(54) Title: A SYSTEM FOR FAXING A PAPER DOCUMENT TO A PLURALITY OF RECIPIENTS AND ADDRESS TYPES

(57) Abstract: Software(4) is used for collecting the names and addresses of the sender and intended recipient(s) of a fax. The addresses may contain both numeric and alphabetic characters in a variety of forms. They are printed in a binary matrix on one or more 'Address Pages' which, together with a paper Document (6), are transmitted from Fax Machine (7) to Control Computer (12) where they are stored as Fax Image File (15). Extraction Software (16), extracts the data from the binary matrix. The resulting addresses are used by the Control Software (32) to transmit each recipient the Document File (18), representing Document (6), using transmission software appropriate to the type of recipient address. Encryption Software (27) may be used to ensure privacy of the contents of Document (6) during transmission. Receipt confirmations are provided to the sender if requested.
A SYSTEM FOR FAXING A PAPER DOCUMENT TO A PLURALITY OF RECIPIENTS AND ADDRESS TYPES

TECHNICAL FIELD

This invention relates to the transmission and delivery of facsimile copies of paper documents.

BACKGROUND ART

The use of fax machines for transmitting a facsimile copy of a paper document (hereinafter 'fax') to a remote recipient is widespread. Estimates indicate that in the year 2000 the number of pages transmitted from one fax machine to another probably exceeded half a trillion and the number of fax machines in use worldwide is believed to exceed 100 million. A fax machine is a device, which, at a given moment, can transmit a fax to just one destination. When faxes of the same original document need to be delivered to a plurality of recipients each must be transmitted separately, thus multiplying the transmission costs. Programming a fax machine for this task is complex and hence error prone. Most fax machines are shared by more than one user and this creates further problems such as costly manual fax distribution, delayed delivery to the recipient, delivery to the wrong recipient, lost or misplaced documents, and loss of privacy.

The growth of the Internet has spurred the widespread adoption of electronic mail for the transmission of text messages. For the cost of one local telephone call many messages may be sent anywhere in the world; copies of a single message can be sent to multiple recipients at no additional cost; the message arrives directly on the recipient's personal computer thereby avoiding the inefficiencies of manual distribution. Compared to faxing these are significant advantages. However, if a document contains hand-drawn sketches; hand-written annotations; signatures or other non-textual information; or if the character sets used are such that handwritten documents are preferred by the senders (e.g. Chinese characters); or if the only available copy of the document is in paper form; then a fax machine remains the simplest and most widely available transmission mechanism, hence its continuing success.

It is clear that many advantages could be obtained by combining the paper handling characteristics of fax machines and the low transmission costs, higher speeds and other advantages available with the Internet. As stated in WO 98/23082 (Anglin) "The problem of providing an easy, reliable and low-cost method for automatically routing and transporting
facsimile traffic at high speeds has presented a major challenge to persons skilled in the telecommunications field. In fact, a plethora of technologies have been tried but to be accepted and used a solution must be as simple and as reliable as regular faxing, and this has proved elusive. The following are examples of the various proposed technologies, some of which have received patent protection.

Fax Over Internet Protocol (FOIP) addresses the question of reducing or eliminating telecommunications charges by diverting fax machine to fax machine signaling from the telephone system to the Internet. They do this using special hardware interceptors and by emulating the real-time fax machine (T30) protocol using a packet switched network. E.g. US No 5,739,919 (Lee et al).

E-Mail to Fax Machine services and systems deliver e-mail messages from a personal computer to a fax machine. They are simple to use and have thus enjoyed widespread success.

Inbound Fax Routing using Direct Inward Dialing logically links a fax number to an e-mail address. (US patents 6,020,980 Freeman, 5,675,507 Bobo). Faxes sent from any fax machine to the recipient's number are converted to e-mail format by a receiving computer and forwarded to the recipient's e-mail address. Although useful to the recipient it has two significant drawbacks, firstly, the sender does not save telecommunications charges, and secondly, a massive increase in telecommunications investment would be required to provide a linked fax number for each of the world's e-mail addresses.

Inbound Fax Routing using paper-based, machine-readable data has been disclosed in US Patent No 5,461,488 (Witek). Optical Character Recognition (OCR) technology to interpret an email address printed on the fax cover page. OCR has significant reliability problems. For this to work in practice a list of valid destination addresses must be maintained on the receiving server to assist the address recognition process. This limits application of the technology to inbound fax routing where the server is used by a single entity such as a corporation, which can maintain a database of all its valid recipient addresses, and can provide personnel to manually route faxes when the OCR process fails. A single database containing all the world's e-mail addresses does not exist, thereby excluding the use of this technology for general purpose outbound fax routing.
The principal object of the disclosed invention is to permit the transmission of facsimile copies of paper documents from any fax machine to any type of address, whether alphanumeric, e.g. e-mail, or numeric only, e.g. a fax number, hence the further prior art discussion focuses on this question. We call this 'Outbound Fax Routing'.

Outbound Fax Routing using Special Equipment has received several patents. For example US 6,023,345 & 5,555,100 (Bloomfield) disclose interceptor devices attached to standard fax machines to re-route faxes over the Internet. US 5,862,202 (Bashoura et al) discloses a complete personal computer connected to a standard fax machine to intercept and re-route faxes to the Internet. In US Patent No. 5,881,233 a purpose-built Internet Fax Machine is disclosed. Essentially these mechanisms add to a standard fax machine an alphabetic keyboard for introducing e-mail addresses and software for accessing the Internet. Such devices have not been widely adopted, probably due to the increased complexity of operation when compared to regular faxing. In addition few fax machine users have the necessary knowledge to set up Internet connections. Additional problems are the inability to encrypt faxes sent to e-mail addresses and the absence or unreliability of e-mail receipt confirmation.

Outbound Routing with Addresses on a Fax Server is disclosed in US Patent No US 5,247,591 (Baran). Optical recognition of a handwritten code placed on a fax cover page prior to transmission is the essential element. The code indicates to the receiving fax server which of a plurality of pre-stored recipient lists indicates the recipients of the fax. This is complex and error prone for the user with serious risks if the wrong code is entered or the recognition software does not work well. Practical examples employing this approach could not be found. A somewhat different approach is disclosed in US Patent No 4,941,170 (Herbst). A set of special marks on the cover page of the fax are used by a receiving fax server to interpret the required routing information. The laborious and error-prone process of placing the marks in the correct place on the cover page has not found favor with users and practical examples employing this technology could not be found.

Outbound Fax Routing with Addresses on a Fax Server is also disclosed in US Patent No 5,838,461 (Hsieh). In this case the user or service operator pre-prepares a list of recipients (fax numbers or e-mail addresses) on a specialized fax server. Both the user and the list are provided with unique numeric identity codes. The list and the codes are saved in a database. The sender dials the server from a fax machine using its handset and, following recorded prompting from
the server, enters on the fax machine's keypad his or her identity code and the code of the recipient list. S/he then faxes the document to the server, which forwards it to the recipients on the list. The main problem with this method is complexity and it has not found favor with regular fax machine users although it is apparently used with some success by fax broadcasting services. Additional problems are the inability to encrypt faxes sent over the public Internet and the absence of any mechanism for confirming receipt of an e-mail message.

A method for Outbound Fax Routing using paper-based, machine-readable data is disclosed in WO 98/28302 (Anglin et al). Recipient fax numbers (only) are extracted from the fax cover page using Optical Character Recognition (OCR). Without the benefit of a pre-established database to aid the recognition process, as disclosed in US Patent No 5,461,488 (Witek), practical applications of this proposal would appear problematic, and no practical examples could be found.

A method for Outbound Fax Routing using paper-based, machine-readable data is disclosed in US Patent No 5,115,326 (Burgess et al). Here a bar code is printed on the first page of the fax using a personal computer. The bar code contains a destination e-mail address to be used by the receiving server for forwarding the fax to its final destination. A difficulty with this system is that the capacity of the bar code limits the number of recipients to one. Furthermore, bar codes are designed to be 'read' by specially designed devices, and present reliability problems when software is used to extract data from a fax image file. A major parcel service has deployed faxed bar codes for use in parcel routing. It has met with significant problems if the sender does not use a high quality laser printer. Practical working systems using this technology for fax routing over the Internet have not been implemented.

Methods for printing and extracting data in machine-readable form are disclosed in US 5,801,848 (Kafri) and US 5,337,362 (Gormish et al.). These patents disclose methods for storing data on paper but do not propose methods for fax routing.

As may be seen from this list many attempts have been made to provide an Outbound Fax Routing solution but none has met with widespread industrial or commercial success. Each suffers from one or more of the following problems that limit their usefulness and wide deployment:
(a) insufficient reliability to be commercially or industrially useful;
(b) too complex to be commercially or industrially useful;
(c) only one recipient per fax transmission;
(d) numeric addresses (fax numbers) only;
(e) faxes delivered to e-mail addresses are not private;
(f) requires the purchase of an interceptor device or a new fax machine.

DISCLOSURE OF INVENTION

According to the present invention a computer software prints on an 'Address Page', in machine-readable format, a list of addresses and fax numbers as entered by the sender. When the Address Page, together with a paper document, is sent from any fax machine to a computer server, facsimile copies of the paper document are routed by the server to the addresses and fax numbers.

The objects and advantages of this invention are:
(a) to provide a reliable method for transmitting facsimile copies of paper documents from any fax machine to any Internet address;
(b) to provide an easy-to-use method for transmitting facsimile copies of paper documents from any fax machine to any type of address;
(c) to provide a method for transmitting facsimile copies of paper documents from any fax machine to a plurality of recipients with no more than one transmission over the public switched telephone network;
(d) to provide a method for transmitting facsimile copies of paper documents from any fax machine to any mix of address types that may be, but are not limited to:
   - any standard fax machine attached to the global telephone system;
   - any Internet fax machine connected to the Internet;
   - any e-mail address on the Internet;
   - any Internet connected server running the File Transfer Protocol (FTP);
   - any Internet connected device running the Internet Print Protocol (IPP);
   - any Internet connected server running the Hypertext Transfer Protocol (HTTP)
   - addresses used for other secure, insecure or instant messaging systems;
   - addresses indicating storage locations in document processing systems;
   - addresses indicating storage locations in workflow or shared workspace systems;
addresses indicating storage locations in archival storage systems available for shared or private use, accessible over the Internet or using some other means;

addresses indicating storage locations in any other on-line or off-line system, wherein a fax may be stored and/or displayed and/or processed on the basis of the information in the machine-readable data;

(e) to provide a method for transmitting to an Internet address encrypted facsimile copies of paper documents sent from any fax machine;

(f) to provide a software-only method for transmitting faxes from any fax machine to any type of address.

An additional object of this invention is to enable an organization to maintain in compressed digital format a copy of all faxes transmitted from its fax machine(s) together with a digital record of the associated administrative information. This will enable corporations to gain control over outgoing faxing activities and their associated costs.

An additional object of this invention is to enable an organization to maintain in compressed digital format copies of all inbound faxes addressed to the organization's fax machines and Internet addressed devices and which are delivered to the organization using this invention.

An additional object of this invention is to permit an organization to offer its correspondents free long distance transmission of faxes directed to the organization's fax machines and Internet addressed devices.

It is a further object of this invention to permit the user to securely and privately transmit and receive encrypted faxes over the public Internet.

It is a further object of this invention to promptly confirm to the sender the successful reception of the document.

It is a further object of this invention to reduce or eliminate telecommunications charges for fax transmissions.

It is a further object of this invention to reduce or eliminate the costs and inefficiencies associated with the manual distribution of inbound faxes.
It is a further object of this invention to permit a user to send and receive e-mail messages using any regular fax machine.

5 It is a further object of this invention to permit users to send and receive messages and faxes to and from Internet addresses without themselves having access to the Internet.

A further object of this invention is the economical and ecological benefits obtained by reducing the overall quantity of paper consumed by the faxing process.

10 An appreciation of other aims and objectives of the present invention and a more complete and comprehensive understanding of the invention may be obtained by studying the following description of preferred and alternative embodiments and by referring to the accompanying drawings.

15 BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates, in a block diagram, a data processing system in accordance with the present invention; and

20 FIG. 2 illustrates, in a flowchart, a method for performing computerized routing and tracking of fax documents in accordance with the present invention.

It will be appreciated that for simplicity and clarity of illustration, elements illustrated in the FIGURES have not necessarily been drawn to scale.

BEST MODES FOR CARRYING OUT INVENTION

30 FIG. 1 illustrates a system used to automate fax 'broadcasting' from a fax machine to a variety of possible destination types.

FIG. 1 illustrates a fax machine 7. Fax machine 7 may be any fax machine capable of transmitting a facsimile copy of a document over a telephone network.
FIG. 1 illustrates a Document 6. Document 6 is any paper document whose characteristics are such that it can be transmitted using a fax machine 7. A facsimile copy of Document 6 is to be transmitted to one or more recipients whose addresses may be without restriction, numeric only addresses such as telephone numbers, Internet addresses such as those used for email or file transfer protocols, Universal Resource Indicators or any other address formulated by a combination of numbers, letters or other codes and characters.

FIG. 1 illustrates a computer 12. Control Computer 12 is any device that manipulates, stores, routes, or transmits data in any manner. In one form, computer 12 can be any computer that comprises one or more of a display screen, a keyboard, a mouse, or a CPU/Memory unit. In other forms, the computer 12 may be a micro-controller, a DSP, a micro-controlling unit, a plurality of microprocessors, a mainframe, a supercomputer, or any like computer device. Control Computer 12 has either external to it or internal to it access to a memory 13, illustrated in FIG. 1. Memory 13 is comprised of one or more of disk storage, tape storage, magnetic media, non-volatile memory, EPROM memory, EEPROM memory, FLASH memory, DRAM memory, SRAM memory, ROM, CD memory, computer memory, and/or any like memory system or device.

FIG. 1 illustrates a computer 1 with memory 2. The description for Computer 1 and Memory 2 is identical to the description for Control Computer 12 and Memory 13.

FIG. 1 illustrates a computer 26 with memory 29. The description for Computer 1 and Memory 2 is identical to the description for Control Computer 12 and Memory 13.

FIG. 1 illustrates a computer 50 with memory 51. The description for Computer 50 and Memory 51 is identical to the description for Control Computer 12 and Memory 13.

FIG. 1 illustrates a computer 56 with memory 54. The description for Computer 1 and Memory 2 is identical to the description for Control Computer 12 and Memory 13.

FIG. 1 illustrates a computer 71 with memory 72. The description for Computer 1 and Memory 2 is identical to the description for Control Computer 12 and Memory 13.
FIG. 1 illustrates a computer 77 with memory 78. The description for Computer 1 and Memory 2 is identical to the description for Control Computer 12 and Memory 13.

Computer 1 has connected to it a printer 3. The printer 3 may be a laser printer, an ink-jet printer, a dot matrix printer or any printer capable of printing images that are composed of printed dots at a density of at least 300 dots per inch.

Collecting Data (software program 4)

Within memory 2 is a data preparation and collection software program 4. Program 4 is generally used to enter or collect data pertaining to an intended facsimile transmission and print them using printer 3. These data may include personal details concerning the fax sender including name, address, fax and telephone numbers (as required by law), information concerning the recipients such as name, address, public encryption key and preferred encryption method, administrative information such as account, cost center or payment information for use by Control Computer 12 or information specific to the message such as the delivery priority to be used. These data may be entered manually by the sender or retrieved from a local or remote database or be the result of an automated data collection system, or any combination of these methods.

The Address Page(s) 5

The data are printed on Printer 3 to produce one or more Address Page(s) 5. The Address Page(s) 5 contain the data collected by program 4 in both human-readable and machine-readable forms. The human-readable portion is for reference only hence sensitive data such as credit card information need not be printed in the human-readable form. The machine-readable form is presented as a matrix of black (printed) and white (not printed) rectangles representing the data in a binary code. Black or printed matrix cells represent binary ‘1’ and white or unprinted cells represent binary ‘0’. This matrix is called the ‘Print Matrix’.

Preparing Data for Printing the Address Page (software program 4)

Prior to printing the Address Page 5 the Software Program 4 uses logical checks to verify the collected data, compresses them, and then encrypts them using the public encryption key of the Control Computer 12. (Public Key Encryption is a method of ‘scrambling’ or ‘encrypting’ data using a code or key that is specific to a recipient but need not be kept secret. The encrypting key or ‘Public Encryption Key’ is provided by the recipient to the sender. Only the recipient can
unscape' or de-encrypt the data using a secret code, or 'Private Encryption Key'. The recipient
may be a real person or a computer system.) The public encryption key of Control Computer 12
is a system constant. Also prior to printing an Address Page 5, and subsequent to compression
and encryption operations, the Software Program 4 embeds in the data error correction codes
that are calculated using the algorithms of Reed-Solomon, or Viterbi or a similar distributed
error correction code scheme. Also prior to printing an Address Page 5 the Software Program 4
manipulates the data in memory to form a digital representation or bitmap of the Print Matrix.

The Print Matrix (software program 4)

The Print Matrix is formed in such a way as to permit reliable extraction of the data by software
on the Control Computer 12. Faxing a document transfers to the receiving device digital images
of the document's pages in a compressed format. The document scanning and transmission
processes used during facsimile transmission may introduce irregularities in the digital images
of the pages. One or more irregularities may occur. 'Skewing' results when the scanned page is
not exactly perpendicular to the horizontal reading element in the fax machine. ‘Speckling’, the
apparently random introduction of dots that do not appear on the original page, can result when
the reading element of the fax machine is either dirty or faulty. ‘Speckling’ may also be
introduced by ‘line noise’ caused by sub-standard functioning of the analog telephone lines used
for fax transmission. The result is that the bitmap of the Print Matrix as received by Control
Computer 12 is rarely if ever an exact replica of the bitmap of the Print Matrix used by the
Software Program 4 to print Address Page(s) 5. Software Program 4 uses several methods to
facilitate error correction (not only error detection) and rapid extraction of the original data by
Control Computer 12. First, as mentioned above, error correction codes are introduced at
regular intervals into the data. The interval is a system constant, known to the extraction
software on Control Computer 12. The error correction codes can permit complete recovery
from the loss of substantial parts of the Print Matrix. Second, the position at which the matrix is
printed on Address Page 5 is a system constant, and therefore 'known' to the extracting software
in Control Computer 12. Typically it is positioned about one inch from the top of a page, with at
least ½ of an inch of white space on all sides. Third, every 8-bit word of binary data is
represented several times (5 times in the preferred embodiment) each representation having a
different binary format. Thus the first representation may be in the original binary format but for
successive representations a logical operator transforms the original 8-bit word. The logical
operators are system constants as is the sequence in which they are employed. The different
representations are arranged in the vertical plane to form a 'Byte Matrix' of printed and not
printed elements 8 positions wide and 5 positions (in the case of the preferred embodiment) deep. Fourth, the byte of data represented by the top left Byte Matrix in the Print Matrix is a system constant and is chosen such that the first data bit in the first row of the Byte Matrix is ‘1’ and therefore represented by a printed rectangle of black dots. Fifth, the dimensions of the Print Matrix are system constants, and ‘fill’ data are added as necessary. Sixth the dimensions (when printed) of the individual cells of the Print Matrix are system constants. The size of the printed cell is of crucial importance to successful transmission using a fax machine. When scanning a document fax machines create a digital representation or bitmap of the image printed on a page. To do this fax machines sense 200 elements of black or white paper per inch in the horizontal direction, repeating the sensing operation at regular intervals as the paper advances through the scanning device. If the width of the Print Matrix cell used when printing the Address Page is exactly, or is an exact multiple of, 1/200th of an inch, misreading of the Print matrix may occur. The exact positioning of paper being scanned by a fax machine relative to the fax machine’s reading element is variable. It is possible therefore that the paper may be so placed that light sources used by the fax machine’s reading element are exactly placed over the dividing line between black (printed) and white (not printed) cells of the Print Matrix. Under these circumstances the individual reading units can as easily report ‘black’ as ‘white’ and thereby produce ambiguous scanning results over the whole width of the paper. Hence the size of the matrix cell used when printing should be slightly larger or slightly smaller than a multiple of 1/200th of an inch so that when such positioning occurs it is not repeated over the entire width of the paper.

Faxing the Document

Document 6 may have a cover page, or a cover page may be printed using the program 4 or the Address Page 5 may be used as a cover page. In the preferred embodiment the Address Page 5 is not a cover page in the normal sense of the term. It is transmitted to the Control Computer 12 but not to the final recipients. The Address Page(s) 5 are placed on top of a Document 6 and together they are transmitted, as a single multipage fax document, using Fax machine 7. It is assumed that Document 6 is a pre-existing document. An automated system could also be established such that program 4 prints in alternation Address Pages followed by the document to be transmitted.

Receiving the Fax Transmission on Control Computer 12
FIG. 1 illustrates a modem 10. Modem 10 (a serial communication device) has an input, which is illustrated in FIG. 1 as being an analog phone line. In general, any compatible telecommunication or communication protocol may be used as input to the modem 10. The modem 10 can be any serial communication device that can interface data from a phone line, communication line, and/or network to a computer. The modem 10 can operate at any speed, from 300 baud to 28.8 baud or above. The modem 10 is coupled to a computer 12 via a serial computer interface. Any serial computer interface that is either parallel or serial in nature can be used for the serial computer interface in FIG. 1. Typically, the serial computer interface in FIG. 1 contains a plurality of conductors to either transmit a plurality of data bits, a plurality of control signals, and/or handshaking signals. A system may have a plurality of modems 10, which may be separate units or mounted together on a printed circuit board to form a single unit.

Creating a Fax Image File 15 (program 14)
Within memory 13 is a Fax Receipt software program 14. Fax Receipt Software 14 is generally used to receive data from the serial computer interface and store it into a Fax Image File 15. In general, the Fax Receipt Software 14 allows the computer 12 to simulate, or appear to be, a fax machine to any fax machine coupled to the modem 10 via the phone line. The Fax Receipt Software 14 is designed to primarily receive fax transmissions of the International Telecommunications Union (ITU) group III type. The Fax Image File 15 stores information received through the modem 10 and processed by Fax Receipt Software 14. In the preferred embodiment the Fax Image File 15 is stored in a format compliant with the ITU Recommendation T.37 for facsimile transmission over the Internet. Fax Receipt Software 14 will create Fax Image File 15 provided at least one page of the fax transmission is successfully received. The data in Fax Image File 15 typically represent a multi-page document composed of at least one Address Page 5 followed by one or more pages representing Document 6. Fax Receipt Software 14 also captures administrative data regarding a specific fax transmission that are passed to the Control Program 32 for storage in the Database File 17. These Administrative Data may include the time, date and duration of the transmission, the number of pages received, the identity code of the Fax Machine 7, the telephone number of the line to which the sending fax machine is attached (using ‘caller id’) and the telephone number of the line to which the modem 10 is attached, plus any error information. Other transmission forms and protocols may also be supported and recognized by Fax Receipt Software 14. Fax Receipt Software 14 also recognizes various fax and coding schemes, such as Huffman encoding, and can be used to communicate at any standard telecommunication speed such as 14.4 kBaud, 12 kBaud, 9.6
kBaud, 7.2 kBaud, 4.8 kBaud, 2.4 kBaud, etc. Also, the Fax Receipt Software 14 is coded to
dynamically and automatically match the transmission speed of the data coming in through the
modem 10. The Fax Receipt Software 14 has the primary purpose of receiving one or more fax
transmissions through the modem 10 and processing that fax transmission into a binary image
format stored in the Fax Image File 15, which can be subsequently processed. In some cases,
many faxed transmissions will be received in a short period of time and multiple Fax Image
Files 15 will be created. A Control Program 32 is typically used to monitor the Fax Receipt
Software 14 to ensure data is not lost and to correctly manage multiple files. The Fax Image
Files 15 may be prioritized either by time or by a fax transmission urgency rating selected by the
sender, or a like priority.

Creating the Document Image File 18 (program 16)
Once one or more Fax Image Files 15 have been formed via program 14, Data Extraction
Software 16 is used to process a Fax Image File 15. If more than one Fax Image File 15 exists
within memory 13 at one point in time, Control Program 32 determines via the priority scheme
discussed above, which Fax Image File 15 is processed in which order by the Data Extraction
Software 16. The Fax Image File 15 contains compressed binary images of both the Address
Page(s) 5 and the pages composing the Document 6. A function of the Data Extraction Software
16 is to remove the Address Page(s) from a Fax Image File 15 thereby creating a Document
Image File 18 representing the original Document 6 without the Address Pages added by the
sender.

Extracting Data from the Print Matrix (program 16)
A further function of the Data Extraction Software 16 is to extract from the binary representation
or bitmap of the Address Page(s) the data printed in the Print Matrix (ices) by the software 4 in
Computer 1. To extract the original data from each Print Matrix the Address Page image data
from the Fax Image File 15 are de-compressed and stored in Memory 13 in the form of a bitmap.
Fax machines scan documents at a fixed horizontal resolution of 200 dots per inch. The vertical
resolution may be either 150 dots per inch (standard mode) or 200 dots per inch (fine mode).
The resolution of a specific facsimile transmission is indicated to modem 10 and software 14
during receipt of the fax. It is then typically stored in a header as part of Fax Image File 15 by
Fax Receipt Software 14. When extracting the bitmap from the compressed binary image of an
address page the resolution for the bitmap should be 200X200 dots per inch. If the Fax Machine
7 was set to standard mode (200X150 dpi) for the transmission of the fax then it is necessary to
modify the resolution artificially. This is a standard operation that is performed by widely available standard de-compression software. The bitmap of the received Print Matrix in Memory 13 represents an image of the Address Page as scanned by the fax machine. Each ‘dot’ scanned by the fax machine is represented by one ‘bit’ in memory. If the scanner reported a ‘black’ the memory bit is set to ‘1’, if ‘white’ was reported the corresponding bit is set to ‘0’. To avoid confusion, in the remainder of this description the term ‘pixel’ will be used to represent a ‘bit’ of Memory 13 that represents a dot scanned by the fax machine. A bitmap of a letter size page is therefore 200 X 8.25 pixels wide and 200 x 11 pixels deep. The Print Matrix is composed of a number of directly adjacent Byte Matrices. In a Byte Matrix each ‘bit’ of data (‘1’ or ‘0’) is a cell of the matrix and will be represented in the bitmap by a square of pixels. The size of the cell, measured in pixels, is a system constant. In the remainder of this description the term ‘data bit’ will be used when referring to a cell of the Byte Matrix. The purpose of Data Extraction Software 16 is to extract the data represented by the Print Matrix. The bitmap of the received Print Matrix is rarely if ever an exact replica of the bitmap of the Print Matrix used by the Software Program 4 to print Address Page(s) 5. It is therefore necessary for Data Extraction Software 16 to first accurately locate the Print Matrix within the bitmap in Memory 13 using the system constants to assist the search. The co-ordinates of the top left corner of the Print Matrix relative to the top and left side of a printed Address Page are system constants as are the width and depth of the print matrix. These co-ordinates are always the same for all Address Pages in the system, although they may vary from implementation to implementation. The Data Extraction Software 16 can use these co-ordinates to calculate an approximate starting position for searching the Address Page bitmap in memory 13 to locate the first Byte Matrix. Once located, the bitmap co-ordinates of the extremities of the Print Matrix may be calculated approximately. (Not exactly because the Print Matrix may be ‘skewed’ within the bitmap of the page.) The physical width of the Byte Matrix cell used when printing the Address Page is also a system constant permitting the calculation of the number of pixels that represent in the bitmap the width of a single cell or ‘data bit’ of the Byte Matrix. The Data Extraction Software 16 starts at the calculated started location and, using standard pattern searching techniques, searches the bitmap row by row until it locates the leftmost and topmost occurrence of a row of pixels set to ‘1’ with the same width as the calculated pixel width of the Byte Matrix cell, plus or minus one pixel. The software may then proceed to locate the remaining pixels of the data bit of the first Byte Matrix. To facilitate this procedure a system convention may be established such that the first byte of data is always the same. This byte is redundant and is eliminated from the data at the end of the extraction process. The first data bit of this first byte must be ‘1’ by convention.
The software may then proceed to locate all the data bits (cells) of the first Byte Matrix using pattern matching techniques. The Data Extraction Software 16 should now apply to each row (5 in the preferred embodiment) of the Byte Matrix the reverse of the logical operation used by Software 4 when preparing the Byte Matrix. It is clear that the irregularities introduced by the scanning process means that not all rows will give the correct result but if at least 3 of the 5 rows give a result equal to the known conventional byte then the correct position of the first Byte Matrix has been located. If this does not give a positive result the test should be re- tried by shifting by one pixel the start location of the complete Byte Matrix. This should be repeated up to at least 4 pixels away from the original position, and in all 4 directions until the desired result (3 out of 5 rows give the conventional byte) is given. In the event a positive result is not obtained it is possible that the Address Page was fed into the sending Fax Machine 7 with the Print Matrix at the bottom of the page, that is, upside down. The bitmap of the Address Page is therefore inverted in Memory 13 and the search operation is repeated. If this is still unsuccessful the recognition procedure must be terminated. Using the first Byte Matrix as a starting point a similar process may be used to interpret every Byte Matrix that makes up the Print Matrix. For the remainder of the Print Matrix no conventional ‘known’ bytes are present, hence the test for a correct interpretation is that 3 out of 5 Byte Matrix rows give the same result. Interpretation should continue even if some subsequent Byte Matrices do not provide a positive result. When this process is complete the Data Extraction Software 16 will use the embedded error correction codes to recover any missing data. Only if this subsequent error correction process fails should the data extraction process be terminated. With a successful extraction of data from the Print Matrix the data may then be de-compressed and decrypted using the private encryption key of Control Computer 12. The extracted data are then passed to Control Program 32 for storage in Database File 17.

Distributing the Fax to the Recipients

The recipient addresses extracted from the Address Page 5 data and stored in the Database File 17 are used by the Control Program 32 to transmit the Document Image File 18 to each recipient or group of recipients using the transmission software appropriate to the type of recipient address. These softwares may include, but are not limited to, Fax Transmit software 19; Internet Print Protocol Software 22; Secure Web Server Software 25; File Transfer Protocol Software 31 and Email protocol Software 30. To keep private and secure the content of Document Image File 18 during its transmission over the public Internet Encryption Software 27 will ‘scramble’ the file using either the recipient’s or the receiving computer’s public encryption key.
Transmitting the Fax to a nearby Fax Machine 21
Where an address is a fax number, the location of the recipient is indicated by the country and area codes entered by the sender using data collection software Program 4. If a recipient address indicates a local fax number (i.e. geographically close to the physical location of Computer 12) then the Document Image File 18 is passed to the Fax Transmit Software 19 for transmission to the recipient’s Fax Machine 21 via modem 20.

Transmitting the Fax to a geographically remote Fax Machine 61
If a recipient address indicates a remote fax number then the Control Code may consult a least-cost information database to determine the Internet Address of a remote Computer 50 enabled with Fax Transmit Software 59. Having encrypted the Document Image File 18 using Encryption Software 27 and Computer 50’s public encryption key, the Encrypted Image File 28 together with the recipient(s) fax number(s) is transmitted, using File Transfer Software 31 or Email Software 30, to Computer 50 where it is decrypted using software 57 prior to transmission to receiving Fax Machine 61 via Modem 60 and Fax Transmit Software 59. Computer 50 then reports to Computer 12 details and/or error information regarding the transmission.

Transmitting the Fax to an Internet Print Protocol Device
Where the address type indicates an Internet Print Protocol device then the Document Image File 18 is passed to Internet Print Protocol Software 22 for transmission to the recipient’s Internet Print Protocol Device 23 that will initiate automatic printing on the recipient’s Printer 24.

Transmitting the Fax using the Internet File Transfer Protocol
If the address type indicates the File Transfer Protocol the Document Image File 18 may optionally be encrypted using Encryption Software 27 and Computer 50’s public encryption key obtained from the data collected by Software Program 4 or from of a public directory. The file is transferred over the Internet to the file transfer protocol server software 53 on Computer 50 and may be accessed by whoever has the authority, for example Computer 77 running file transfer protocol client software 79. An alternative is to transfer the file direct to a computer 71 running file transfer protocol server software 73 for the exclusive attention of the recipient in which case it should be encrypted using the recipient’s public encryption key.

Transmitting the Fax to Email Addresses
If the address type indicates Email the Document Image File 18 may be delivered in one of several different ways. For the content of the file to remain private it must be encrypted with the recipient's unique Public Encryption Key using Encryption Software 27. In the preferred embodiment the recipient's public encryption key will have been provided by the sender as part of the data entered with Software Program 4 and extracted by Data Extraction Software 16. If the sender requests encryption but does not provide the recipient's Public Encryption Key it may be obtained from Database 17 or from some other source such as a public Internet directory. If it is still unavailable then Computer 12 can generate both a private and a public key for the recipient. The private key is then communicated to the recipient by a separate email message together with the recommendation that it be changed immediately after use and that the sender be advised of the new Public Encryption Key. The new Public Key should also be registered in an appropriate directory, which could be Database File 17 updated via Secure Web Browser 33 and Secure Web Server 25. Three email delivery methods are described and they may all co-exist within the same Computer 12 providing a choice of services to users.

Indirect delivery of Electronic Mail

Generally, email messages are delivered by the 'store and forward' method and a file such as the Document Image File 18 or the Encrypted Image File 28 is 'attached' to an email message and sent (using the 'Simple Mail Transfer Protocol') to a Computer 50 equipped with Email Server Software 52. Email Server Software 52 delivers a copy of the message to the mailbox of all the recipients whose addresses are on the Computer 50. The user may retrieve the message from the mailbox using for example Computer 56 equipped with email client software 49, plus suitable decryption, fax viewing and printing softwares that allows the recipient to conveniently process Document Image File 18 or Encrypted Image File 28. The Email Server Software 52 removes from the list of recipients the addresses to which copies of the message have been delivered and then directly or indirectly forwards the message to other 'Mail Servers' following a routing scheme common to the Internet. These 'Mail Servers' operate in a similar manner delivering copies of the message to 'their' users and removing them from the recipient's list. The process continues until all the email messages are delivered to the recipient's mailboxes. This method is later referred to as 'Indirect Delivery Email'.

Direct Delivery of Electronic Mail
An alternative method is for the Email Protocol Software 30 to deliver the email message containing Document Image File 18 or Encrypted Image File 27 directly to the Mail Server that holds the recipient’s mailbox. This method is later referred to as ‘Direct Delivery Email’. The advantage of this method for the present invention is that it enables reliable notification of deliver. The reason ‘Direct Delivery Email’ is not widely used is that the server, in this case Control Computer 12, must transmit the same message, together with any attached files, to every email server that services a mailbox in the recipient list, whereas with ‘Indirect Delivery Email’ a message with any attached files, and a complete list of recipients is transferred to the next server in a single transmission.

Web Delivery of Email
If the recipient has an email address with a specific domain name recognized by Control Program 32 as being served by Computer 12 then the Document Image File 18 may be stored in a Database 17. The recipient may then view the Document Image File 18 using a Computer 26 equipped with a secure World-Wide-Web Browser Software 33. In this case prior encryption of the Document Image File 18 is not required because secure versions of web server and web browser software's encrypt and de-encrypt (respectively) messages and files as they are transmitted. This method is later referred to as ‘Web Delivery Email’.

Notifications of delivery and/or receipt of the Fax
The present invention permits a user of a regular fax machine to send a facsimile copy of a paper document to a wide variety of destinations types, including Internet addresses without the necessity of having access to the Internet. The sender must be provided with information concerning the success or otherwise of the transmission. Where the sender does not have Internet access delivery notifications are provided by a return facsimile transmission using Fax Transmit Software 19, which for sending notifications will be connected to the sender’s fax machine. The sender with Internet access may also choose, additionally or alternatively, to receive notifications via email, having entered the address in the Program 4, or via access to the Database File 17 using the Secure Web Server Software 25. A further user choice, indicated by the data entered in Program 4, is to receive a notification for every transmission to every recipient, or only receive notification of those deliveries that are known to be unsuccessful. For the purposes of this invention ‘delivery’ is considered to be complete when Document Image File 18 or Encrypted Image File 28 is delivered to a device at the recipient’s address. This is analogous to a regular mail delivery with return receipt or a fax transmission to a fax machine, in
both cases delivery to an address has been accomplished but there is no guarantee that the message has been read, or even received by the recipient. A ‘Delivery Notification’, positive or negative, is an indication that delivery to a device has taken place, or was not possible. A ‘Fax Notification’ positive or negative indicates that the recipient has processed, or was unable to process, the fax. A positive ‘Fax Notification’ confirms that an action authorized by the recipient has been taken leading either to printing or displaying the content of Document 6. A negative ‘Fax Notification’ indicates that the fax was retrieved from the recipient’s mailbox and an attempt was made to open it.

Failure Notifications
If the Data Extraction Software 16 fails to extract data from the Print Matrix, or if the Fax Image File 15 contains only Address Pages 5 and not Document 6 the sender is notified immediately by the return of the offending fax to the sender, with a cover page indicating the problem. This may be performed via Fax, Email or Secure Web Server softwares as requested by the sender.

Delivery Notifications
The present invention describes facsimile transmission to a number of address types. For each address type, with the exclusion of email addresses, the software employed to ‘deliver’ Document Image File 18 or Encrypted Image File 28 to the specified address can provide to Control Program 32 confirmation or otherwise of delivery to a device at the specified address. That is, successful transmission of the file to an address (not an individual) will be considered a successful delivery. The details of the transmission are passed to the Control Program 32 that prepares a confirmatory message for immediate transmission to the sender via Fax, Email or Web Server Softwares as requested by the sender. In the case of email three different delivery methods exist. Where File 18 is stored in Database File 17 for accessing by the Secure Web Server Software 25, and thereby made available to the recipient, a delivery notification may be immediately transmitted to the sender. Where File 18 is delivered direct to the mail server (Direct Delivery Email) that services the recipient’s email box, as described above, a delivery notification may also be provided immediately to the sender because Email Protocol Software 30 can provide this information. In the case of ‘Indirect Delivery Email’ a delivery notification may possibly be returned by the server servicing the recipient’s mailbox but not in all cases. This absence of reliable delivery confirmation is due to the fact that some ‘Mail Servers’ do not generate delivery notifications.
Fax Receipt Notification

Document Image File 18 is encrypted using Data encryption Software 27 and the recipient’s public encryption key. Email Protocol Software 30 transmits the file to Computer 50 as an Email attachment using either the direct or the indirect delivery method. When the recipient’s Computer 56 retrieves the message from the mailbox using standard email client software 49, the recipient will generally attempt to open the attached Encrypted Image File 28 in order to view its contents. The action of opening the attached file automatically starts a de-encryption Software. In order to proceed the recipient must provide the correct private key for de-encrypting the Encrypted Image File 28. As an integral part of the de-encryption software a Fax Notification is created and returned via email or file transfer protocol to Control Computer 12. Control Program 32, having stored the Fax Notification in Database File 17, may then forward it to the sender by the preferred method. On successful completion of the de-encryption process a document viewing software is automatically started and the decrypted file is displayed to the recipient. This Fax Notification method may be extended to delivery by File Transfer Protocol in the case where the final recipient is an individual (Computer 71) as opposed to a server (Computer 50) that makes the fax available to more than one recipient. A Fax Notification may also be generated by the Secure Web Server 25 at the moment when Document Image File 18 is opened by the recipient using a Secure Web Browser 33. In these cases also the Control Program 32 processes the Fax Notification and forwards it to the sender by the preferred method.

Unlimited Number of Addressable Recipients

In FIG. 1, several devices are illustrated via a combination of computer and fax machines. It is important to note that any number N of destinations, computers, or users or fax machines can be coupled to the Email Protocol Software 30, the File Transfer Protocol Software 31, the Secure Web Server Software 25, the Internet Print Protocol Software 22, the Fax Transmit Software 19 via the Internet or the telephone network wherein N is a finite positive integer. It should also be noted that although the devices indicated are either fax machines or computers it is possible that other, possibly special-purpose, devices may be used to perform similar functions.

The Control Program 32

The Control Program 32 will interact with one or more of software 14, 16, 19, 22, 25, 27, 30 and 31 to coordinate the execution of these software programs and to record information regarding the processes performed by computer 12. For example, Control Program 32 can prioritize, memory manage, and store Fax Image Files 15, Document Image Files 18 and Encrypted Image
Files 28 as they are processed by software 14 and Data Extraction Software 16 and Encryption Software 27. In addition, the Control Program 32 can communicate with the various software components to store in a database notification times, processing errors, information regarding destination identification, client payments and charges, delivery confirmations and notifications and time of transmission to recipients.

Log File 34 and Database File 17
Since the Control Program 32 functions as a coordinator for the entire system illustrated in computer 12, the control code contains valuable information as to the receipt and transmission of faxed documents. This information can be stored in a log file 34 and or Database File 17 for subsequent reference and future use. The log file 34 is generated by the Control Program 32 and has optional or required (depending upon a system set-up) entries for each fax received by the modem 10 and processed by the computer 12. The fax transmission will be logged so that the receipt and routing of the fax can be determined at a later date. The log file 34 will contain, per fax, information such as the time and date of receipt by the program 14, the time of the generation of file 15, any complications or information regarding the Data Extraction Software 16, the time the Encrypted Image File 28 was generated, the destinations determined by the code 16, the time and destinations transmitted by the e-mail program 30, user information from computers 26, and 71 when logging onto or accessing the computer 12, number of pages received per faxed transmission, the sender of the fax, telephone numbers, addresses, fax machine identity, public encryption codes, delivery notifications, and fax receipts from the delivery system and any other information which could be regarded as useful to a facsimile user or sender, or for the correct administration of the system.

Using Multiple Computers
FIG. 1 illustrates a system whose principal software components are contained within a single computer 12. Modern computer and networking technologies include multi-processor architectures that allow each software, 14 16, 19, 22, 25, 27 and 31 to be loaded in separate computers connected by high-speed data networks. This can permit load balancing of the various processes, by increasing the number of computers running any given software, and thereby avoid bottlenecks that may be created by one process being slower than the others. In addition such an ‘architecture’ enables processing to continue even in the event of the failure of one of the networked computers. Furthermore, using such techniques as Virtual Private Networking in which encrypted (‘scrambled’ and therefore private) data may be passed between
two computers over the public Internet, it is possible to arrange for some functions to be
geographically remote from the main Control Computer 12. This is of great importance to the
system illustrated in FIG. 1.

Fax Receipt Software 14 at a remote Location
For example, it is clear that a sender will prefer that the initial fax transmission, from fax
machine 7 to modem 10 is as inexpensive as possible. To achieve this it is possible to configure
a (smaller less expensive) computer exclusively for receiving fax transmissions with Fax
Receipt Software 14 and modem 10 and then to use an internet transmission protocol to transmit
the resulting Fax Image File 15 together with the control information concerning the fax
transmission to Control Computer 12 for the subsequent Data Extraction and Document
Distribution functions. This Internet Transmission would preferably take place over a Virtual
Private Network connecting the two computers, but could also function acceptably using email
or file transfer protocols with prior encryption of the Fax Image File 15 using the Public
Encryption Key of Control Computer 12. The remote computer may serve a geographic area and
be made publicly accessible over the telephone system or placed within a building or campus
and connected to the internal telephone system, to be at the exclusive disposition of the fax
machine users within the serviced organization. It will be appreciated that such an approach can
make the system readily available to fax machine users in all parts of the globe.

Eliminating Long Distance Telephone Charges
It is also clear that this remote computer, when equipped with a plurality of modems 10 may be
configured to simultaneously perform the functions of fax receipt (Fax Receipt Software 14) and
fax transmission (Fax Transmit software 52). This enables fax delivery by means of an
inexpensive local telephone call (free if delivered via an internal telephone system), thus
eliminating long distance charges from the delivery of faxes received by Control Computer 12
and destined for the geographical area, or organization serviced by the remote system.

Receiving Email and transmitting to Fax machines
FIG 1 illustrates a system whose principal object is to allow the user of any fax machine to
transmit a document to multiple recipients with varied address types with no more than a single
telephone call. But a system such as this may, with the addition of appropriate software modules
be extended to provide fax machine users with their own email address and mailbox and receive
email messages that are converted for facsimile transmissions to be delivered by Fax Transmit
Softwares 19 or 52. By this means fax machine users may enjoy complete two-way access to Internet messages without ever having direct access to the Internet.

The system illustrated in FIG. 1 has many advantages.

Transmitting a facsimile of a paper document from a fax machine to an Internet Address. Prior art includes several possible methods for transmitting faxes from fax machines to Internet Addresses. Several require modified fax machines or the connection of 'black boxes' of some kind connected to the fax machine. These may be: 're-dialers', 're-directors', 'interceptors', 'faxjacks' or in some cases complete personal computers. The present invention requires none of these. The only requirements are a fax machine, a telephone line and the availability of a personal computer with a printer. The personal computer may be completely 'free-standing' i.e. not attached in any way to the fax machine or to any other device or service except a printer. This is a substantial improvement over prior art.

'Broadcasting' (sending to a plurality of recipients) Faxes from a Fax Machine
Prior art faxing requires that recipients fax numbers are stored in the memory of the fax machine. The fax machine scans the document into memory and then makes separate transmissions to each recipient, multiplying the cost. The present invention makes one transmission only that includes all the addresses and fax numbers together with the document.

Unrestricted Addresses and Addressing
Some prior art presents superficial similarities to the present invention however the present invention provides substantial improvements over prior-art methods. First, the quantity of data that can be transmitted using an Address Page 5 is substantially increased (up to 100,000 bytes of data per page). The result is that the sender is no longer limited to a single addressee per fax transmission but can easily 'broadcast' the same document to multiple recipients each with a public encryption key (which can be rather long) as appropriate. In addition, ample space is available in a Print Matrix to transmit sufficient data to administer the user's account and transmit confidential information such as payment authorizations, private encryption key for file encryption and digital signing by the Control Computer 12. Second, the reliability of the method of printing and extracting data is such that a 'control list' of pre-defined addresses stored in a database in the Control Computer 12 is no longer necessary for address recognition, as is required by some prior art. Instead of limiting the recipients to a particular organization the fax
sender has the possibility of broadcasting Document 6, without any restrictions, to any of the millions of fax machines and Internet addresses worldwide.

Fax machine users tend to be uncomfortable with email for two reasons, confirmation of receipt and privacy. In both cases the system illustrated in FIG. 1 provides substantial improvements over prior art.

Fax Delivery Notification.
Generally, fax machine users get immediate feedback on the successful (or otherwise) delivery of the document to the receiving device. This tends to give the sender the (often false) impression that the intended recipient has received the fax. In fact, faxes are delivered to a device at a specific address, and the sender has no way of knowing if the intended recipient has received it unless the recipient takes the action of informing the sender by some means, or the sender contacts the recipient for confirmation. Thus there are two levels of notification. The first is a 'delivery notification' provided by the receiving device, and for regular fax transmissions this is immediate. The second is a 'confirmation of receipt' from the recipient. Fax delivery over the Internet, as with delivery of desktop computer generated faxes delivered by a fax server, employs store and forward techniques and a 'delivery notification' confirming delivery to the addressed device can never be truly immediate. By using the 'Direct Delivery Email' method for delivering faxes the present invention ensures the speedy return of a delivery notification to the sender. This is a substantial improvement on prior art where the sender of a fax to be delivered by email could never be sure that the fax was in fact delivered.

Fax Notifications
Using a Fax Notification, as described above, as a 'confirmation of receipt' provides a further substantial improvement over prior art. A Fax Notification is generated when the recipient 'opens' the Encrypted Document File 28 for viewing or printing. If the document was encrypted using the recipient's public key, then it can only be opened by the intended recipient using the corresponding private key that is known only to the recipient. A positive Fax Notification is generated and transmitted only after the successful decryption of the fax image file, thereby providing ample demonstration to the sender both that the intended recipient has received the fax and that the file has been successfully opened. If decryption is unsuccessful the sender receives a negative Fax Notification. This is a confirmation that the fax has been retrieved from the recipient's mailbox and that an attempt has been made to open the file. A negative 'Fax
Notification’ may also be interpreted as a warning that someone is attempting to read private communications. The sender may wish to communicate this warning to the recipient by some other means. Fax Notification has the added advantage that it works equally well for Indirect Delivery Email, Direct Delivery Email, File Transfer Protocol to an individual recipient and for delivery using a Secure Web Server as described above. In the latter case the recipient uses a password to access the fax and is thereby providing confirmation both of receipt and the identity of the recipient. The ‘Fax Notification’ of the present invention very substantially improves on prior art, both when compared to systems of fax delivery by email and when compared to fax delivery over the telephone system.

Privacy
Fax machine users are uncomfortable with the perceived absence of privacy when sending information over the Internet but tend to overlook the deficiencies of regular faxes that are, after all, transmitted ‘in the clear’. It is technically simple to intercept regular fax transmissions on the public telephone system, but it is illegal and inconvenient and is generally believed to be a rare occurrence. Fax machines are usually shared by many users all of whom may see each other’s faxes. Illegal interception is much easier after the fax has been printed on the receiving machine. Some Internet Protocols such as Internet Print Protocol and Secure Web Server protocols are more secure than regular faxes as they automatically encrypt and de-encrypt data as it is transferred over the Internet. Intercepting email transmissions over the Internet is, however, very easy, and can be easily automated. The invention illustrated in FIG. 1 uses email protocols for delivery direct to the recipient’s desktop, which need not be publicly accessible, whilst ensuring the content of the fax remains private during transfer over the public Internet. In this way only the intended recipient can view the content of the fax. The system may be extended to digital signing of the encrypted document to provide proof of the sender’s identity. The privacy achieved by the invention illustrated in FIG.1 is a substantial improvement over prior art faxing.

Permanent Copies
In prior art faxing, many organizations make photocopies of all outgoing faxes prior to transmission. Also in prior art faxing, many organizations make photocopies of all incoming faxes prior to physical distribution. Many organizations do both. The system illustrated in FIG. 1 renders this unnecessary as a complete and permanent record of all outgoing faxes passing through the system may be maintained and may be provided to senders and recipients on
inexpensive permanent storage media such as CD-ROM. This is a substantial improvement over prior art.

Costs

Many organizations that use fax machines do not know how much it costs and hence have little or no control over this activity. This invention provides all the information necessary to bring costs under control.

Manual Distribution

In prior art the time required by support staff to log, copy and then distribute incoming faxes to their recipients is considerable. By using the system illustrated in FIG. 1 to provide secure delivery to the desktop, the time required to log and physically distribute incoming faxes is very significantly reduced compared to the prior art. When a fax is printed on paper in a prior art fax, the faxes need to be routed by human personnel and may be lost, routed late, or routed incorrectly. Once lost, routed incorrectly, or routed late, the fax can usually not be regained and resubmitted to its final destination. The system of FIG. 1 prevents this loss by storing the received fax permanently on disk or a like media and ensures that the fax will be routed to an end user in a timely, efficient, and secure manner. In addition, the system of FIG. 1 ensures extensive and proper logging of the receipt and communication of fax files without extensive human interaction.

Delivery free of charge to sender

When a fax is delivered to a recipient’s desktop, the receiving organization gains significant benefits. In the case where the present invention is offered as a public service it is in the interests of the recipient to encourage use of the invention by arranging with the supplier of the service that incoming faxes are paid for by the recipient. This may be achieved by maintaining on Control Computer 12 a database of client email addresses and fax numbers and identifying all incoming faxes destined for ‘known’ addresses. Delivery may then be arranged such that any charge is made to the receiving client’s account and not the sender’s. In the case where this ‘free to sender’ delivery is directed to a fax machine located at a remote server within an organization it will be necessary to associate some additional addressing information in the database in order to direct the fax to the correct server and internal telephone number. This is a further substantial advantage over prior art.
ALTERNATIVE PREFERRED EMBODIMENTS

Computer with Document Scanner or Similar Device used for Document Transmission.

In the previously described preferred embodiment the document transmitting device is a fax machine 7 connected to a telephone line. The same function can be served by a Computer equipped with a document scanner and a modem, or any similar, possibly purpose-built device, connected either to a telephone line or directly to the Internet via a broadband (high-speed data) network. The Personal Computer is programmed such that the Address Page(s) 5 and Document 6 are scanned and saved as a Fax Image File on the hard drive of the Personal Computer. The file is then transmitted to Control Computer 12 either to the Fax Receipt Software 14, by emulation of the fax transmission protocol, or to the Secure Web Server Software 25, the Email Protocol Software 30 or the File Transfer Protocol Software 31. In the latter two cases the Fax Image File may be encrypted prior to transmission using the Control Computer’s Public Encryption Key and software similar to Encryption Software 27 loaded in the memory of the transmitting Computer. The file is de-encrypted on receipt by Control Computer 12 using its Private Encryption Key. In all cases the Control Program 32 organizes the receipt of the incoming file such that a Fax Image File 15, and the associated transmission data as prepared by Fax Receipt Software 14 in the previous embodiment, may be subsequently processed following the sequence previously described and starting with Data Extraction Software 16. This method may be preferred in cases where an organization has a central fax transmitting office with multiple fax machines. A combination of high-speed document scanner, computer, and broadband Internet connection to Computer 12 can achieve document transmission speeds vastly superior to fax machines whose transmission speed is limited by the analog telephone line connection. This is a very substantial improvement on prior art.

The Sender has Internet Access

The preferred embodiment of the invention permits a sender to broadcast faxes to other fax machines and to Internet addresses without having Internet Access. Where the user has access to the Internet an alternative preferred embodiment is used. With Internet access using a Computer 26 and a Secure Web Browser 33 the user may transmit directly to Control Computer 12 the recipient address(es), and other data printed in the Print Matrix described in the previous embodiment. Under control of program 32 these data are stored in a Database File 17. Control Program 32 then assigns these data a unique identifying code, also saved in Database File 17. The unique identifying code is transmitted using Secure Web Server Software 25, to a Computer 26 where it is printed on an Address Page in a Print Matrix. An Address Page 5 and a Document
6 are then transmitted using a Fax Machine 7. The processing on Control Computer 12 follows the same sequence as the previous preferred embodiment with the exception that Data Extraction Software 16 will obtain from the Print Matrix on the Address Page a single unique code. This code is used by the Control Program 32 to obtain the previously stored (in Database File 17) recipient address data that are then used for distributing copies of Document Image File 18 or Encrypted Image File 28 to the requested destinations.

Alternative embodiments
The method and means for representing and transferring data in printed form as a ‘Print Matrix’, described in the preferred embodiment, has advantages of reliability and capacity over other potential methods. For example bar codes can be used to create systems that fulfill similar functions as described in the preferred embodiment, but with less reliability and with limits on the number of recipients that can be comfortably be serviced by one fax transmission.

OPERATION

FIG. 2 illustrates a flow chart that describes the operation of the system illustrated in FIG. 1. In FIG. 2, a step 100 is used to determine if a fax is incoming from modem 10 into the computer 12. If a fax is not currently being received by computer 12, the Fax Receipt software 14 may continue to poll the modem or watch the serial computer interface line for incoming information, or the computer 12 can selectively disable and enable the fax software in a periodic manner to enable time multiplexing of the processor within computer 12 so that other tasks may be performed other than waiting for a fax to come in along the serial computer interface. In the same way Email Protocol software 30 may receive incoming messages and, in step 130, filter those messages to determine the arrival of a Fax Notification. On receipt of a Fax Notification step 132 updates the Database File 17 and, if the sender requested positive notifications when entering data in Software 4 prior to the fax transmission, duly noted in Database File 17 by program 32, then the Fax Notification will be forwarded to the sender by Email Protocol Software 30 or Fax Transmit software 19. Once a fax transmission is identified as being received via the serial computer interface, a step 102 receives the fax via software 14. The fax is then saved either after receipt or during receipt to a Fax Image File 15 in a step 104. Once the file 15 in FIG. 1 is formed, a step 106 uses the software 16 to extract from the binary image of the Print Matrix on Address Page 5. A step 108 using software 16 checks the extracted data to determine if a valid recipient or destination or a plurality of valid recipients/destinations are
found and in step 110 checks the Image File 15 to determine that the document to be transmitted was not omitted by the sender. If any of the steps 106, 108 and 110 produces negative results the Step 112 determines if the sender's return address is available. If the result of step 112 is positive step 114 returns the complete Fax Image File 15 to the sender with an appropriate cover page indicating the problem, either via Fax or via email or by posting to Secure Web Server Software 25 for access by the sender. If the result of step 112 is negative the Fax Image File 15 is passed to a human operator for action. Where all three steps 106, 108, 110 result positive step 118 uses software 16 to separate the document image file 18 from the Fax Image File 15 and software 27 encrypts (if necessary) the Document Image File 18 to create Encrypted Image File 28 using the recipient's Public Encryption Key. In step 120 Control Program 32 uses the recipient address type to determine which of the softwares Fax Transmit Software 19, Internet Print Protocol Software 22, Secure Web Server Software 25, File Transfer Protocol Software 30 or Email Protocol Software 30 to use for transmission and then controls that this transmission does take place. During the steps 100-112 or after the steps of 100-120 have been executed, a step 122 updates the Database file with all the data which relates to the fax reception and transmission. Also in step 122 a copy of Document File 18 is saved in log file 34. After the fax is processed via step 122, step 100 is re-executed in order to process another fax received via the serial computer interface or step 132 is re-executed to process another Fax Notification received via email.

While the present invention has been illustrated and described with reference to specific embodiments, further modification and improvements will occur to those skilled in the art. For example, "software" or "program", as used herein, is any plurality of binary values or any executable, interpreted or compiled code that can be used by a computer or execution device to perform a task. This software or program can be written in any of several known computer languages. A "computer", as used herein, can mean any device that stores, processes, memorizes, manipulates, or performs like operation on data. A "modem" is any serial communication device that can be used for taking fax information and inputting the fax information into a computer. "Data", as used herein, may be any information coded in a binary format. The computer 56 herein may be any type of computer or destination that may not necessarily require display devices, user input devices, or hard drives. For example, an end-user or destination computer 56 may simply be a memory with a printer. It is to be understood, therefore, that this invention is not limited to the particular forms illustrated and that it is intended to cover all modifications that do not depart from the spirit and scope of this invention.
INDUSTRIAL APPLICABILITY

The reader will see that the system for transmitting facsimile copies of paper documents of the invention provides many advantages over prior art, being highly reliable, secure, easy to use, and efficient, bringing important financial advantages to the sender and positive consequences for world ecology by reducing the world's paper consumption. Furthermore the system has additional advantages in that:

- it permits the sender to choose from a wide variety of recipient address types;
- it permits the sender to transmit the copies of a document to a plurality of recipients of various types anywhere in the world with no more than one local telephone call;
- as a software-only solution it does not require the user to purchase any new or special equipment;
- it permits organizations large and small to gain control over their outbound faxing activities;
- it eliminates the costs and inefficiencies associated with the manual distribution of inbound faxes;
- it removes any necessity for scanning or photocopying of outbound and inbound faxes;
- it keeps the content of the faxes private both during their transmission over the Internet and on arrival at the recipient's address;
- it provides the opportunity for confirmed and non-repudiable delivery of the fax;
- it provides the sender the opportunity to send messages over the Internet from any fax machine in the world without requiring an Internet connection;
- it provides the opportunity for organizations to offer free faxing to clients, partners and correspondents.

While my above description contains many specificities, these should not be construed as limitations on the scope the invention, but rather as an exemplification of one preferred embodiment thereof. Many other variations are possible:
- Program 4 is described above as an independent computer program. The same functionality may be provided by embedding the program logic in a page on a world-wide-web site thereby making it available to anyone with an Internet connection and a world-wide-web browser;
- an enhancement to program 4 could allow the sender to include with the fax an additional text message that could be printed as a 'Data Matrix' and transmitted together with an 'Address Page'
thereby providing the opportunity to send an e-mail message without having Internet access, the paper document would be an optional attachment to the message;

- program 4 could also be used to digitally sign the message using the sender's private key and encrypt it using the recipient's public key, prior to printing it in a Data Matrix and faxing it to the computer 12;

- although the transmission from a fax machine to the control computer 12 cannot be encrypted it would be possible, for maximum security, to arrange the programming of the latter such that the image file in its various forms is never stored on the computer's hard disk drives in an unencrypted format;

- program 4 and Control Computer 12 can be programmed to permit delivery of messages and faxes via almost any secure messaging system from the simplest to the most secure and complex including those that use pre-established and confirmed identities for sender and receiver;

- program 4 and Control Computer 12 could be programmed to permit delivery of messages, faxes and delivery advice messages via any instant messaging system.

A further possibility exists for delivering the faxes in an entirely private manner to any e-mail address. A method would be to make the File 18 available on Secure Web Server software 25. The recipient is advised by regular e-mail that a private fax communication from the sender is awaiting pick-up at a specific location (URL - Universal Resource Location). Using any www browser enabled for secure transmission (HTTPS protocol) the recipient accesses the location and the File 18 is encrypted during the transmission between the control computer 12 and the recipient's browser 33. Control Computer 12 could be programmed to allow the recipient to set up a login procedure based on his/her e-mail address.

Thus the scope of the invention should be determined by the following claims and their legal equivalents, rather than by the example given.
CLAIMS

1. A data processing system for processing facsimile transmissions, the data processing system comprising:
a computer coupled to a printing device;
a memory portion coupled to the computer comprising:
a software for collecting data regarding an intended facsimile transmission and paper printing
said data in machine-readable form using the coupled printer;
a communication device having an input for receiving facsimile data from a communication line
and an output for providing the facsimile data;
a control computer coupled to the output of the communication device;
a memory portion coupled to the control computer comprising:
software for receiving the facsimile data from the communication device and storing the
facsimile data in a file;
software for storing data;
software for extracting from the file machine-readable data; and
software, which uses the machine-readable data to determine where to transmit the facsimile.

2. The data processing system of claim 1 wherein the machine-readable format is a binary matrix
composed of black (printed) squares and white (not printed) squares using a plurality of different
binary data encoding methods to repeatedly represent on adjacent lines or columns of the matrix
the same original data with the insertion of error correcting codes at intervals within the original
data.

3. The data processing system of claim 2 wherein the machine-readable data includes one or
more addresses of the recipients of the facsimile.

4. The data processing system of claim 2 wherein the software for collecting data transmits to
the control computer for storage in its memory a list that includes one or more addresses of the
recipients of the facsimile and the control computer returns to the software for collecting data a
code that identifies the list, such code being included in the machine-readable data.

5. The data processing system of claim 3 wherein the types of address to which the facsimile
may be transmitted include:
- an e-mail address;
- a fax number;
- a Universal Resource Location (URL) accessible using the file transfer protocol (FTP);
- a Universal Resource Location (URL) accessible using the hypertext transfer protocol (http);
- a Universal Resource Location (URL) accessible using the secure hypertext transfer protocol (https);
- a Universal Resource Indicator (URI) identifying an Internet print protocol (IPP) device;
- addresses used for other secure, insecure or instant messaging systems;
- addresses indicating storage locations in document processing systems;
- addresses indicating storage locations in workflow or shared workspace systems;
- addresses indicating storage locations in archival storage systems available for shared or private use, accessible over the Internet or using some other means;
- addresses indicating storage locations in any other on-line or off-line system, wherein a facsimile may be stored and/or displayed on the basis of the information in the machine-readable data.

6. The data processing system of claim 4 wherein the types of address to which the facsimile may be transmitted include:
- an e-mail address;
- a fax number;
- a Universal Resource Location (URL) accessible using the file transfer protocol (ftp);
- a Universal Resource Location (URL) accessible using the hypertext transfer protocol (http);
- a Universal Resource Location (URL) accessible using the secure hypertext transfer protocol (https);
- a Universal Resource Indicator (URI) identifying an Internet print protocol (ipp) device;
- addresses used for other secure, insecure or instant messaging systems;
- addresses indicating storage locations in document processing systems;
- addresses indicating storage locations in workflow or shared workspace systems;
- addresses indicating storage locations in archival storage systems available for shared or private use, accessible over the Internet or using some other means;
- addresses indicating storage locations in any other on-line or off-line system, wherein a facsimile may be stored and/or displayed on the basis of the information in the machine-readable data.
FIG. 2

100 IS A FAX INCOMING?

130 IS A FAX NOTIFICATION INCOMING?

132 UPDATE DATABASE FORWARD NOTIFICATION TO SENDER

114 RETURN FAX TO SENDER WITH EXPLANATORY COVER PAGE

112 IS SENDER'S FAX OR EMAIL AVAILABLE?

116 PASS FAX TO HUMAN OPERATOR

102 RECEIVE FAX

104 SAVE FAX AS FAX IMAGE FILE COPY FILE TO LOG SAVE DATA IN DATABASE

106 DOES FAX IMAGE FILE CONTAIN ADDRESS PAGE?

108 EXTRACT ADDRESSES

110 DOES FAX IMAGE FILE CONTAIN DOCUMENT?

118 PREPARE ENCRYPTED IMAGE FILE

120 TRANSMIT ENCRYPTED IMAGE FILE TO RECIPIENTS AND NOTIFY SENDER

122 UPDATE DATABASE WITH TRANSMISSION DATA AND SAVE DOCUMENT IMAGE FILE IN LOG FILE