



US010067942B2

(12) **United States Patent**  
**Manzano**

(10) **Patent No.:** **US 10,067,942 B2**  
(45) **Date of Patent:** **\*Sep. 4, 2018**

(54) **ARCHITECTURE FOR MANAGEMENT OF  
DIGITAL FILES ACROSS DISTRIBUTED  
NETWORK**

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(\*) Notice: Subject to any disclaimer, the term of this  
patent is extended or adjusted under 35  
U.S.C. 154(b) by 345 days.

This patent is subject to a terminal dis-  
claimer.

(21) Appl. No.: **14/860,289**

(22) Filed: **Sep. 21, 2015**

(65) **Prior Publication Data**

US 2016/0012067 A1 Jan. 14, 2016

**Related U.S. Application Data**

(63) Continuation of application No. 12/267,852, filed on  
Nov. 10, 2008, now Pat. No. 9,143,561.

(Continued)

(51) **Int. Cl.**  
**G06F 17/30** (2006.01)  
**G06F 15/16** (2006.01)  
**H04L 29/08** (2006.01)

(52) **U.S. Cl.**  
CPC ..... **G06F 17/30082** (2013.01); **G06F 15/16**  
(2013.01); **G06F 17/30** (2013.01);  
(Continued)

(58) **Field of Classification Search**  
CPC .. G06F 17/30; G06F 17/132; G06F 17/30017;  
G06F 17/30067; G06F 17/3007;  
(Continued)

(56) **References Cited**

**U.S. PATENT DOCUMENTS**

5,600,834 A 2/1997 Howard  
5,806,078 A \* 9/1998 Hug ..... G06F 17/2288  
707/999.202

(Continued)

**FOREIGN PATENT DOCUMENTS**

EP 1130511 9/2001  
WO WO 98/56149 \* 12/1998  
WO WO 2007047302 4/2007

**OTHER PUBLICATIONS**

U.S. Office Action dated Aug. 13, 2014 for U.S. Appl. No.  
11/739,083.

(Continued)

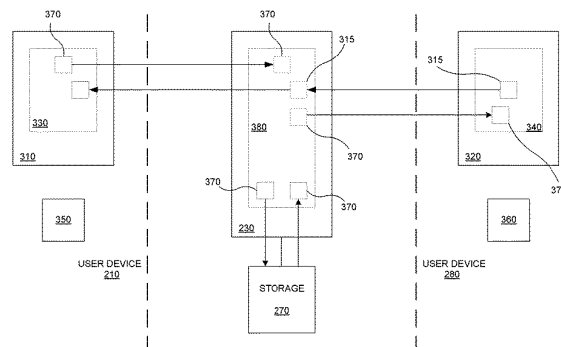
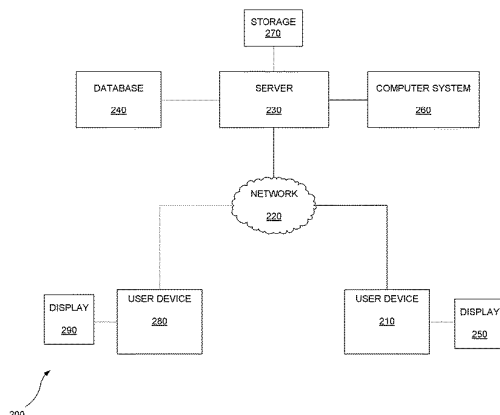
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(57) **ABSTRACT**

A system includes a first application executable on a first electronic device. The system further includes a second application executable on a second electronic device in communication with the first electronic device. The second electronic device is configured to store a first electronic file. Subsequent to a user modifying the first electronic file, the second application is operable to automatically transfer the modified first electronic file, or a copy thereof, to the first electronic device. The system further includes a third application executable on a third electronic device in communication with the first electronic device. The third electronic device is configured to store a second electronic file. Subsequent to the user modifying the second electronic file, the third application is operable to automatically transfer the modified second electronic file, or a copy thereof, to the first electronic device. The first application is operable to automatically transfer the modified first electronic file or copy to the third electronic device, and automatically transfer the

(Continued)



modified second electronic file or copy to the second electronic device.

### 18 Claims, 3 Drawing Sheets

#### Related U.S. Application Data

- (60) Provisional application No. 60/986,896, filed on Nov. 9, 2007.

(52) **U.S. CL.**

CPC ..... **G06F 17/301** (2013.01); **G06F 17/30088** (2013.01); **G06F 17/30091** (2013.01); **G06F 17/30165** (2013.01); **G06F 17/30174** (2013.01); **H04L 67/1095** (2013.01)

(58) **Field of Classification Search**

CPC ..... G06F 17/3023; G06F 17/2288; G06F 17/30091; G06F 17/30176; G06F 17/30194; G06F 8/71; G06F 17/30082; G06F 17/30165; G06F 17/301; G06F 17/30174; G06F 17/30088

See application file for complete search history.

(56) **References Cited**

#### U.S. PATENT DOCUMENTS

5,909,581 A \* 6/1999 Park ..... G06F 8/65 717/170

6,026,414 A 2/2000 Anglin

6,154,817 A 11/2000 Mohan et al.

6,260,069 B1 7/2001 Anglin

6,449,624 B1 9/2002 Hammack et al.

6,463,463 B1 10/2002 Godfrey et al.

6,504,994 B2 1/2003 Kawamura et al.

6,505,200 B1 1/2003 Ims et al.

6,606,646 B2 8/2003 Feigenbaum

6,611,849 B1 8/2003 Raff et al.

6,671,700 B1 12/2003 Creemer et al.

6,708,221 B1 3/2004 Mendez et al.

6,757,696 B2 6/2004 Multer et al.

6,760,759 B1 7/2004 Chan

6,810,405 B1 10/2004 Larue et al.

6,829,622 B2 12/2004 Beyda

6,874,037 B1 3/2005 Abram et al.

6,931,454 B2 8/2005 Deshpande et al.

6,990,522 B2 1/2006 Wu

7,024,428 B1 4/2006 Huang et al.

7,054,594 B2 5/2006 Bloch et al.

7,065,658 B1 6/2006 Baraban et al.

7,089,307 B2 8/2006 Zintel et al.

7,136,934 B2 11/2006 Carter et al.

7,155,488 B1 12/2006 Lunsford et al.

7,224,973 B2 5/2007 Tsutazawa et al.

7,243,163 B1 7/2007 Friend et al.

7,260,646 B1 8/2007 Stefanik et al.

7,269,433 B2 9/2007 Vargas et al.

7,290,244 B2 10/2007 Peck et al.

7,325,038 B1 1/2008 Wang

7,340,534 B2 3/2008 Cameron et al.

7,398,327 B2 7/2008 Lee

7,415,615 B2 8/2008 Skygebjær

7,457,631 B2 11/2008 Yach et al.

7,467,353 B2 12/2008 Kurlander et al.

7,483,925 B2 1/2009 Koskimies et al.

7,526,575 B2 4/2009 Rabbers et al.

7,574,711 B2 8/2009 Zondervan et al.

7,584,186 B2 9/2009 Chen et al.

7,587,446 B1 9/2009 Onyon et al.

7,613,773 B2 11/2009 Watt

7,639,116 B2 12/2009 Saunders

7,657,271 B2 2/2010 Kim

7,680,885 B2 3/2010 Schauser et al.

7,752,166 B2 7/2010 Quinlan et al.

7,761,414 B2 7/2010 Freedman

7,788,303 B2 8/2010 Mikesell et al.

7,895,334 B1 2/2011 Tu et al.

7,987,420 B1 7/2011 Kloba et al.

8,009,966 B2 8/2011 Bloom et al.

8,112,549 B2 2/2012 Srinivasan et al.

8,244,288 B2 8/2012 Chipchase

8,321,534 B1 11/2012 Roskind et al.

8,370,423 B2 2/2013 Ozzie et al.

8,386,558 B2 2/2013 Schleifer et al.

9,143,561 B2 \* 9/2015 Manzano ..... G06F 17/30174

2002/0026478 A1 2/2002 Rodgers et al.

2002/0035697 A1 \* 3/2002 McCurdy ..... G06F 17/30011 726/3

2002/0087588 A1 7/2002 McBride et al.

2003/0028514 A1 \* 2/2003 Lord ..... G06F 11/2064

2003/0028542 A1 2/2003 Muttik et al.

2003/0038842 A1 2/2003 Peck et al.

2003/0078946 A1 \* 4/2003 Costello ..... G06F 11/2064

2003/0125057 A1 7/2003 Pesola

2003/0135565 A1 7/2003 Estrada

2004/0049345 A1 3/2004 McDonough et al.

2004/0093361 A1 5/2004 Therrien et al.

2004/0107225 A1 6/2004 Rudoff

2004/0133629 A1 \* 7/2004 Reynolds ..... G06F 17/30902 709/202

2004/0158817 A1 \* 8/2004 Okachi ..... G06F 8/65 717/122

2004/0172424 A1 9/2004 Edelstein et al.

2005/0091316 A1 4/2005 Ponce et al.

2005/0097225 A1 5/2005 Glatt et al.

2005/0220080 A1 10/2005 Ronkainen et al.

2006/0010150 A1 1/2006 Shaath et al.

2006/0058907 A1 3/2006 Suderman

2006/0074985 A1 \* 4/2006 Wolfish ..... G06Q 20/322

2006/0129627 A1 \* 6/2006 Phillips ..... H04L 63/10 709/200

2006/0143129 A1 \* 6/2006 Holm ..... G06F 8/61 705/52

2006/0168118 A1 \* 7/2006 Godlin ..... G06F 17/30212 709/218

2006/0189348 A1 8/2006 Montulli et al.

2007/0014314 A1 1/2007 O'Neil

2007/0016629 A1 \* 1/2007 Reinsch ..... G06F 8/71

2007/0027936 A1 \* 2/2007 Stakutis ..... G06F 11/1451

2007/0100913 A1 5/2007 Sumner et al.

2007/0180084 A1 \* 8/2007 Mohanty ..... G06F 11/1451 709/223

2007/0191057 A1 8/2007 Kamada

2007/0238440 A1 10/2007 Sengupta et al.

2008/0005114 A1 \* 1/2008 Li ..... G06F 17/30209

2008/0005280 A1 1/2008 Adams

2008/0086494 A1 4/2008 Heller et al.

2008/0168526 A1 7/2008 Robbin et al.

2008/0288578 A1 11/2008 Silfverberg

2009/0013009 A1 \* 1/2009 Nakayama ..... G06F 11/1453

2009/0063711 A1 3/2009 Finkelstein

2013/0226871 A1 8/2013 Sarnowski

#### OTHER PUBLICATIONS

FolderShare—Secure Remote Access VPN Solution; Document Management & Real-time File Mirroring Solution; < <https://web.archive.org/web/20040804020435/http://www.foldershare.com:80/>>; Aug. 4, 2004.

FolderShare; Your Files Anywhere; <<https://web.archive.org/web/20030808183932/http://www.foldershare.com:80/>>; Aug. 8, 2003.

FolderShare—Secure Remote Access VPN Solution; Need your files on more than one computer?; <<https://web.archive.org/web/20040814015727/http://www.foldershare.com:80/>>; Aug. 14, 2004.

FolderShare—Secure Remote Access VPN Solution; Need your files on more than one computer?; <<https://web.archive.org/web/20040820052105/http://www.foldershare.com:80/>>; Aug. 20, 2004.

(56)

**References Cited****OTHER PUBLICATIONS**

FolderShare—Secure Remote Access VPN Solution; Need your files on more than one computer?; <<https://web.archive.org/web/20041211020957/http://foldershare.com:80/>>; Dec. 11, 2004.

FolderShare—Secure Remote Access VPN Solution; Need your files on more than one computer?; <<https://web.archive.org/web/20041217041726/http://foldershare.com:80/>>; Dec. 17, 2004.

FolderShare; Your Smart File Transfer Solution; <<https://web.archive.org/web/20031220151508/http://www.foldershare.com:80/>>; Dec. 20, 2003.

FolderShare—Secure Remote Access VPN Solution; Need your files on more than one computer?; <<https://web.archive.org/web/20041230211050/http://www.foldershare.com:80/>>; Dec. 30, 2004.

FolderShare—Secure Remote Access VPN Solution; Document Management & Real-time File Mirroring Solution; <<https://web.archive.org/web/20040701113739/http://foldershare.com:80/>>; Jul. 1, 2004.

FolderShare—Secure Remote Access VPN Solution; Document Management & Real-time File Mirroring Solution; <<https://web.archive.org/web/20040711062548/http://www.foldershare.com:80/>>; Jul. 11, 2004.

FolderShare; Your Files Anywhere; <<https://web.archive.org/web/20030722054342/http://foldershare.com:80/>>; Jul. 22, 2003.

FolderShare—Secure Remote Access VPN Solution; Document Management & Real-time File Mirroring Solution; <<https://web.archive.org/web/20040730030655/http://www.foldershare.com:80/>>; Jul. 30, 2004.

FolderShare—Secure Remote Access VPN Solution; Document Management & Real-time File Mirroring Solution; <<https://web.archive.org/web/20040603205113/http://www.foldershare.com:80/>>; Jun. 3, 2004.

FolderShare—Secure Remote Access VPN Solution; Document Management & Real-time File Mirroring Solution; <<https://web.archive.org/web/20040613161906/http://www.foldershare.com:80/>>; Jun. 13, 2004.

FolderShare—Secure Remote Access VPN Solution; Document Management & Real-time File Mirroring Solution; <<https://web.archive.org/web/20040629075057/http://www.foldershare.com:80/>>; Jun. 29, 2004.

FolderShare—Secure Remote Access VPN Solution; Your Smart File Transfer & Real-time File Mirroring Solution; <<https://web.archive.org/web/20040316235151/http://foldershare.com:80/>>; Mar. 16, 2004.

FolderShare—Secure Remote Access VPN Solution; Your Smart File Transfer & Real-time File Mirroring Solution; <<https://web.archive.org/web/20040325034239/http://www.foldershare.com:80/>>; Mar. 25, 2004.

FolderShare—Secure Remote Access VPN Solution; Document Management & Real-time File Mirroring Solution; <<https://web.archive.org/web/20040512211417/http://www.foldershare.com:80/>>; May 12, 2004.

FolderShare; Your Files Anywhere; <<https://web.archive.org/web/20030531180252/http://www.foldershare.com:80/>>; May 31, 2003.

FolderShare—Secure Remote Access VPN Solution; Need your files on more than one computer?; <<https://web.archive.org/web/2004104031510/http://www.foldershare.com:80/>>; Nov. 4, 2004.

FolderShare—Secure Remote Access VPN Solution; Need your files on more than one computer?; <<https://web.archive.org/web/20041117092357/http://www.foldershare.com:80/>>; Nov. 17, 2004.

FolderShare—Secure Remote Access VPN Solution; Need your files on more than one computer?; <<https://web.archive.org/web/20041123085254/http://www.foldershare.com:80/>>; Nov. 23, 2004.

FolderShare; Your Files Anywhere; <<https://web.archive.org/web/20031128143634/http://foldershare.com:80/>>; Nov. 28, 2003.

FolderShare; Your Files Anywhere; <<https://web.archive.org/web/20031001071631/http://foldershare.com:80/>>; Oct. 1, 2003.

FolderShare—Secure Remote Access VPN Solution; Need your files on more than one computer?; <<https://web.archive.org/web/20041012083127/http://www.foldershare.com:80/>>; Oct. 12, 2004.

FolderShare—Secure Remote Access VPN Solution; Need your files on more than one computer?; <<https://web.archive.org/web/20041029085820/http://www.foldershare.com:80/>>; Oct. 29, 2004.

FolderShare—Secure Remote Access VPN Solution; Need your files on more than one computer?; <<https://web.archive.org/web/20040901034646/http://www.foldershare.com:80/>>; Sep. 1, 2004.

FolderShare—Secure Remote Access VPN Solution; Need your files on more than one computer?; <<https://web.archive.org/web/20040909075254/http://www.foldershare.com:80/>>; Sep. 9, 2004.

FolderShare; Your Files Anywhere; <<https://web.archive.org/web/20030920051943/http://www.foldershare.com:80/>>; Sep. 20, 2003.

FolderShare—Secure Remote Access VPN Solution; Need your files on more than one computer?; <<https://web.archive.org/web/20040924032146/http://www.foldershare.com:80/>>; Sep. 24, 2004.

\* cited by examiner

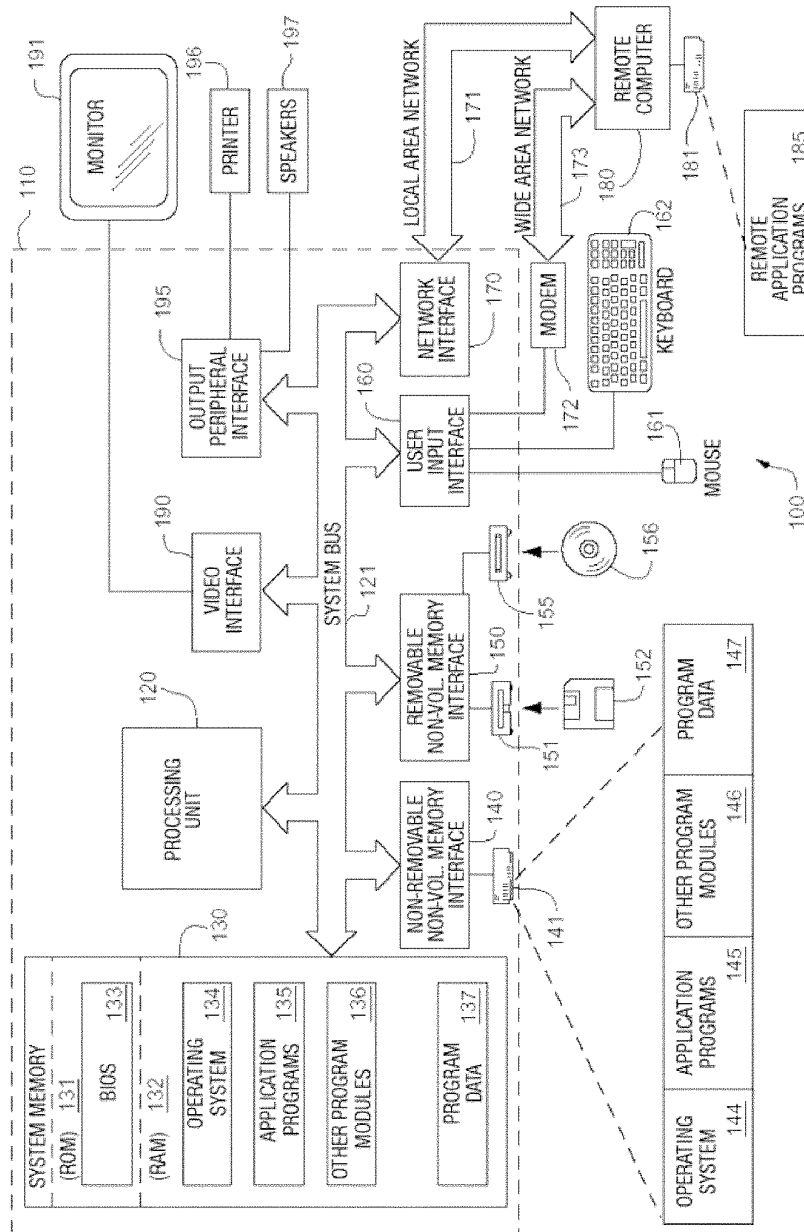
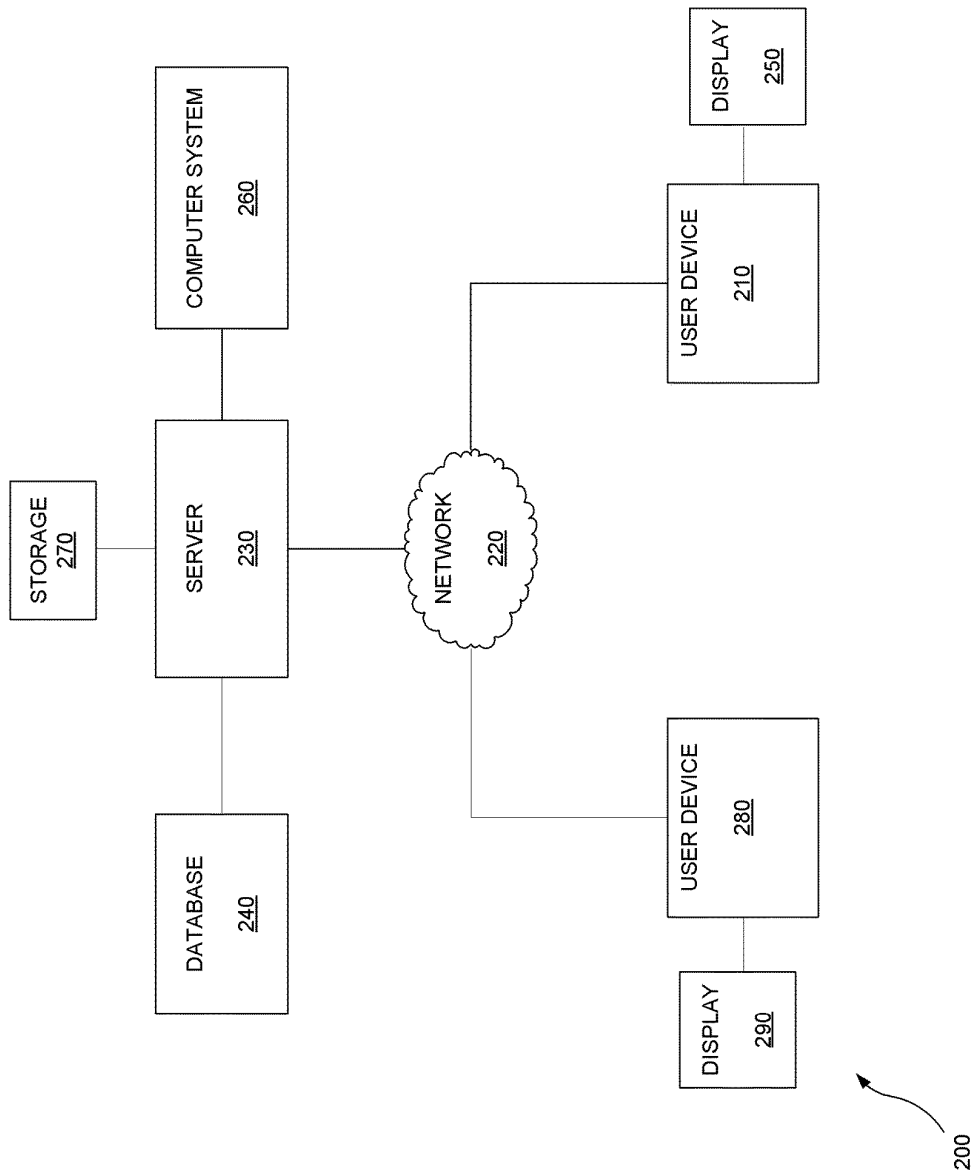


FIG. 1



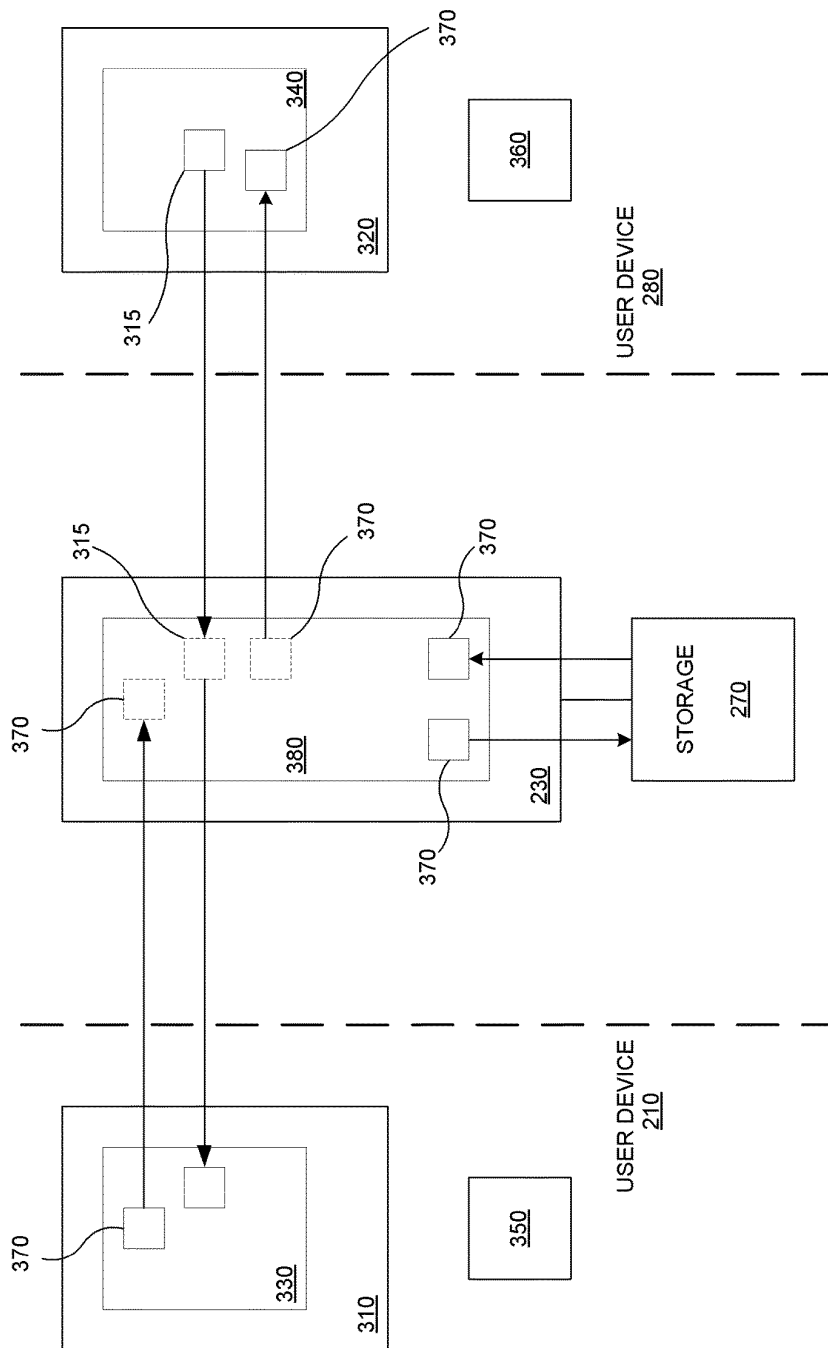


FIG. 3

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## ARCHITECTURE FOR MANAGEMENT OF DIGITAL FILES ACROSS DISTRIBUTED NETWORK

### CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 12/267,852, filed Nov. 10, 2008, which claims priority to U.S. Provisional Application No. 60/986,896 entitled "ARCHITECTURE FOR MANAGEMENT OF DIGITAL FILES ACROSS DISTRIBUTED NETWORK" and filed Nov. 9, 2007, the contents of which are hereby incorporated by reference in their entirety.

### FIELD OF THE INVENTION

This invention relates generally to computer-implemented processes and, more specifically, to sharing of electronic files among electronic devices.

### BACKGROUND OF THE INVENTION

Users of modern computing systems are increasingly finding themselves in constantly-connected, high-speed networked environments. The Web continues to be a killer application, second only to email, on the Internet. Further, customers are increasingly using more than one computing device; a customer may have a desktop computer at home, one at work, and a constantly connected "smart phone". Due to the confluence of these two trends, file management across these devices has become a problem.

Although modern devices are easily connected, they do not provide the customer a seamless environment; the customer must manually handle many aspects of that connection. With regards to file management, customers must manually move files between their devices using some protocol like email, ftp, or by posting them on the Web. These practices lead to problems that include:

The proliferation of redundant file copies. This proliferation creates a confusing environment where the customer is unclear where the "official" or newest version of a file exists.

The creation of an error-prone environment. Some documents, such as those associated with word processing and desktop publishing, externally reference other files. Copying such a document can break these references causing errors that the customer has to handle manually. An example of such a document is a desktop publishing document that contains a reference to an image. If that image file is not transferred along with the desktop publishing file, the image will appear as a broken link.

Unnecessary complexity. Because devices tend to have their own filing system, customers must manage a different filing model on each of his devices. For example, instead of having a single "Movies" folder, he may have to deal with many "Movies" folders, which may be in different locations on each of his devices. Each device may also have its own security model, further complicating the matter.

That a customer has to manually move files around to ensure their accessibility on his devices is unnecessary, and is an indicator of a lack of customer-focused design in modern file systems. File systems in use today are direct offspring of systems used when graphical customer interfaces were nonexistent. Modern file system customer inter-

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faces, such as Windows® Explorer and Mac OS X's Finder are just now starting to provide experiences that are more in line to a customer's workflow. Whereas, before, these interfaces were concerned with representing files with abstracted icons, the file's actual contents are becoming paramount in how files are organized and presented.

Problems still exist with how these newer customer interfaces are implemented. They are not completely integrated with applications, suffer from performance problems, and do not generally work well outside of a device's local file system.

There are several solutions to this problem that are in one way or another inadequate to the task:

Remote Desktop software allows a customer to remotely "see" his desktop. Remote desktop software screen-scrapes a remote machine's screen (a "server") and displays it on a screen local to the customer (a "client"). Remote desktop gives a customer access to not only his files, but also to his applications. However, this approach requires that the host machine be turned on and connected to the internet at all times. Consequently, this approach would not be appropriate for mobile hosts such as laptops. Remote desktop does not use the resources of a local machine. For full accessibility, the customer would have to keep all files and application on the host machine as any files stored on a client are not guaranteed to be accessible.

Distributed File Systems, like remote desktop software, place data on an always-connected host machine. Unlike remote desktop software, the host machine is not one on which the customer performs computing tasks. The host machine is used as a storage mechanism, and any computation performed on that machine serves to support its use as such. Distributed file systems generally provide the right functionality for customers to share files between their devices. However, distributed file systems are usually deployed as a shared resource; that is, other customers have access to it. Because of this sharing, a customer's files may be buried deep in a filing structure, and it may not always be immediately evident to customers what kind of access they have to a particular file. Further, to use a distributed file system, the customer must always be connected to it. Files stored on a distributed file system are generally inaccessible if the customer's machine is not connected to it, unless the customer has copied or moved the files to his machine's local hard drive. However, doing so immediately creates the problem of having two filing systems for the same file, creating a mental burden on the customer.

Additionally, accessing a file located on a distributed file system tends to be slower than accessing files on the local hard drive. Modern applications are usually written to assume that the files they access are located locally, and thus are not optimized to access remote files. When these applications are used with remote files, they can lose performance by an order of magnitude. This problem can be fixed by automatically caching often-used files on the local file system, and only synchronizing them when they have been changed. However, this separate synchronization step introduces another problem: because the synchronization process can be lengthy, the customer is never entirely sure if the file he is remotely accessing is the latest version of the file, versus an earlier one that has been marked to be updated. Further, the directory may not reflect the existence of the file at all until synchronization finishes.

FTP is similar to a distributed file system with regards to files being hosted on a remote server. However FTP generally does manifest as a "disk drive" on the customer's desktop; the customer must use special FTP client software

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to access an FTP server. It shares the same problem as distributed file systems, with the additional problem of weak integration with applications. Applications can generally write and read files directly to and from a distributed file system. This is not the case with FTP, as the customer has to manually use the client software to perform these operations as a separate task.

Email was originally invented for messaging. From the beginning, the model it employs to make files accessible remotely is necessarily inefficient. Email's model for making files accessible is in the form of an email "attachment". Attachments are so named because they piggy-back on a message sent from one customer to another. A customer can make a file remotely available using email by attaching the file to an email and sending it to himself. He can then retrieve the file from a remote location by accessing the message on the email server. Email used in this way is even worse than FTP as the process is even more manual: a customer must find the message containing the file before he can even access it. Further, the location in which the attachment lives is read only. If the customer, for example, were to open the file, change it, then save it back out, the results would be ambiguous to the user because the email application, not the user, specified its location. Usually, the saved file would end up buried in an email file cache in an undisclosed area of the file system.

Flash Drives and External Disk Drives, although seemingly the most "primitive" way to ensure file availability, avoid all the problems related to network latency. However, these devices must be physically connected to the computer on which the files will be accessed. These restrictions preclude the customer from employing several effective work-flows including: using more than one computer to complete a single task (the files can only be accessed on one computer) and setting up an automated backup (the computer running the backup can't guarantee that the storage device will be connected come backup time). Further, to ensure full availability of the files, the customer must carry the device with them at all times, and must follow the associated protocols for mounting and dismounting the device.

Other problems with the prior art not described above can also be overcome using the teachings of embodiments of the present invention, as would be readily apparent to one of ordinary skill in the art after reading this disclosure.

#### SUMMARY OF THE INVENTION

In an embodiment, a system includes a first application executable on a first electronic device. The system further includes a second application executable on a second electronic device in communication with the first electronic device. The second electronic device is configured to store a first electronic file. Subsequent to a user modifying the first electronic file, the second application is operable to automatically transfer the modified first electronic file, or a copy thereof, to the first electronic device. The system further includes a third application executable on a third electronic device in communication with the first electronic device. The third electronic device is configured to store a second electronic file. Subsequent to the user modifying the second electronic file, the third application is operable to automatically transfer the modified second electronic file, or a copy thereof, to the first electronic device. The first application is operable to automatically transfer the modified first electronic file or copy to the third electronic device, and auto-

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matically transfer the modified second electronic file or copy to the second electronic device.

#### BRIEF DESCRIPTION OF THE DRAWING

Preferred and alternative embodiments of the present invention are described in detail below with reference to the following drawings.

FIG. 1 is a schematic view of an exemplary operating environment in which an embodiment of the invention can be implemented;

FIG. 2 is a functional block diagram of an exemplary operating environment in which an embodiment of the invention can be implemented; and

FIG. 3 is a functional block diagram illustrating file sharing and/or synchronization according to an embodiment of the invention.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

An embodiment of the invention leverages remote programming concepts by utilizing processes called mobile agents (sometimes referred to as mobile objects or agent objects). Generally speaking, these concepts provide the ability for an object (the mobile agent object) existing on a first ("host") computer system to transplant itself to a second ("remote host") computer system while preserving its current execution state. The operation of a mobile agent object is described briefly below.

The instructions of the mobile agent object, its preserved execution state, and other objects owned by the mobile agent object are packaged, or "encoded," to generate a string of data that is configured so that the string of data can be transported by all standard means of communication over a computer network. Once transported to the remote host, the string of data is decoded to generate a computer process, still called the mobile agent object, within the remote host system. The decoded mobile agent object includes those objects encoded as described above and remains in its preserved execution state. The remote host computer system resumes execution of the mobile agent object which is now operating in the remote host environment.

While now operating in the new environment, the instructions of the mobile agent object are executed by the remote host to perform operations of any complexity, including defining, creating, and manipulating data objects and interacting with other remote host computer objects.

File transfer and/or synchronization, according to an embodiment, may be accomplished using some or all of the concepts described in commonly owned U.S. patent application Ser. No. 11/739,083, entitled "Electronic File Sharing," the entirety of which is incorporated by reference as if fully set forth herein.

FIG. 1 illustrates an example of a suitable computing system environment 100 in which one or more embodiments of the invention may be implemented. The computing system environment 100 is only one example of a suitable computing environment and is not intended to suggest any limitation as to the scope of use or functionality of the invention. Neither should the computing environment 100 be interpreted as having any dependency or requirement relating to any one or combination of components illustrated in the exemplary operating environment 100.

Embodiments of the invention are operational with numerous other general purpose or special purpose computing system environments or configurations. Examples of



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well known computing systems, environments, and/or configurations that may be suitable for use with the invention include, but are not limited to, personal computers, server computers, hand-held or laptop devices, multiprocessor systems, microprocessor-based systems, set top boxes, programmable consumer electronics, network PCs, minicomputers, mainframe computers, distributed computing environments that include any of the above systems or devices, and the like.

Embodiments of the invention may be described in the general context of computer-executable instructions, such as program modules, being executed by a computer and/or by computer-readable media on which such instructions or modules can be stored. Generally, program modules include routines, programs, objects, components, data structures, etc. that perform particular tasks or implement particular abstract data types. The invention may also be practiced in distributed computing environments where tasks are performed by remote processing devices that are linked through a communications network. In a distributed computing environment, program modules may be located in both local and remote computer storage media including memory storage devices.

With reference to FIG. 1, an exemplary system for implementing the invention includes a general purpose computing device in the form of a computer 110. Components of computer 110 may include, but are not limited to, a processing unit 120, a system memory 130, and a system bus 121 that couples various system components including the system memory to the processing unit 120. The system bus 121 may be any of several types of bus structures including a memory bus or memory controller, a peripheral bus, and a local bus using any of a variety of bus architectures. By way of example, and not limitation, such architectures include Industry Standard Architecture (ISA) bus, Micro Channel Architecture (MCA) bus, Enhanced ISA (EISA) bus, Video Electronics Standards Association (VESA) local bus, and Peripheral Component Interconnect (PCI) bus also known as Mezzanine bus.

Computer 110 typically includes a variety of computer readable media. Computer readable media can be any available media that can be accessed by computer 110 and includes both volatile and nonvolatile media, removable and non-removable media. By way of example, and not limitation, computer readable media may comprise computer storage media and communication media. Computer storage media includes both volatile and nonvolatile, removable and non-removable media implemented in any method or technology for storage of information such as computer readable instructions, data structures, program modules or other data. Computer storage media includes, but is not limited to, RAM, ROM, EEPROM, flash memory or other memory technology, CD-ROM, digital versatile disks (DVD) or other optical disk storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other medium which can be used to store the desired information and which can be accessed by computer 110. Communication media typically embodies computer readable instructions, data structures, program modules or other data in a modulated data signal such as a carrier wave or other transport mechanism and includes any information delivery media. The term "modulated data signal" means a signal that has one or more of its characteristics set or changed in such a manner as to encode information in the signal. By way of example, and not limitation, communication media includes wired media such as a wired network or direct-wired connection, and wireless media such as

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acoustic, RF, infrared and other wireless media. Combinations of any of the above should also be included within the scope of computer readable media.

The system memory 130 includes computer storage media in the form of volatile and/or nonvolatile memory such as read only memory (ROM) 131 and random access memory (RAM) 132. A basic input/output system 133 (BIOS), containing the basic routines that help to transfer information between elements within computer 110, such as during start-up, is typically stored in ROM 131. RAM 132 typically contains data and/or program modules that are immediately accessible to and/or presently being operated on by processing unit 120. By way of example, and not limitation, FIG. 1 illustrates operating system 134, application programs 135, other program modules 136, and program data 137.

The computer 110 may also include other removable/non-removable, volatile/nonvolatile computer storage media. By way of example only, FIG. 1 illustrates a hard disk drive 140 that reads from or writes to non-removable, nonvolatile magnetic media, a magnetic disk drive 151 that reads from or writes to a removable, nonvolatile magnetic disk 152, and an optical disk drive 155 that reads from or writes to a removable, nonvolatile optical disk 156 such as a CD ROM or other optical media. Other removable/non-removable, volatile/nonvolatile computer storage media that can be used in the exemplary operating environment include, but are not limited to, magnetic tape cassettes, flash memory cards, digital versatile disks, digital video tape, solid state RAM, solid state ROM, and the like. The hard disk drive 141 is typically connected to the system bus 121 through a non-removable memory interface such as interface 140, and magnetic disk drive 151 and optical disk drive 155 are typically connected to the system bus 121 by a removable memory interface, such as interface 150.

The drives and their associated computer storage media discussed above and illustrated in FIG. 1, provide storage of computer readable instructions, data structures, program modules and other data for the computer 110. In FIG. 1, for example, hard disk drive 141 is illustrated as storing operating system 144, application programs 145, other program modules 146, and program data 147. Note that these components can either be the same as or different from operating system 134, application programs 135, other program modules 136, and program data 137. Operating system 144, application programs 145, other program modules 146, and program data 147 are given different numbers here to illustrate that, at a minimum, they are different copies. A user may enter commands and information into the computer 110 through input devices such as a keyboard 162 and pointing device 161, commonly referred to as a mouse, trackball or touch pad. Other input devices (not shown) may include a microphone, joystick, game pad, satellite dish, scanner, or the like. These and other input devices are often connected to the processing unit 120 through a user input interface 160 that is coupled to the system bus, but may be connected by other interface and bus structures, such as a parallel port, game port or a universal serial bus (USB). A monitor 191 or other type of display device is also connected to the system bus 121 via an interface, such as a video interface 190. In addition to the monitor, computers may also include other peripheral output devices such as speakers 197 and printer 196, which may be connected through an output peripheral interface 190.

The computer 110 may operate in a networked environment using logical connections to one or more remote computers, such as a remote computer 180. The remote computer 180 may be a personal computer, a server, a router,

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a network PC, a peer device or other common network node, and typically includes many or all of the elements described above relative to the computer 110, although only a memory storage device 181 has been illustrated in FIG. 1. The logical connections depicted in FIG. 1 include a local area network (LAN) 171 and a wide area network (WAN) 173, but may also include other networks. Such networking environments are commonplace in offices, enterprise-wide computer networks, intranets and the Internet.

When used in a LAN networking environment, the computer 110 is connected to the LAN 171 through a network interface or adapter 170. When used in a WAN networking environment, the computer 110 typically includes a modem 172 or other means for establishing communications over the WAN 173, such as the Internet. The modem 172, which may be internal or external, may be connected to the system bus 121 via the user input interface 160, or other appropriate mechanism. In a networked environment, program modules depicted relative to the computer 110, or portions thereof, may be stored in the remote memory storage device. By way of example, and not limitation, FIG. 1 illustrates remote application programs 185 as residing on memory device 181. It will be appreciated that the network connections shown are exemplary and other means of establishing a communications link between the computers may be used.

Referring now to FIG. 2, an embodiment of the present invention can be described in the context of an exemplary computer network system 200 as illustrated. System 200 includes electronic user devices 210, 280, such as personal computers or workstations, that are linked via a communication medium, such as a network 220 (e.g., the Internet), to an electronic device or system, such as a server 230. The server 230 may further be coupled, or otherwise have access, to a database 240, electronic storage 270 and a computer system 260. Although the embodiment illustrated in FIG. 2 includes one server 230 coupled to two user devices 210, 280 via the network 220, it should be recognized that embodiments of the invention may be implemented using two or more such user devices coupled to one or more such servers.

In an embodiment, each of the user devices 210, 280 and server 230 may include all or fewer than all of the features associated with the computer 110 illustrated in and discussed with reference to FIG. 1. User devices 210, 280 include or are otherwise coupled to a computer screen or display 250, 290, respectively. User devices 210, 280 can be used for various purposes including both network- and local-computing processes.

The user devices 210, 280 are linked via the network 220 to server 230 so that computer programs, such as, for example, a browser or other applications, running on one or more of the user devices 210, 280 can cooperate in two-way communication with server 230 and one or more applications running on server 230. Server 230 may be coupled to database 240 and/or electronic storage 270 to retrieve information therefrom and to store information thereto. Additionally, the server 230 may be coupled to the computer system 260 in a manner allowing the server to delegate certain processing functions to the computer system.

Referring now to FIG. 3, illustrated is functionality of an embodiment of the invention allowing a user (not shown) who owns or otherwise controls devices 210, 280 to automatically maintain file synchronization between at least devices 210, 280, or any other user devices on which principles of the present invention are implemented. In an embodiment, an administrator (not shown) of the server 230 or other appropriate electronic device transfers a file-transfer

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and/or synchronization application to the user devices 210, 280 for installation thereon. Once installed on the user devices 210, 280, the file-transfer application provides file-transfer clients 310, 320 executable by the user devices 210, 280, respectively. Each of the file-transfer clients 310, 320 may, but need not, include a respective mobile-agent runtime environment 330, 340. The mobile-agent runtime environment 330, 340 include portions of memory of the user devices 210, 280 dedicated to allowing a mobile object the ability to perform operations that the mobile object is programmed to carry out. Also included in the file-transfer application are user interfaces 350, 360 that are displayable on the displays 250, 290, respectively. In an embodiment, the interfaces 350, 360 allow a user to view, access and/or organize files to be synched among the various user devices.

Generally, all files that the user desires to be synched or shared may at some point be uploaded by one or more of the user devices 210, 280 and stored in storage 270. Upon receiving the files to be synched, the server 230 can store such files in the storage 270 and/or transfer the files to one or more of the respective hard drives of the user devices 210, 280, thereby enabling each respective user device to access such files. In this manner, the server 230 is operable to treat each hard drive of the respective user devices 210, 280 as a local document cache for files received by the server. Typically, the server 230 will store one or more of the received files to the storage 270 only if the destination user device is offline or otherwise temporarily not in communication with the server 230. Upon resuming communication with the destination user device, the server 230 will transfer the temporarily stored files to the destination device.

In operation, according to an embodiment, the user may open and modify a file 370, such as a word-processing document or other electronic file. Alternatively, the user may create a first instance of the file 370. The user may have previously have associated, or may now associate, the file 370 with the transfer client 310. Upon a predetermined and user-configurable triggering event, the transfer client 310 transfers the modified file 370, or a copy of the modified file, to the server 230. Such a triggering event may include, but be not limited to, the user saving the file, the elapsing of a predetermined amount of time during which the file has been opened, or the re-initiation of a communication session between the device 210 and the server 230.

The file 370 is transferred to the server 230 on which is executing a synchronization application 380, which may include a mobile-agent runtime environment. Through user configuration, the synch application 380 monitors a set of user devices to which the file 370 should be transferred to effect file synchronization. In the illustrated embodiment, this set of user devices includes the user device 280. The synch application 380 polls the device 280 to determine whether the device 280 is in communication with the server 230. If the device 280 is in communication with the server 230, the synch application 380 transfers the file 370 to the device 280, whereupon the transfer client 320 resident on the device 280 replaces the previous version of the file 370, previously cached on the device 280, with the latest version of the file 370 modified on the user device 210. If the device 280 is not currently in communication with the server 230, the synch application 380 may store the file 370 in the storage 270 until such time as communication between the device 280 and server 230 is reestablished. As illustrated in FIG. 3, a similar reverse-direction synchronization process may be performed by the synch application 380 and the transfer clients 310, 320 with regard to a file 315 modified on device 280 and synchronized to device 210.

In an embodiment, the user interfaces **350**, **360** may include a list of the customer's documents and related metadata, as well as any one-to-one or one-to-many relationships between the documents and metadata. An embodiment can always provide customers with an accurate "picture" of their document collection, regardless of whether their devices physically contain the documents. As alluded to earlier, a problem with distributed file systems and FTP is the latency between a file being put onto a file system and it showing up on a remote machine. To prevent this problem, an embodiment directory is decoupled from the movement of files. An embodiment's directory update system updates at a higher priority than the documents to be synchronized. This feature ensures that when a customer browses or searches through his set of documents, they appear even if they have not yet been cached locally on the user device. An indicator signifying a document's availability may be prominently displayed adjacent to the document's representation so that customers are aware of the document's availability.

An embodiment may include a stand-alone application that allows customers to find and manage documents associated with transfer clients **310**, **320** by visualizing relationships between documents and their metadata. It allows customers to tag documents with any number of identifiers. Customers can relate both documents and tags with each other in any number of user-specified one-to-one and one-to-many relationships, and an embodiment provides a user interface to browse and search on these relationships. To mitigate the customers' learning curve, an embodiment can implement relationships common to contemporary file systems, including a folder hierarchy. In addition to this, an embodiment provides direct support for methods that the customer uses to organize documents by manifesting them as user interface idioms. This is unlike conventional document filing systems which require the customer to work within a strict folder metaphor for organization.

Some alternate methods that an embodiment supports for organizing documents include:

- Allow customers to organize their documents by application. Many times customers remember the application used to create a document instead of the document's name or its location in a hierarchy.
- Allow customers to organize their documents by most recent access. Customers are likely to access a document they've accessed in the near past. Usually, such documents are part of a task that the customer is actively working.
- Allow customers to organize their documents by project or subproject.
- Allow customers to organize their documents by people. Many times, especially in the context of a collaboration, a document is directly related to one or more people other than the customer.
- Allow the customer to organize their document by process stage. Documents may represent one or more stages of a process. Customers need a method for organizing documents by process stage, and a mechanism for moving the document through a set of predefined stages.
- Allow customers to organize their documents by any of the aforementioned methods concurrently. These organization methods are not mutually exclusive.

An embodiment presents an interface that allows a customer to locate one or more documents associated with the transfer clients **310**, **320** and open such document into a separate software application. Since this interface is intended to be used from within the separate application, that

application may need to know how to invoke such interface. Advantageously, this invocation behavior can be provided to the application using the application's plug-in API.

An embodiment presents an interface that allows a customer to synchronize a currently opened document according to processes described elsewhere herein. This interface can be invoked within an application and can be made available to the application in the manner described above in connection with the application's plug-in API.

Some files associated with the transfer clients **310**, **320** are dependent on other files associated with the transfer clients **310**, **320**. For example, a desktop publishing document may include images that are stored in files separate from the main document. Previous file-synching solutions treat these files as separate. Because of this, for example, a document synchronized from the device **210** to the device **280** may be opened by the user of the device **280** before the image files have been fully transferred to the device **280**. This causes the document to fail to open, or break, since the image files don't exist or are incomplete. An embodiment prevents this by: (1) always ensuring the file catalog (e.g., the stand-alone application that allows customers to find and manage documents associated with transfer clients **310**, **320**, as discussed above herein) is synchronized before any file data is synchronized, and (2) pausing any file access by any program until the file contents have been fully synchronized. In such an embodiment, if a user attempts, using a software program, to open a file whose related files haven't yet finished transferring to the local (hard drive) cache, if that software attempts to open the related files, the software program is blocked by an embodiment until the requested files are downloaded and ready to access.

Other file sending and synchronizing software requires the user to upload their data to a storage device owned by the operator of the service. An embodiment treats storage as a participant in the synchronization process; this means that the user can choose the service or device where their files will be stored. The file transfer/synching is abstracted from the storage system allowing any storage to be used. An embodiment treats storage like any other synch target, such as a desktop computer, or a cell phone. As such, any device owned or otherwise controlled by the user and running a synch application, such as synch application **380**, as provided in an embodiment of the invention can perform the storage and/or synching functions described elsewhere herein. That is, the user device **280** or user device **210**, rather than the server **230**, may perform such functions.

While a preferred embodiment of the invention has been illustrated and described, as noted above, many changes can be made without departing from the spirit and scope of the invention. For example, as an alternative to the approach described with reference to FIG. **3**, wherein the transfer clients **310**, **320** function to "push" modified or created files to the synch application **380**, the synch application **380** may instead function to periodically "pull" or otherwise actively retrieve such files from the transfer clients **310**, **320**. Instead, the invention should be determined entirely by reference to the claims that follow.

What is claimed is:

1. A system comprising:

a first electronic device, associated with a user, configured to:

receive, via a first application at the first electronic device, a copy of a modified first electronic file from a second application at a second electronic device associated with the user, wherein the modified first electronic file copy is automatically received from

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the second application responsive to the user modifying a content of the first electronic file;  
determine whether the first electronic device is in communication with a third electronic device;  
automatically send, via the first application, the modified first electronic file copy to a third application at the third electronic device responsive to the determination that the first electronic device is in communication with the third electronic device and responsive to receiving the modified first electronic file copy from the second electronic device;  
receive, via the first application, a copy of a modified second electronic file from the third application at the third electronic device associated with the user, wherein the modified second electronic file copy is automatically received from the third application responsive to the user modifying a content of the second electronic file;  
determine whether the first electronic device is in communication with the second electronic device;  
and  
automatically send, via the first application, the modified second electronic file copy to the second application at the second electronic device responsive to the determination that the first electronic device is in communication with the second electronic device and responsive to receiving the modified second electronic file copy from the third electronic device, wherein, responsive to sending the modified first electronic file copy to the third electronic device, an older version of the first electronic file stored on the third electronic device is automatically caused to be replaced with the modified first electronic file copy such that the modified first electronic file copy is stored on the third electronic device in lieu of the older version of the first electronic file, and  
wherein, responsive to sending the modified second electronic file copy to the second electronic device, an older version of the second electronic file stored on the second electronic device is automatically caused to be replaced with the modified second electronic file copy such that the modified second electronic file copy is stored on the second electronic device in lieu of the older version of the second electronic file.

2. The system of claim 1, wherein at least one of the second application or the third application comprises a runtime environment for mobile-agent objects.

3. The system of claim 1, wherein the first electronic device is configured to:  
store, via the first application, the modified first electronic file copy to a memory device associated with the first electronic device.

4. The system of claim 3, wherein the modified first electronic file copy is stored on the memory device associated with the first electronic device in lieu of an older version of the first electronic file copy that was stored on the memory device associated with the first electronic device.

5. The system of claim 3, wherein the modified first electronic file copy is stored on the memory device associated with the first electronic device responsive to a determination that the first electronic device is not in communication with the third electronic device.

6. The system of claim 5, wherein the first electronic device is configured to:  
responsive to resuming communication with the third electronic device, automatically transfer, via the first

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application, the modified first electronic file copy to the third electronic device to cause the older version of the first electronic file stored on the third electronic device to be replaced with the modified first electronic file copy.

7. The system of claim 1, wherein the second application is operable to create a first mobile object, and wherein the first mobile object is operable to create a proxy object at the first electronic device.

8. The system of claim 7, wherein the first mobile object is operable to provide the modified first electronic file copy to the proxy object.

9. The system of claim 8, wherein the proxy object is operable to store the modified first electronic file copy on a memory device associated with the first electronic device.

10. A method comprising:  
receiving, via a first application at a first electronic device, a copy of a modified first electronic file from a second application at a second electronic device associated with a user, wherein the modified first electronic file copy is automatically received from the second application responsive to the user modifying a content of the first electronic file;  
determining whether the first electronic device is in communication with a third electronic device;  
automatically sending, via the first application, the modified first electronic file copy to a third application at the third electronic device responsive to the determination that the first electronic device is in communication with the third electronic device and responsive to receiving the modified first electronic file copy from the second electronic device;  
receiving, via the first application, a copy of a modified second electronic file from the third application at the third electronic device associated with the user, wherein the modified second electronic file copy is automatically received from the third application responsive to the user modifying a content of the second electronic file;  
determining whether the first electronic device is in communication with the second electronic device; and  
automatically sending, via the first application, the modified second electronic file copy to the second application at the second electronic device responsive to the determination that the first electronic device is in communication with the second electronic device and responsive to receiving the modified second electronic file copy from the third electronic device,  
wherein, responsive to sending the modified first electronic file copy to the third electronic device, an older version of the first electronic file stored on the third electronic device is automatically caused to be replaced with the modified first electronic file copy such that the modified first electronic file copy is stored on the third electronic device in lieu of the older version of the first electronic file, and  
wherein, responsive to sending the modified second electronic file copy to the second electronic device, an older version of the second electronic file stored on the second electronic device is automatically caused to be replaced with the modified second electronic file copy such that the modified second electronic file copy is stored on the second electronic device in lieu of the older version of the second electronic file.

11. The method of claim 10, wherein at least one of the second application or the third application comprises a runtime environment for mobile-agent objects.

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12. The method of claim 10, further comprising:  
storing, via the first application, the modified first elec-  
tronic file copy to a memory device associated with the  
first electronic device.

13. The method of claim 12, wherein the modified first 5  
electronic file copy is stored on the memory device associ-  
ated with the first electronic device in lieu of an older  
version of the first electronic file copy that was stored on the  
memory device associated with the first electronic device.

14. The method of claim 12, wherein the modified first 10  
electronic file copy is stored on the memory device associ-  
ated with the first electronic device responsive to a deter-  
mination that the first electronic device is not in communi-  
cation with the third electronic device.

15. The method of claim 14, further comprising: 15  
responsive to resuming communication with the third  
electronic device, automatically transferring, via the  
first application, the modified first electronic file copy  
to the third electronic device to cause the older version  
of the first electronic file stored on the third electronic 20  
device to be replaced with the modified first electronic  
file copy.

16. The method of claim 10, wherein the second appli-  
cation is operable to create a first mobile object, and wherein  
the first mobile object is operable to create a proxy object at 25  
the first electronic device.

17. The method of claim 16, wherein the first mobile  
object is operable to provide the modified first electronic file  
copy to the proxy object.

18. The method of claim 17, wherein the proxy object is 30  
operable to store the modified first electronic file copy on a  
memory device associated with the first electronic device.

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