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(54) **COMBINATION PERSONAL DATA ASSISTANT AND PERSONAL COMPUTING SYSTEM DYNAMIC MEMORY RECLAMATION**

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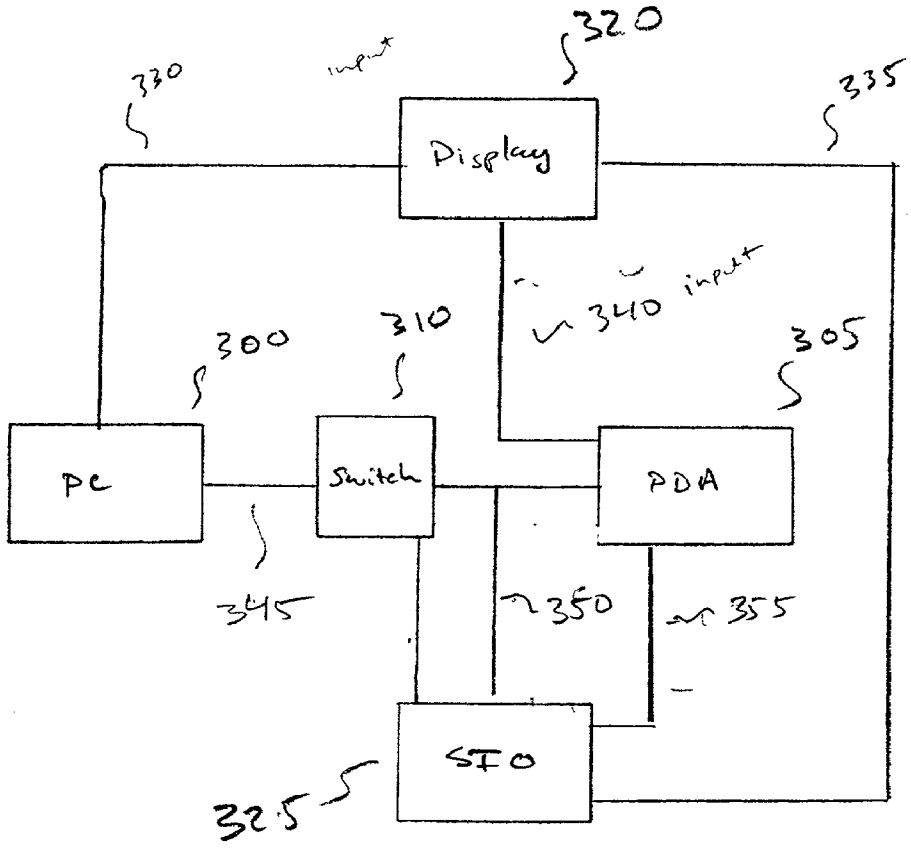
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(57) **ABSTRACT**

In order to continually receive messages in a dual personal computer system (PC) and personal digital assistant system (PDA) computer architecture, the PC system is deactivated to conserve battery power while the PDA continues to receive messages. As PDA memory is filled with messages, messages that are synchronized and archived with the PC system are deleted and space is freed for incoming messages. When new and non-synchronized messages completely fill the PDA memory array, the PC system is reactivated or the user is informed.



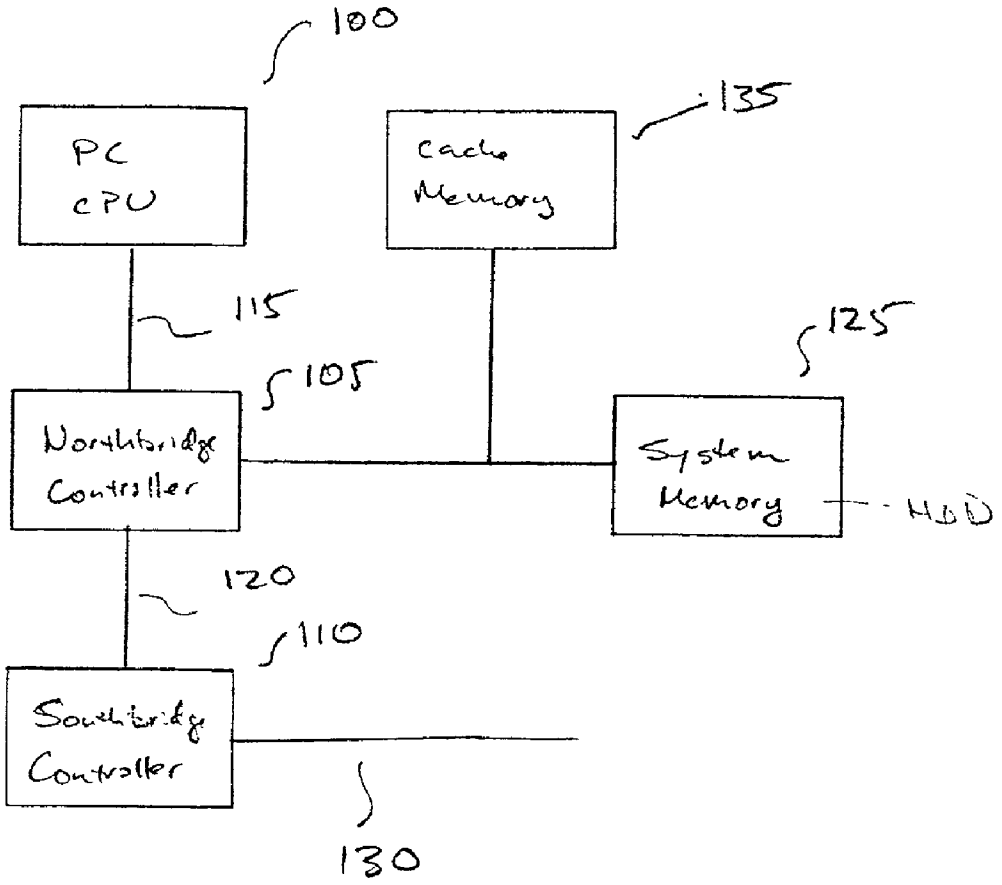


Fig. 1
(PRIOR ART)

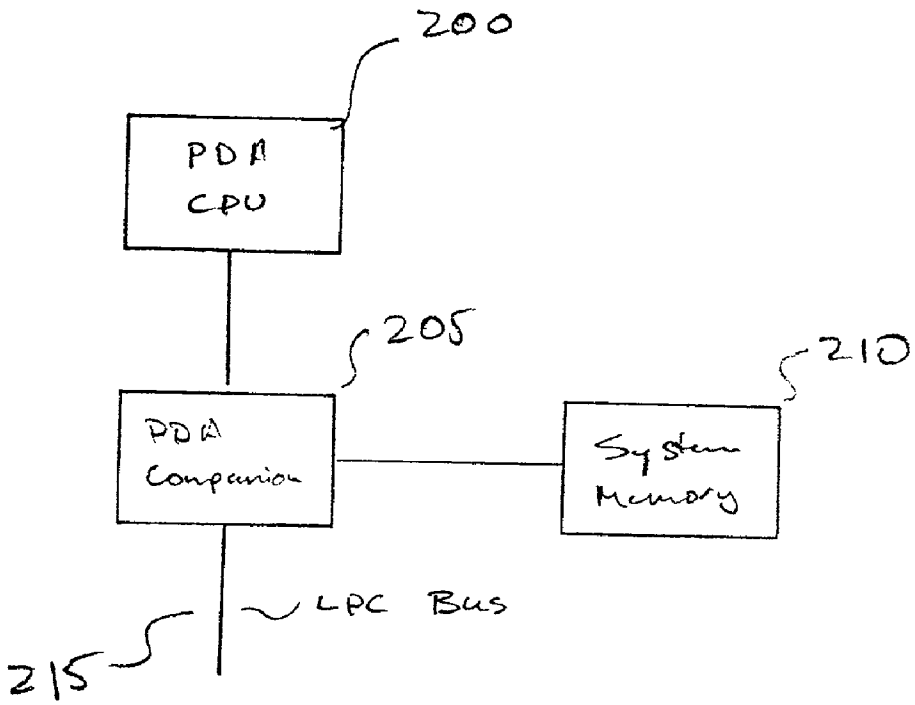


Fig. 2
(PRIOR ART)

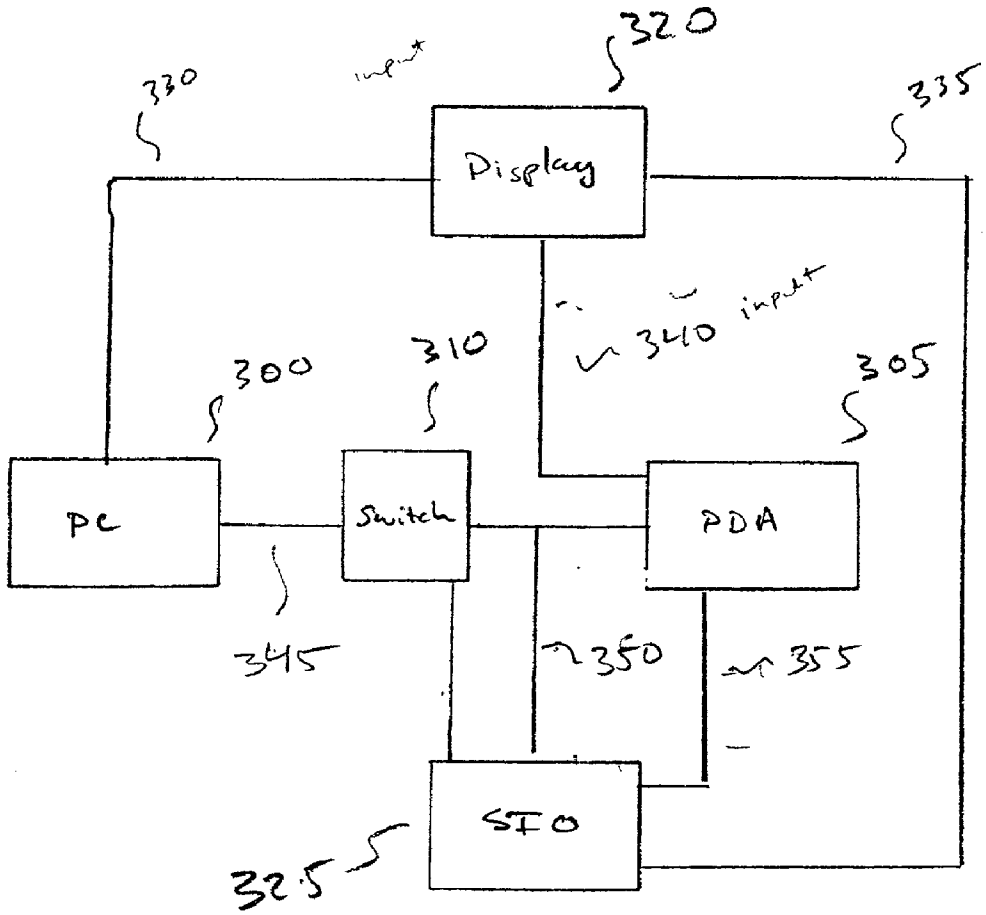

320
input
330
335
Display
340
input
300
310
305
PC
Switch
PDA
345
350
355
STO
325

Fig 3

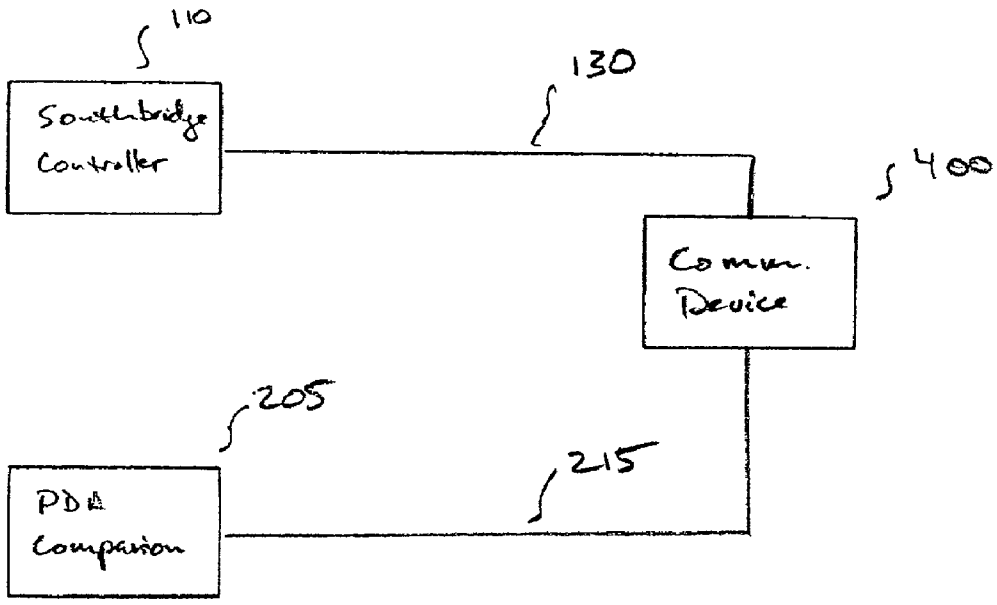

110
Southbridge Controller
130
400
Comm. Device
205
PDA Companion
215

Fig 4

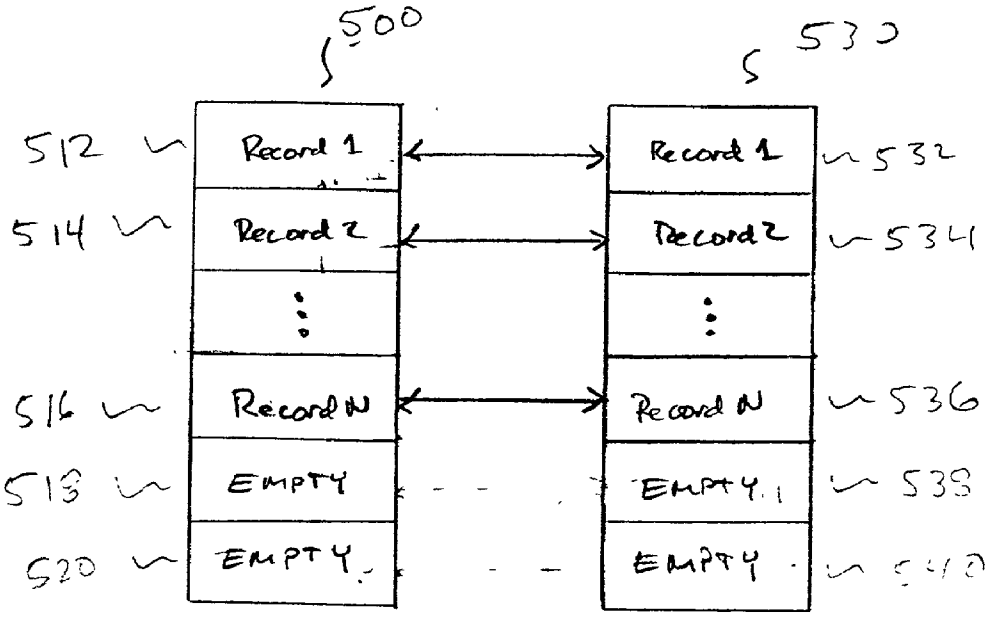

500
530
512
Record 1
532
514
Record 2
534
516
Record N
536
518
EMPTY
538
520
EMPTY
540

Fig. 5A

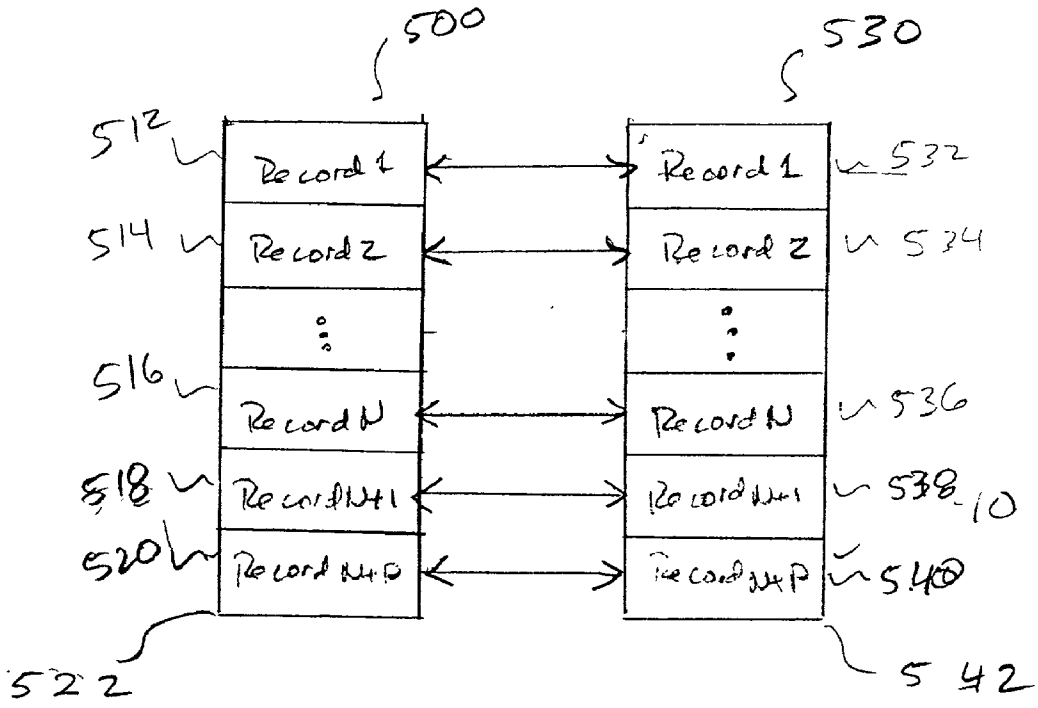

500
530
512
514
516
518
520
522
532
534
536
538
540
542
Record 1
Record 2
Record N
Record N+1
Record N+P
Record 1
Record 2
Record N
Record N+1
Record N+P

Fig. 5B

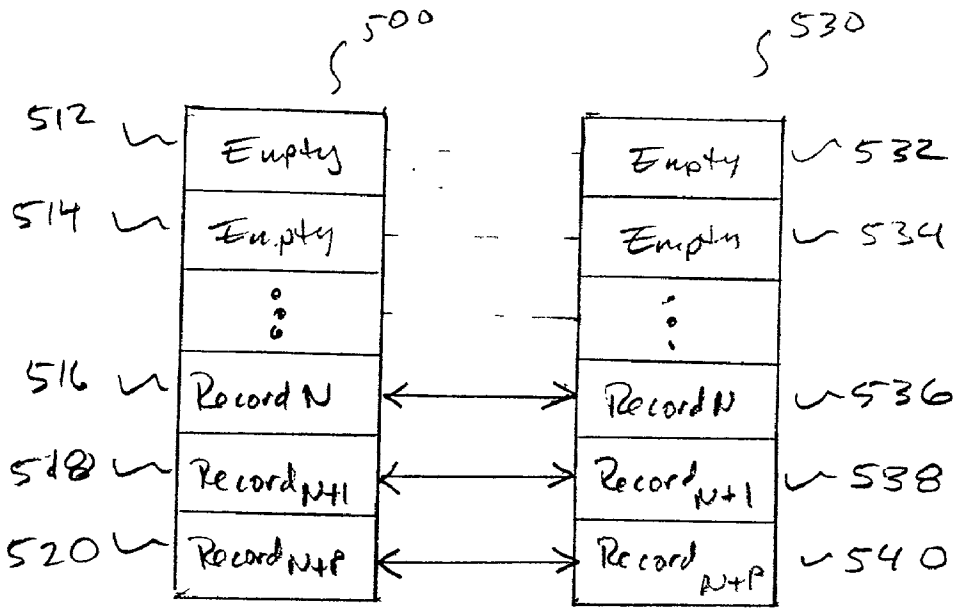

500
530
512
514
516
518
520
Empty
Empty
Record N
Record N+1
Record N+P
532
534
536
538
540

Fig. 5C

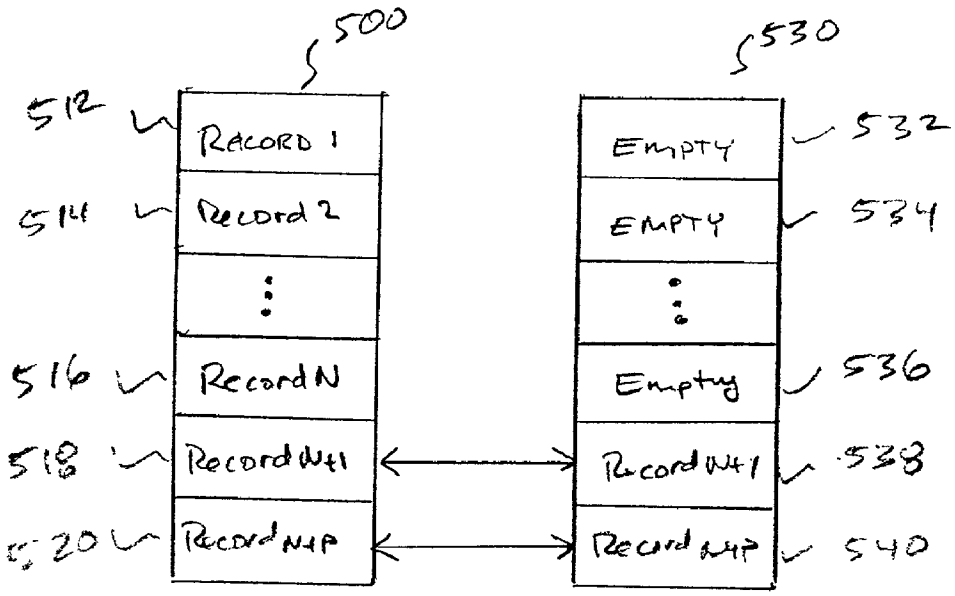

500
530
512
RACORD 1
514
Record 2
516
Record N
518
Record N+1
520
Record N+P
532
EMPTY
534
EMPTY
536
Empty
538
Record N+1
540
Record N+P

Fig. 5D

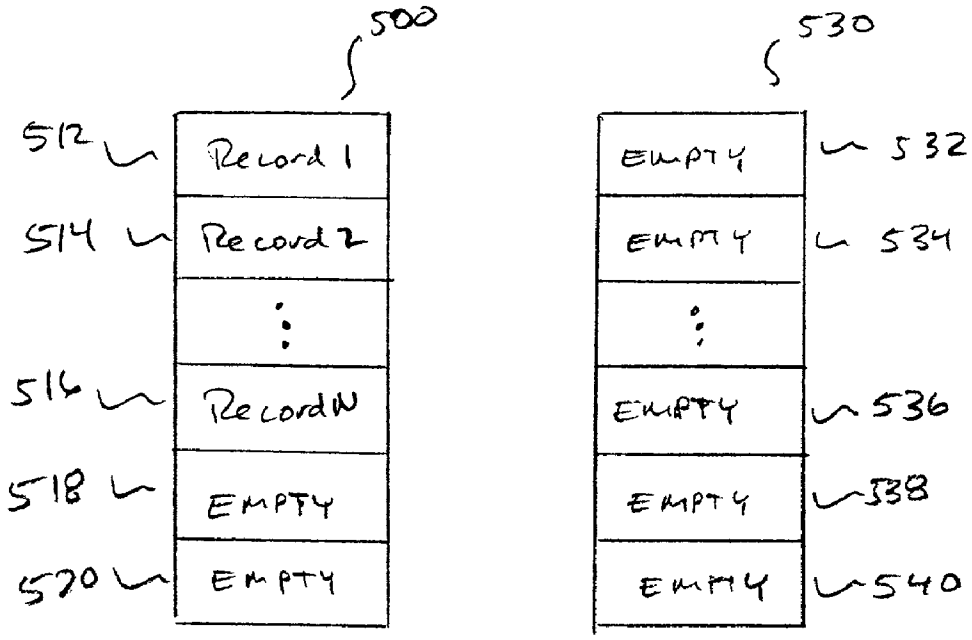

500
512
Record 1
514
Record 2
516
Record N
518
EMPTY
520
EMPTY
530
EMPTY
532
EMPTY
534
EMPTY
536
EMPTY
538
EMPTY
540

Fig 5E

COMBINATION PERSONAL DATA ASSISTANT AND PERSONAL COMPUTING SYSTEM DYNAMIC MEMORY RECLAMATION

CROSS REFERENCE TO RELATED PATENT APPLICATIONS

[0001] This application is related to commonly assigned patent application Ser. No. 09/740,138, filed Dec. 18, 2000 and entitled "A COMBINATION PERSONAL DATA ASSISTANT AND PERSONAL COMPUTING DEVICE" having La Vaughn F. Watts, Jr. and Ronald D. Shaw as inventors.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] This invention relates generally to a computing system and more particularly to a mobile computing system integrating dissimilar computing architectures and receiving messages and files, with the messages and files arranged to conserve memory space with minimal user intervention.

[0004] 2. Description of the Related Art

[0005] There are currently two popular types of mobile computing systems. The mobile Personal Computer (PC) system is a fully functional data processing system, typically having the same functionality as a desktop PC or a workstation PC. The mobile PC system (PC system) can run under any number of standard operating systems (OS), such as one of the releases of Windows® by the Microsoft Corporation. In implementing the PC system in a mobile computing architecture, several relatively undesirable features are apparent. First, the batteries of the PC system must be recharged after a relatively short time, typically in the order of a few hours. Despite improvements in battery technology, the quest for lighter and more compact portable units have tended to reduce the space allocated to the batteries so that time between charging of the batteries has not been significantly improved. The batteries used in the PC system, however, are capable of relatively rapid charging. As with the desktop PC unit and the workstation PC from which they are derived, the OS needed for the PC system requires a relatively long time from the activation of the power switch to the time when the processing system is available for actual computation. The PC system, however, has remarkable flexibility and can provide processing capability of extraordinary power. PC systems also have great memory capacity, having disk drives that can store significant amounts of information.

[0006] More recently the personal digital assistant (PDA) system has been developed to take advantage of operating systems (OS) such as Palm® OS and Windows®. These operating systems, in conjunction with a PDA system, permit a reduced or specialized functionality computing system.

[0007] PDA systems are relatively small in physical size and can perform a variety of useful functions such as arrange calendars; schedule appointments; send and receive e-mail; provide presentations; create documents; and provide communications. The PDA OS can permit exchange of files between the PDA systems and a PC system with Microsoft Windows® files. While the reduced functionality can be a disadvantage of the PDA system, the PDA vsystem has several advantages. An advantage is the time between charging of the batteries can be greatly extended, a result of the reduced functionality and the absence of disk storage units. The PDA system has its memory loaded in a memory circuit, such as a flash memory, which allows the PDA system to become active much quicker than a PC system. This memory, however, has limited capacity and can quickly be filled up.

[0008] Current PC systems and PDA systems have the capability to communicate and receive messages such as email, particular through wireless communication technologies. The PC systems with their large memory capacity can receive and store a great number of messages before memory space is exhausted. PC systems, however, with their draining power requirement cannot continuously be left on while in battery mode. Therefore a PC system is limited in the number of messages it receives because it cannot continually be left on. A PDA system with its low battery consumption has the capability to remain on for a very long time. A PDA system, however, with its limited memory capacity can quickly run out of memory. Without operator intervention, a PDA system with its memory capacity fully filled, is not able to receive incoming messages. Therefore current PC systems and PDA systems are limited in their abilities to receive incoming messages such as email.

[0009] A need has been felt for a mobile computing architecture having the desirable features of both the PC systems and of the PDA systems. In particular, the computing architecture would have the feature of an expanded time between battery charges. Another feature of the computing architecture would be the ability to continually receive incoming messages such as email and store messages until a user reads the messages. Yet another feature would be provide for a computing architecture that archives messages and allows incoming messages to be continually received with minimal user intervention.

SUMMARY OF THE INVENTION

[0010] The aforementioned and other features are accomplished, according to the present invention, by providing a mobile computing architecture that includes a PC system and a pDA system which independently have access to a communication device, allowing either system to communicate and receive messages regardless of the active state of the other System.

[0011] Messages are synchronized between the PDA system and the PC system so either system is able to read messages that have been received by the other system. The PC system with its large memory capacity is able to archive and store messages, therefore the PDA is Able to free up memory space by deleting records whenever its memory is filled and new messages are unable to be stored.

[0012] To conserve battery power, the PC system is deactivated or placed in a suspend state while the PDA system continues to receive messages. As the memory of the PDA system is filled with new non-synchronized messages, synchronized messages in the PDA memory are automatically deleted. When the PDA memory array is filled with new non-synchronized messages the PC system can be activated to synchronize messages, archive messages, and clear messages in order to free up space for incoming messages. The user may also be informed to read new messages and take action to free up space.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The present invention may be better understood, and it's numerous objects, features and advantages made apparent to those skilled in the art by referencing the accompanying drawings. The use of the same reference number throughout the figures designates a like or similar element.

[0014] **FIG. 1** illustrates a block diagram of a personal computer (PC) system.

[0015] **FIG. 2** illustrates a block diagram of a personal digital assistant (PDA) system.

[0016] **FIG. 3** illustrates a combined PC and PDA computing architecture.

[0017] **FIG. 4** illustrates a combined PC and PDA computing architecture that provides communication access to either the PC system or the PDA system.

[0018] **FIG. 5A** illustrates a memory array for a PDA system synchronized to a memory array for a PC system.

[0019] **FIG. 5B** illustrates filled memory arrays for the PC system and the PDA system.

[0020] **FIG. 5C** illustrates cleared and empty records of memory arrays for the PC system and the PDA system.

[0021] **FIG. 5D** illustrates a PDA memory array and a PC memory with synchronized and non-synchronized records.

[0022] **FIG. 5E** illustrates a PDA memory array **500** with free space and an empty PC memory array **530**.

[0023] While the invention is susceptible to various modifications and alternative forms, specific embodiments thereof are shown by way of example in the drawings and will herein be described in detail, it should be understood, however, that the drawings and detailed description thereto are not intended to limit the invention to the particular form disclosed but on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the present invention as defined by the appended claims.

DETAILED DESCRIPTION

[0024] Now referring to **FIG. 1** illustrated is a block diagram of a PC system. The PC system of **FIG. 1** is typical of systems based on the Intel Pentium® and equivalent type processors. A PC CPU **100** is connected by a bus **115** to a north bridge controller **105**. Bus **115** typically is a peripheral component interconnect (PCI) bus. The north bridge controller **105** interfaces to a system memory **125**. Between the system memory **125** and the north bridge controller **105** is a cache memory **135**. The cache memory **135** is used as "temporary" memory, particularly in displaying information to a user. From the north bridge controller **105** is a south bridge controller **110** used to interface to peripheral or input output **(10)** devices. A bus **120** connects the north bridge controller **105** to the south bridge controller **110**. The bus **120** is also typically a PCI bus. From the south bridge controller a bus **130** connects peripheral or 10 devices. Bus **130** can be a PCI bus.

[0025] Now referring to **FIG. 2** illustrated is a block diagram of a PDA system. In a PDA system a PDA CPU **200** interfaces to a companion processor **205**. The companion processor **205** handles interfacing to peripherals and to a system memory **210**. From the companion processor **205** is a bus **215**. Bus **215** can be a low pin count (LPC) bus and communicate to peripherals and **10** devices.

[0026] Now referring to **FIG. 3** illustrated is a combined PC and PDA computing architecture. A PC system **300** is connected to a switch **310** by a bus **345**. The bus **345** can be an LPC bus. The switch **310** is connected to a PDA system **305** by a bus **350**. The bus **350** can also be an LPC bus. Either the PC system **300** or the PDA system **305** can have control over the common peripherals and **10** devices, including a display **320**. The switch **310** isolates either the PC system **300** or the PDA system **305**, placing one of the systems in control of the entire computer system. Input and output control is conducted through a serial or super input output controller (SIO) **325**. The SIO **325** is connected to the PDA system **305** by the bus **350** and another bus **355**. Bus **350** allows the PC system **300** to interface to the SIO **325** and the PDA system **305**, with the PC system **300** acting as a "master" device and the PDA system **305** as a "slave." When the PDA system **305** is in control of the computing architecture, the PDA system **305** communicates to the S10 **325** by a bus **355**. The bus **355** can be an LPC bus. The S10 **325** provides video control to the display **320** by bus **335** when either the PC system **300** or the PDA system **305** is in control. When in control, the PDA system **305** provides video content by way of bus **340**. When the PC system **300** is in control of the computing architecture video content is provided by way of bus **330**. Other embodiments of the architecture can include providing a separate and independent connection by way of busses to other common devices from the PC system **300** and the PDA system **305**. Common devices can include wireless communication technologies.

[0027] Now referring to **FIG. 4**, illustrated is a combined PC and PDA computing architecture that provides communication access to either the PC system or the PDA system. In a PC system the south bridge controller can directly connect to a communication device **400** by the PCI bus **130**. In a PDA system the companion processor **205** can be connected to the communication device **400** by the LPC bus **215**. This computing architecture allows either the PC system or the PDA system to have access to communication, in particular wireless technology. Access by either the PC system or the PDA system is possible, regardless of the active status of either system. Therefore if the PDA system is off, the PC system is able to receive messages such as email. If the PC system is off, the PDA system is able to receive messages.

[0028] Referring back to **FIG. 3**, the PC system **300** and the PDA system **305** are connected by the bus **345** and the bus **350**, and are able to exchange data between their respective memory. Further the connection allows both systems to synchronize messages that are received and eventually archived in the memory of the PC system **300** or the PDA system **305**. Considering the limited memory capacity of the PDA system **305**, archiving messages would best be undertaken by the PC system **300** with its significantly larger memory.

[0029] Now referring to **FIG. 5A** illustrated is a memory array for a PDA system synchronized to a memory array for a PC system. A PDA memory array **500** has several records for messages such as email or information. A PC memory

array **530** has corresponding records to store or refer to messages or information. The records of the memory arrays may be read or unread by a user. The PC memory array **530** may be a separate logical or physical device to the PC system hard drive (permanent storage unit). Therefore in certain embodiments, the PDA memory array **500** is synchronized directly to the PC system hard drive.

[**0030**] The PC system with its large capacity storage has the ability to clear records in its memory array **530** and place messages in its hard drive. Since the PDA memory array **500** and PC memory array **530** are synchronized whenever the PC memory array **530** retrieves messages from the hard drive, the PDA memory array **500** is able to read the messages. In this particular example, "Record 1"**512** of PDA memory array **500** is synchronized to "Record **1**"**532** of PC memory array **530**. Going down each memory array, "Record 2"**514** is synchronized to "Record 2"**534**; "Record N"**516** is synchronized to "Record N"**536**; and "Record N+1"**518** is synchronized to "Record N+1"**538**. A direct one to one correspondence of each record of the respective memory arrays of the PDA and PC system is made available. In this particular example "Record N+1"**518** of PDA memory array **500** is empty and available to receive a new message, therefore "Record N+1"**538** the corresponding record of PC memory array **530** is also empty. "Record N+P"**520** and "Record N+P"**540** are also empty. In this particular embodiment the records that are empty are not synchronized until a message is received or placed in the corresponding record of the other system's memory array. In this embodiment, the memory array of the respective systems are filled from the first record to the last, in this case the last record is "Record N+P"**520** of PDA memory array **500** and "Record N+P"**540** of PC memory array **530**.

[**0031**] Now referring to **FIG. 5B** illustrated are filled memory arrays for the PC system and the PDA system. As messages are received by either system the memory arrays fill up until the end of memory (EOM) of each array is reached. In the case of the PDA memory array **500** the EOM **522** is after "Record N+P"**520**, and for the PC memory array **530**, the EOM **630** is after "Record N+P"**542**.

[**0032**] In order to receive new messages such as email, the record arrays must be cleared. Now referring to **FIG. 5C** illustrated are cleared and empty records of memory arrays for the PC system and the PDA system. In certain applications, the first records such as "Record 1"**512**, "Record 1"**532**, "Record 2"**514**, and "Record 2"**534** are cleared and emptied to provide for incoming messages. The records are deleted after the old messages that occupied the records are placed in the hard drive of the PC system. With the empty records, new messages may be received by either system then the filled records are synchronized with corresponding records of the memory array of the other system.

[**0033**] When the PC system is active, the computing architecture is able to determine when the memory arrays are completely filled and all records are occupied. The PC system can request that the user archive into the hard disk selected records, delete those selected records from the memory arrays, thus providing empty records in which new messages can be received. An alternative method would be to automatically, without user intervention, archive and delete the oldest records first.

[**0034**] When the PC is inactive, and the PDA is receiving incoming messages, there is a greater concern of running out of records in the PDA memory array **500**. A typical scenario is the following. In order to save battery power, the PC system is made inactive or placed into a suspend state. The PC system is not able to receive messages, however, the computer architecture is able to continue receiving messages through the PDA system. Messages come in, take up record space, and without some operator intervention, accumulate, and fill up the PDA memory array **500**. New messages cannot be received until messages are deleted and records clear. A predetermined method to delete old messages to free up records to receive new messages can be arranged. This arrangement however, presents a problem when a user has not read all of the messages and older unread messages are deleted without the user saving or having the opportunity to read the message.

[**0035**] Now referring to **FIG. 5D** illustrated are a PDA memory array and a PC memory With synchronized and non-synchronized records. When the PC system is inactive, the PDA system continues to receive messages and its records are filled with the messages. Since the PC system is inactive, the records of PC memory array **530** that correspond to records of PDA memory array **500** that are filled with new messages are not synchronized. "Record 1"**512** of PDA memory array **500** is not synchronized to "Record 1"**532** of PC memory array **530**. Therefore "Record 1"**532** is "empty" and contains no message (information). As new messages are received by the PDA system, while the PC is inactive the records fill up, however, only the records in PDA memory array **500** are filled. Illustrated is a filled PDA memory array **500**. "Record 1"**512**, "Record 2"**514**, and all records up to and including "Record N" are filled records in PDA memory array **500**. These new messages contained in PDA memory array **500**, however, are not synchronized with their corresponding records in PC memory array **530** which are "Record 1"**532**, "Record 2"**534** up to and including "Record N"**536**. In this particular example, "Record N+1"**518** of PDA memory array **500** is synchronized to "Record N+1"**538** of PC memory array **530**. And all records up to and including "Record N+P"**520** of PDA memory array **500** are synchronized with "Record N+P"**540** of PC memory array **530**.

[**0036**] Since the PC memory array **500** can archive old messages into hard drive memory, the older synchronized files can be archived and the records deleted, thus freeing up space for new messages. Now referring to **FIG. 5E** illustrated is PDA memory array **500** with free space and an empty PC memory array **530**. After archiving the messages of the synchronized records, in this particular example, "Record N+1"**538** up to and including "Record N +P"**540** of PC memory array **500**, the records "Record N+1"**518** up to and including "Record N+P"**520** of PDA memory array **500** are deleted, freeing up these records in order to receive new messages. The user can be made aware that messages have been deleted from the PDA system, and that they may be retrieved since they have been archived in the PC system.

[**0037**] This archiving and deletion process takes place until all the records of the PDA memory array **500** are filled. This process occurs while the PC system is inactive or suspended. When the PC system is activated, synchronization of the records can take place. As the PDA system remains active and receiving messages, and the PC system remains inactive, the PDA memory array **530** fills up with non-synchronized messages. When the EOM **522** of PDA

memory array **530** is reached, the PDA system can either look to a predetermined preference to delete records and provide space for incoming messages or the PDA system can alert the user that the PDA memory array **500** is filled and request action from the user.

[**0038**] In order to avoid having the user manually look at, read, and select records to delete from the PDA memory array **500**, the following can take place. The PDA system can activate or wake up from a suspend state the PC system when PDA memory array **500** is full. As the PC system is awoken, records from the PDA memory array **500** are synchronized to the PC memory array **530**. As files are synchronized, records from the PDA memory array **500** are erased and the space made available for new messages. Alternatively, the PDA system can stop receiving messages and allow the user to read the messages, and delete the messages from the records after they have been read.

[**0039**] Variations of the synchronization process can include providing alerts to the user as to messages that are being deleted from the memory arrays. The user can also be informed of actions that are needed to be taken such as reading messages or manually activating the PC system. A provision can be made for the PDA memory array **500** to contain headers for the records contained therein. The headers of the individual records are used to identify that messages have been purged and archived to the PC system memory. The user also is made aware that the messages can be retrieved from the PC system memory. Embodiments of the invention can include provision for the user to set preferences as to messages that may be received and stored in the PDA memory array **500** without purging. Also the preference can include automatically purging certain messages. A flag may be set for incoming messages which identifies them as important messages that require the user's attention. Alternatively, "junk e-mail" or other unwanted messages without a special flag, messages that would take up valuable record space in the PDA memory array, may be automatically purged and sent or not sent to the PC system memory.

[**0040**] Although the present invention has been described in connection with several embodiments, the invention is not intended to be limited to the specific forms set forth herein, but on the contrary, it is intended to cover such alternatives, modifications, and equivalents as can be reasonably included with in the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. A mobile computing system comprising of:

a communication device;

a personal computing system (PC) comprised of

a storage device capable of receiving and storing messages from the communication device; and

a personal digital assistant system (PDA) comprised of

a storage device capable receiving and storing messages from the communication device, whereby the storage device of the PC is capable of synchronizing received messages with the storage device of the PDA.

2. The mobile computing system of claim 1 wherein the storage device of the PC is a memory array comprised of a set of records, and the storage device of the PDA is a memory array comprised of a set of records.

3. The mobile computing system of claim 2 wherein a direct correspondence is established between the set of records of the PC memory array and the set of records of the PDA memory array.

4. The mobile computing system of claim 2 wherein messages are synchronized between the memory array of the PC and the memory array of the PDA.

5. The mobile computing system of claim 3 wherein messages are synchronized between records of the PC memory array and records of the PDA memory array.

6. The mobile computing system of claim 1 wherein the storage device of the PC is a hard disk drive.

7. The mobile computing system of claim 6 wherein the hard disk drive is comprised of a memory array, and the PDA storage device is comprised of a memory array, wherein the PC hard disk drive memory array corresponds directly to the PDA memory array.

8. A mobile computing system comprising of:

a communication device;

a personal computing system (PC) capable of receiving messages through the communication device; and

a personal digital assistant system (PDA) capable of receiving messages through the communication device and synchronizing the messages with the PC.

9. The mobile computing system of claim 8 wherein the PDA is further comprised of a memory array where messages are received and entered, and the memory array is synchronized to the PC.

10. The mobile computing system of claim 9 wherein the PC is further comprised of a memory array that is synchronized to the memory array of the PDA.

11. The mobile computing system of claim 9 wherein the PC is further comprised of a hard disk drive that is synchronized to the memory array of the PDA.

12. A method of clearing and archiving messages in a dual system computer architecture comprised of:

receiving and storing messages by a first computer system to a first memory device;

synchronizing the messages with a second computer system, where by the second computer system archives synchronized messages to a second memory device; and

deleting synchronized and archived messages whenever the first memory device is filled.

13. The method of clearing and archiving messages in a dual system computer architecture of claim 12 further comprising:

identifying the deleted messages in the first memory devices.

14. The method of clearing and archiving messages in a dual system computer architecture of claim 12 wherein the first computer system is a personal digital assistant system (PDA) and the second computer system is a personal computer system (PC).

15. The method of clearing and archiving messages in a dual system computer architecture of claim 13 wherein the first computer system is a personal digital assistant system (PDA) and the second computer system is a personal computer system (PC).

16. A method of clearing and archiving messages in a dual system computer architecture comprised of:

receiving and storing messages by a first computer system to a first memory device;

synchronizing the messages with a second computer system, whereby the second computer system archives synchronized messages to a second memory device; and

informing a user whenever the first memory device is filled.

17. The method of clearing and archiving messages in a dual system computer architecture of claim 14 further comprised of:

deleting messages from the first memory device after the messages have been read by the user.

18. The method of clearing and archiving messages in a dual system computer architecture of claim 16 wherein the first computer system is a personal digital assistant (PDA) and the second computer system is a personal computer system (PC).

19. The method of clearing and archiving messages in a dual system computer architecture of claim 17 wherein the first computer system is a personal digital assistant (PDA) and the second computer system is a personal computer system (PC).

20. The method of clearing and archiving messages in a dual system computer architecture of claim 12 further comprised of:

setting preferences as to received and stored messages.

21. The method of clearing and archiving messages in a dual system computer architecture of claim 13 further comprised of:

setting preferences as to received and stored messages.

22. The method of clearing and archiving messages in a dual system computer architecture of claim 14 further comprised of:

setting preferences as to received and stored messages.

23. The method of clearing and archiving messages in a dual system computer architecture of claim 15 further comprised of:

setting preferences as to received and stored messages.

24. The method of clearing and archiving messages in a dual system computer architecture of claim 16 further comprised of:

setting preferences as to received and stored messages.

25. The method of clearing and archiving messages in a dual system computer architecture of claim 17 further comprised of:

setting preferences as to received and stored messages.

26. The method of clearing and archiving messages in a dual system computer architecture of claim 18 further comprised of:

setting preferences as to received and stored messages.

27. The method of clearing and archiving messages in a dual system computer architecture of claim 19 further comprised of:

setting preferences as to received and stored messages.

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