computing device **125** is powered-on and functioning under operating system **141**, a user may input and store data in main memory **129**, for example, using applications **143** and user input device **139**. Data stored within handheld computing device **125** may be accessed using applications **143**, or transferred to another device, such as laptop computer **100**, through external cable **150**. Similarly, data may be transferred from a device such as laptop computer **100**, to handheld computing device **125** via external cable **150**. External cable **150** represents a detachable general purpose transfer cable, such as a RS-232 based serial cable.

In addition to data transfer, laptop computer **100** and handheld computing device **125** may also be equipped to perform data synchronization using external cable **150**. Data synchronization is a process whereby one or more data files residing on one device are compared to, and if needed, updated to conform with, one or more data files residing on a second device. Sync services **122** represents various synchronization applications that enable such data synchronization between devices.

FIG. **2** is a block diagram illustrating a dual form computing device architecture according to one embodiment of the present invention. Referring to FIG. **2**, dual form computing device **200** represents a single computing device that incorporates the functionality of laptop computer **100** with that of handheld computing device **125**, and allows each functionality to be selectively employed. Dual form computing device **200** operates in one of two modes, a low power, "instant on" mode and a high performance, "non instant on" mode. In the first low power, "instant-on" operational mode, dual form computing device **200** provides

instant-on functionality similar to that of handheld computing device **125**, whereby a lengthy bootstrap process and operating system load is not required. Unlike handheld computing device **125**, however, while dual form computing device **200** is in the instant-on operational mode, a "full size" keyboard device and "full size" display screen, both similar to that of laptop computer **100** may be utilized. In the second high performance, "non-instant on" operational mode, dual form computing device **200** functions substantially similar to laptop computer **100**.

Referring again to FIG. **2**, dual form computing device **200** includes first microprocessor **202**, first memory **204**, data storage device **206**, keyboard **208**, display device **210**, I/O **212**, and first communication device **214**. First microprocessor **202** represents one or more a general purpose processors known in the art to process data signals. In one embodiment of the present invention, microprocessor **202** represents a processor belonging to the PENTIUM® family of processors available from Intel Corporation of Santa Clara, Calif.

First memory **204** represents a volatile data storage device that may store instructions and/or data to be executed by microprocessor **202**. Examples of such volatile data storage devices include for example, random access memory (RAM), dynamic random access memory (DRAM), synchronous dynamic random access memory (SDRAM), and the like, available from any one of a number of semiconductor manufacturers, such as Micron Inc., of Boise, Id.

Additionally, dual form computing device **200** may also contain a read-only memory device (not shown), such as a programmable read-only memory (PROM) or an electronically erasable programmable read-only memory (EEPROM) equipped to store instructions and/or data to be executed by microprocessor **202**. Data storage device **206** represents a non-volatile data storage device equipped to store large amounts of data that is accessible by microprocessor **202**. Data storage device **206** may include, for example, a hard disk drive, CD-ROM, DVD-ROM, DVD-RAM, DVD-R/W and the like.

Keyboard **208** represents a "full size" alphanumeric input device, while display device **210** represents any "full size" video display device known in the art to display digital data, such as for example, a 15" TFT or active matrix. In one embodiment, display device **210** comprises a touchscreen, whereby a user may input data into dual form computing device **200** by touching or "tapping" the touchscreen with a stylus or similar object. Dual form computing device **200** may also contain other input devices including a mouse, trackball, and touchpad. Additionally, dual form computing device **200** also includes first communication device **214** and second communication device **235**. Both first and second communication devices represent input/output communication devices equipped to transfer data within dual form computing device **200**. I/O **112**, however, represents input and output ports equipped to transmit data to and from devices external to dual form computing device **200**.

First operating system **216** may represent any one of the various operating systems known in the art to function with first microprocessor **202**. In one embodiment, first operating system **216** is the WINDOWS®-98 operating system available from Microsoft Corporation. In one embodiment, applications **220** represent one or more WINDOWS®98-based application programs equipped to function under first operating system **216**. Sync services **222** represents a set of services equipped to provide interoperability between first operating system **216** and second operating system **241**. In one embodiment, Sync services **222** represents the CE

services available from Microsoft to sync between a WIN-DOWS-98 device and a WINDOWS CE device.

Dual form computing device **200** also includes second microprocessor **227**, second memory **229**, and flash memory **231**. Second microprocessor **227** represents a processor known in the art to process data signals. In one embodiment, second microprocessor **227** is a MIPS processor, available from MIPS, Inc., of Milpitas, Calif.

Second memory **229** and flash memory **231** each represents memory storage devices that store instructions and/or data that may be executed by second microprocessor **227**. Second memory **229** may comprise nonvolatile read-only memory (ROM) and/or volatile random access memory (RAM) that may be coupled to a power supply, such as a battery or capacitor (neither shown), to retain stored data after power is removed from dual form computing device **200**. Flash memory **231** may comprise a nonvolatile memory device that can be erased and reprogrammed.

Second operating system **241** represents any one of the various operating systems available for use with dual form computing device **200** having second microprocessor **227**. In one embodiment, second operating system **241** comprises the WINDOWS CEO operating system available from Microsoft Corporation. In another embodiments, second operating system **241** may comprise various other operating systems including PALMOS'Im from 3COM Corporation, and EPOC' from Psion Software Inc.

In one embodiment of the present invention, dual form computing device **200** determines the proper operational mode within which to function, based upon hardware settings detected at startup. In one embodiment, dual form computing device **200** determines the proper operational mode based upon settings indicated by one or more switching mechanisms (discussed more fully below). In another embodiment, dual form computing device **200** may determine the operational mode within which to function based upon various software settings.

The startup process that dual form computing device **200** follows depends upon which of its operational modes is selected. In one embodiment, if an instant-on operational mode is selected, dual form computing device **200** follows a startup process similar to that described above with respect to handheld computing device **125**. That is, when dual form computing device **200** is powered-on, second microprocessor **227** immediately processes instructions representing operating system **241** stored within second memory **229** and flash memory **231**. A user may immediately input and store data in second memory **229** using WINDOWS CE based applications **243** and full-size keyboard **208**. In addition, WINDOWS CE applications **243** and various other data may be viewed on "full size" video display device **210**. Such advantages are not available in the two device approach of the prior art.

If, on the other hand, dual form computing device **200** detects that a non-instant on operational mode is selected, dual form computing device **200** follows a startup process similar to that described above with respect to laptop computer **100**. That is, after a successful POST, dual form computing device **200** loads operating system **216** from data storage device **206** into first memory **204** to be executed by first microprocessor **202**. As operating system **216** is loaded, device drivers **218** may also be loaded. Once operating system **216** and device drivers **218** (if any) have been loaded and executed, various WINDOWS® based applications **220** may also load and execute. Thus, dual form computing device **200** preserves the advantages of laptop computers while it offers the advantages of handheld computing.

In one embodiment, in addition to first microprocessor **202** functioning while dual form computing device **200** is in the non-instant on operational mode, second microprocessor **227** also functions. With both microprocessors functioning, dual form computing device **200** may automatically synchronize data stored within data storage device **206** and second memory **229**. In such a manner, data previously stored while dual form computing device **200** was functioning in instant on operational mode becomes accessible when dual form computing device **200** functions in the non-instant on operational mode. In one embodiment, data synchronization occurs through an internal serial communications link between first communication device **214** and second communication device **235**. In another embodiment, data synchronization may occur through a dedicated data transfer bus within dual form computing device **200**.

In one embodiment of the present invention, dual form computing device **200** may be implemented through a conventional laptop that has been slightly modified to accept a WINDOWS CE-based add-on card of the present invention. FIG. **3** is a block diagram illustrating an add-on card implementation of a dual form computing device according to one embodiment of the present invention. Referring to FIG. **3**, laptop computer **300** is shown comprising previously described "full size" display device **210**, "full size" keyboard **208**, and first communications device **214**. Likewise, add-on card **305** is shown comprising previously described second communication device **235**, second microprocessor **227**, second memory **229**, and flash memory **231**. In one embodiment, first communication device **214** and second communication device **235** are connected by data transfer line **236**.

In addition to the previously described components, add-on card **305** also includes display interface **319** and keyboard/mouse interface **317**. Similarly, laptop computer **300** additionally includes keyboard/mouse switch **308** and display switch **310**. Keyboard/mouse switch **308** comprises a mechanism whereby signal data from keyboard **208** may be selectively routed to components within laptop computer **300** via signal line **312**, or to components of add-on card **305** via signal line **313** and keyboard/mouse interface **317**. Likewise, data signals may be routed from components of laptop computer **300** and components of add-on card **305** to keyboard **208** by way of signal lines **312** and **313** respectively, and keyboard & mouse switch **308**. In one embodiment, keyboard & mouse switch **308** comprises one of a number of mechanical or electronic switches known in the art such as, for example, a toggle switch, a debounced push-button switch, or a programmable multiplexor.

Display switch **310** also comprises a mechanism whereby video display signal data may be selectively routed from multiple devices. Depending upon the setting of display switch **310**, data may be routed to display device **210** from other electronic components of laptop computing device **300** or components of add-on card **305**. Data routed from components of laptop computing device **300** passes over signal line **314**, through display switch **310** and into display device **210**. Data routed from components of add-on card **305** passes through display interface **319**, over signal line **315**, though display switch **310** and into display device **210**. In one embodiment, display interface **319** and keyboard/mouse interface **317** are detachably coupled to laptop computer **300**. In a case where display device **210** is equipped with a touchscreen for example, data flow may be reversed, whereby data may be selectively routed from display device **210** to either components of laptop computer **300** or components of add-in card **305** through display switch **310**. In

one embodiment, display switch **310** comprises one of a number of mechanical or electronic switches known in the art such as, for example, a toggle switch, a debounced push-button switch, or a programmable multiplexor. In a further embodiment, at least one of display switch **310** and keyboard & mouse switch **308** may be implemented via software.

In another embodiment of the present invention, much of the functionality described above with respect to add-on card **305** is incorporated into a single integrated circuit. FIG. **4** is a block diagram illustrating a system-on-a-chip implementation of a dual form computing device according to one embodiment of the present invention. Referring to FIG. **4**, add-on card **405** is shown including previously described flash memory **231** and second memory **229**, as well as IC **440** of the present invention. IC **440** represents an integrated circuit manufactured according to methods known in the art. Integrated circuit **440** combines the functional aspects of second microprocessor **227**, second communication device **235**, display interface **319**, and keyboard/mouse interface **317** within a single chip. Additionally, IC **440** also comprises connector interface **446**. Connector interface **446** enables add-on card **405** to communicate with another device, such as laptop computer **400**, through a single data connection. Connector **442** represents any connector equipped to transmit data between add-on card **405** and laptop computer **400**. In one embodiment, connector **442** is a cable that may be releasably coupled to add-on card **405** through connector interface **446**. In another embodiment, connector **442** may represent one or more signal traces between add-on card **405** and laptop computer **400**.

In another embodiment, selected ones of functional components from both add-on card **305** and laptop computer **300** are incorporated into one integrated circuit. FIG. **5** is a block diagram illustrating an integrated circuit (IC) implementation of a dual form computing device according to one embodiment of the of the present invention. Referring to FIG. **5**, dual form computing device **500** includes IC **540**, first memory **204**, second memory **229**, display device **210** and keyboard **208**, all of which, except for IC **540**, were previously described above with respect to FIGS. 2–4.

IC **540** represents an integrated circuit manufactured according to methods known in the art, and includes first microprocessor **502**, second microprocessor **527**, display switch **510**, and keyboard/mouse switch **508**. First microprocessor **502** and second microprocessor **527** represent processors known in the art to process data. Display switch **510** represents a switch mechanism equipped to selectively route data from either first microprocessor **502** or second microprocessor **527** to external display device **210**, whereas keyboard/mouse switch **508** represents a switch mechanism equipped to selectively route data from either first microprocessor **502** or second microprocessor **527** to external keyboard **208**. It should be apparent to one skilled in the art that IC **540** and/or dual form computing device **500** may contain additional components without parting from the spirit and scope of the invention.

In yet another embodiment, rather than the dual form computing device of the present invention utilizing two separate microprocessors, a single, dual mode microprocessor solution may also be implemented. In such an embodiment, a microprocessor having at least two operating modes is utilized in place of two separate microprocessors. FIG. **6** is a block diagram illustrating one embodiment of the dual form computing device of the present invention including a single, dual mode microprocessor. Referring to FIG. **6**, dual form computing device **600** is shown including IC **640**, data

storage device **606**, and first memory device **604**, as well as display device **210** and keyboard **208** (both previously described). Data storage device **606** represents a non-volatile data storage device known in the art, whereas first memory device **604** represents a read only memory and/or random access memory device, however, power is provided to at least a subset of the memory banks of memory **604**, sufficient to hold a "reduced function" operating system.

IC **640** is an integrated circuit manufactured according to methods known in the art. IC **640** comprises dual mode microprocessor **602** and O/S switch **610**. Dual mode microprocessor **602** represents a general purpose microprocessor having a first high performance mode, whereby the microprocessor operates at high frequency and voltage levels, and having a second low power mode, whereby the microprocessor operates at frequency and voltage levels lower than that of the first high performance mode, thereby consuming less power. O/S switch **610** represents a switching mechanism through which dual mode microprocessor **602** selectively accesses instructions residing within memory device **604** depending upon the operational mode of dual mode microprocessor **602**. In one embodiment, O/S switch **610** represents logic equipped to select one or more ranges of memory addresses within first memory device **604**. More specifically, a range that is typically powered for instant on mode of operation and a range that is powered on demand for non-instant on mode of operation.

In one embodiment, when dual mode microprocessor **602** operates in a high performance mode, dual mode microprocessor **602** executes instructions representing a first full-featured, large overhead operating system residing in the not always powered portion of first memory device **604**. When dual mode microprocessor **602** operates in a low power mode, however, dual mode microprocessor **602** executes instructions representing a second, reduced function or streamlined operating system residing in the typically powered portion of memory device **604**. Even though this portion of memory device **604** is typically powered, power consumption may actually be reduced by the reduced size and complexity of the operating system executed by dual mode microprocessor **602**.

In one embodiment, instructions representing the first operating system are loaded from data storage device **606** into first memory device **604** to be executed by dual mode microprocessor **602**, whereas in another embodiment, instructions representing the second operating system reside in first memory device **604** and are executed in place by dual mode microprocessor **602**. In an alternative embodiment, instructions representing the first or second operating systems may reside in a second memory device powered in a like manner. In one embodiment, the first operating system comprises Microsoft WINDOWS-98, and the second operating system comprises Microsoft WINDOWS CE.

FIGS. **7** and **8** show an embodiment of the present invention in which a hand-held computing device **705**, such as a palm-top computer, is used together with laptop computer **400** to afford both instant on and high-performance, non-instant on operation. Laptop computer **400** has a receptacle **710** for receiving hand-held computing device **705**. As long as the hand-held device is not inserted into the receptacle, however, the laptop computer and the hand-held device operate substantially independently of one another, like the conventional computer **100** and handheld device **125** of FIG. **1**. In this separated configuration, the hand-held device operates autonomously, by means of its own display

237 and user interface device 239, running any suitable operating system, such as Windows CE, PalmOS or EPOC, for example.

When hand-held device 705 is inserted into receptacle 710, connector 442 in the receptacle mates with connector interface 446 of the hand-held device. In this configuration, laptop computer 400 operates in a manner substantially similar to that described hereinabove with reference to FIG. 4, wherein add-on card 405 enables computer 400 to operate in either the instant on or non-instant on, high-performance mode. In the instant on mode, display switch 310 and keyboard/mouse switch 308 enable low-power microprocessor 227 in hand-held device 705 to access display 210, keyboard 208 and other resources of laptop computer 400, while the main microprocessor of the laptop computer is substantially shut down. Display 237 and user interface device 239 are typically inactive in this mode. In the non-instant on mode, hand-held device 705 and its microprocessor 227 are largely dormant, while the laptop runs under the control of its own main microprocessor. While the laptop computer runs in this latter, high-performance mode, data stored in memory 229 of the hand-held device are updated as required to maintain synchronization with corresponding data stored in the laptop computer.

Optionally, when hand-held device 705 is operating autonomously, outside receptacle 710, it communicates with laptop computer 400 by means of suitable communication devices 750 and 755 in the hand-held device and laptop computer, respectively. Such communication enables data synchronization to be maintained between the hand-held device and the laptop computer. In one embodiment, devices 750 and 755 comprise wireless communication devices, such as infrared ports for short-range communications, or radio-frequency devices, which may be adapted either for short-range communications directly between the hand-held device and the laptop computer, or for long-range communications, via a cellular network, for example. In another embodiment, one or both of devices 750 and 755 comprise modems, which are coupled via wire to a communications network, such as a telephone or data network. Alternatively, any other suitable communications interface known in the art may be used.

Whereas many alterations and modifications of the present invention will no doubt become apparent to a person of ordinary skill in the art after having read the foregoing description, it is to be understood that any particular embodiment shown and described by way of illustration is no way intended to be considered limiting. Therefore, references to details of various embodiments are not intended to limit the scope of the claims which in themselves recite only those features regarded as essential to the invention.

What is claimed is:

1. An apparatus comprising:
a first plurality of electronic components defining an instant on computing device for use in a first instant on mode of operation wherein said first plurality of electronic components includes a first processor to execute instructions representing a first operating system;
a second plurality of electronic components, including a plurality of input and output devices defining a non-instant on computing device for use in a second non-instant on mode of operation, wherein said second plurality of electronic components includes a second processor to execute instructions representing a second operating system and wherein upon initiating execution

of said non-instant on mode of operation, said instant on device is inhibited from executing a startup sequence; and
one or more switching mechanisms coupled to said input and output devices and selectively, to selected ones of said first and second plurality of electronic components to enable said input/output devices to be available for use in said first instant on as well as said second non-instant on mode of operation.

2. The apparatus of claim 1, wherein said first plurality of electronic components includes a first memory device and said second plurality of electronic components includes a second memory device, and wherein said first and second processors operate simultaneously to synchronize data between said first and second memory devices.

3. The apparatus of claim 2, wherein said first plurality of electronic components are embodied in a hand-held computing device, and wherein said second plurality of electronic components are embodied in a portable computer, having a connector which receives the hand-held so as to enable said input/output devices to be available to said first processor for use in said first instant on mode.

4. An apparatus comprising:
a first plurality of electronic components defining an instant on computing device for use in a first instant on mode of operation;
a second plurality of electronic components, including a plurality of input and output devices defining a non-instant on computing device for use in a second non-instant on mode of operation and wherein upon initiating execution of said non-instant on mode of operation, said instant on computing device is inhibited from executing a startup sequence, said first or second plurality of electronic components includes a processor having at least two operating modes, wherein when in a first operating mode said processor executes instructions representing a first operating system, and when in a second operating mode said processor executes instructions representing a second operating system; and
one or more switching mechanisms coupled to said input and output devices and selectively, to selected ones of said first and second plurality of electronic components to enable said input/output devices to be available for use in said first instant on as well as said second non-instant on mode of operation.

5. The apparatus of claim 4, wherein said one or more switching mechanisms includes a mechanical switch.

6. An apparatus comprising:
a first plurality of electronic components defining an instant on computing device for use in a first instant on mode of operation;
a second plurality of electronic components, including a plurality of input and output devices defining a non-instant on computing device for use in a second non-instant on mode of operation and wherein upon initiating execution of said non-instant on mode of operation, said instant on computing device is inhibited from executing a startup sequence; and
one or more switching mechanisms coupled to said input and output devices and selectively, to selected ones of said first and second plurality of electronic components to enable said input/output devices to be available for use in said first instant on as well as said second non-instant on mode of operation wherein said one or more switching mechanisms includes a digital multiplexor.

7. The apparatus of claim **6**, wherein said plurality of input and output devices include a keyboard and a display device.

8. A system comprising:

an integrated circuit comprising a first plurality of electronic components and defining a first instant on mode of operation wherein said first plurality of electronic components includes a first processor to execute instructions representing a first operating system;

a second plurality of electronic components, including a plurality of input and output devices, said second plurality of electronic components defining a second non-instant on mode of operation, wherein said second plurality of electronic components includes a second processor to execute instructions representing a second operating system and wherein upon initiating execution of said non-instant on mode of operation, said first processor is inhibited from executing a startup sequence; and

one or more switching mechanisms coupled to said input and output devices and selectively, to selected ones of said first and second plurality of electronic components to enable said input and output devices to be available for use in said first instant on as well as said second non-instant on mode of operation.

9. The apparatus of claim **8**, further comprising a connector interface to couple said one or more switching mechanisms to said integrated circuit.

10. The apparatus of claim **9**, wherein said first plurality of electronic components includes a first memory device, wherein said second plurality of electronic components includes a second memory device, and wherein said first and second processors operate simultaneously to synchronize data stored within said first and second memory devices.

11. A system comprising:

an integrated circuit comprising a first plurality of electronic components and defining a first instant on mode of operation;

a second plurality of electronic components, including a plurality of input and output devices, said second plurality of electronic components defining a second non-instant on mode of operation wherein said first or second plurality of electronic components includes a processor having at least two operating modes,

wherein when in a first operating mode said processor executes instructions representing a first operating system, and when in a second operating mode said processor executes instructions representing a second operating system and wherein upon initiating execution of said non-instant on mode of operation, said processor is inhibited from executing a startup sequence; and

one or more switching mechanisms coupled to said input and output devices and selectively, to selected ones of said first and second plurality of electronic components to enable said input and output devices to be available for use in said first instant on as well as said second non-instant on mode of operation.

12. The apparatus of claim **11**, wherein said one or more switching mechanisms includes a mechanical switch.

13. A system comprising:

an integrated circuit comprising a first plurality of electronic components and defining a first instant on mode of operation for an instant on device;

a second plurality of electronic components, including a plurality of input and output devices, said second plurality of electronic components defining a second non-instant on mode of operation and wherein upon initiating execution of said non-instant on mode of operation, said instant on device is inhibited from executing a startup sequence; and

one or more switching mechanisms coupled to said input and output devices and selectively, to selected ones of said first and second plurality of electronic components to enable said input and output devices to be available for use in said first instant on as well as said second non-instant on mode of operation wherein said one or more switching mechanisms includes a digital multiplexor.

14. The apparatus of claim **13**, wherein said plurality of input and output devices include a user input device and a display device.

15. A dual-mode portable computer, comprising:

a first microprocessor, said first microprocessor executing a first startup sequence upon selection of a first instant on mode of operation;

input and output devices;

a connector, configured to receive a plug-in device that includes a second microprocessor, said second microprocessor executing a second startup sequence upon selection of a second non-instant on mode of operation and wherein upon initiating execution of said non-instant on mode of operation, said first microprocessor is inhibited from executing said first startup sequence; and

switching circuitry, adapted to selectively couple the input and output devices to the first microprocessor in a first mode of operation of the computer or, alternatively, to the second microprocessor in a second mode of operation of the computer when the plug-in device is connected to the connector.

16. An apparatus comprising:

a memory device having a plurality of memory banks;

a first operating system residing in a first range of said plurality of memory banks;

a second operating system residing in a second range of said plurality of memory banks; a dual mode processor having at least two operational modes including:

a low power mode; and

a high performance mode, wherein upon initiating execution of said high performance mode, said low power mode is inhibited from executing a startup sequence; and

logic equipped to selectively provide said dual mode processor with said first or second operating system in response to said operational mode of said dual mode processor.

17. The apparatus of claim **15**, wherein said input and output devices include a user input device and a display device.

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