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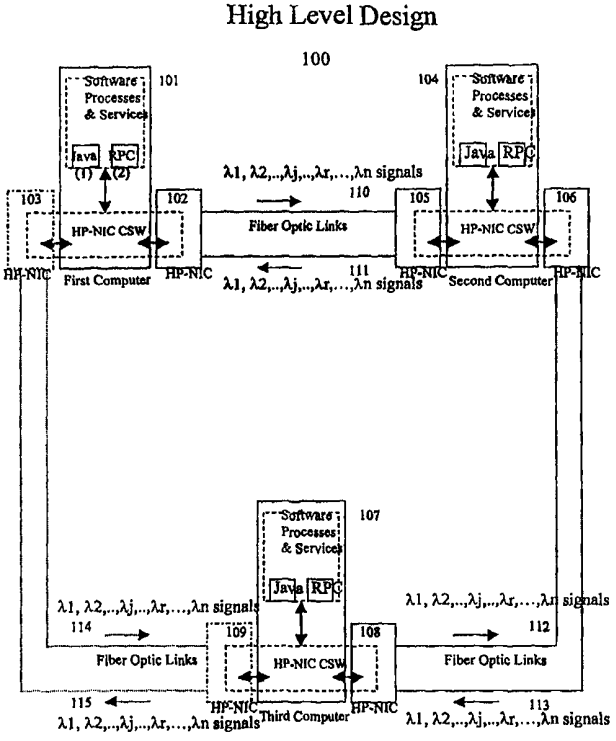
(54) Title: DEVICE, METHOD, AND SYSTEM FOR IMPLEMENTING QUALITY OF SERVICE ZERO LATENCY NETWORKS USING DENSE WAVELENGTH DIVISION MULTIPLEXING

(57) Abstract

A high performance network interface card (HP–NIC) (102) comprising a first interface that connects to a first computer (101), a second interface that connects to a second computer (104) via at least two fiber optic links (110, 111), an HP–NIC communications software (HP–NIC SW) that transfers information between the first computer (101) and the second computer (104). This transfer is accomplished by sending and receiving Dense Wavelength Division Multiplex (DWDM) Laser signals across the at least two fiber optic links (110, 111).



NOTES:
(Examples)
1. Java Code modules are transported using wavelength λj Laser signals
2. Remote Procedure Call (RPC) contents are transported using wavelength λr Laser signals

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Device, Method, and System For Implementing Quality of Service Zero Latency Networks Using Dense Wavelength Division Multiplexing

Background of the Invention

Field of the Invention

The present invention generally relates to Dense Wavelength Division Multiplexing (DWDM) over fiber optic media.

Related Art

What is needed is the capability to network computers at very fast speeds using Dense Wavelength Division Multiplexing over fiber optic media.

Summary of the Invention

The present invention includes a high performance network interface card (HP-NIC) comprising a first interface that connects to a first computer, a second interface that connects to a second computer via at least two fiber optic links, an HP-NIC communications software (HP-NIC SW) that transfers information between the first computer and the second computer. This transfer is accomplished by sending and receiving Dense Wavelength Division Multiplex (DWDM) Laser signals across said at least two fiber optic links.

According to another embodiment of the present invention, a computer network interface includes a high performance network interface card (HP-NIC) that links application computers using fiber optic links. The HP-NIC sends and receives Dense Wavelength Division Multiplex (DWDM) Laser signals to transport computer data bits and bytes to implement parallel independent communications of software services and processes using different wavelength

Laser signals. The HP-NIC also includes communication software that exchanges data between a computer and the HP-NIC. Furthermore, the HP-NIC enables transmission and reception of Laser signals to and from fiber optic links.

According to a further embodiment of the present invention, a method of communication of streams of data includes transporting streams of data associated with a software task, service, socket, daemon, software object access, and for an application or parts thereof. This transporting is performed by using, assigning and dedicating one or more Laser wavelength signals to each of the tasks, services, daemons, software object accesses, information streams, and applications or a part thereof, from among the wavelengths in the DWDM signals implemented in a HP-NIC card and the software that implements this method. The uniqueness of the invention is the mapping of the tasks, services, daemons, software object accesses, information streams and applications or a part thereof, that is, any higher layer (layer 4 and above) entities of the protocol stack to wavelengths as compared to the current designs and operations of routing or switching layer 3 network protocol layer or below. The present invention thus results in Quality of Service (QoS) by minimizing delays, delay jitter and delivery assurance of signals or information associated with end to end communications at higher layers of the protocol stack or streams. The present invention thus supercedes all existing networking techniques.

The present invention also includes a method to network computers and to switch, route and forward parallel independent data streams within and between the computers to implement very high performance 'zero latency' parallel processing networks, and software to implement the methods

An additional embodiment of the present invention includes a computer having an operating system connected to a HP-NIC includes an operating system. Examples of such operating systems include Microsoft Windows NT, Microsoft Windows 95, Microsoft Windows 98, several versions of UNIX operating system, as well as any mainframe operating system or platform. Examples of mainframe

operating systems and platforms include IBM VM 370, IBM MVS and IBM platforms.

Also, the present invention enables an HP-NIC to be connected to any future computer or electronic devices that can communicate using DWDM and/or software based communications.

According to yet a further embodiment of the present invention, computers connected to an HP-NIC may include distributed database management systems such as Oracle, DB2, Microsoft SQL server. Also, the present invention may comprise high speed disk arrays, CD juke boxes and other memory systems. Furthermore, these computer systems may include core network services such as Domain Name Service, Directory Systems, and other such core services.

Furthermore, an embodiment of the present invention implements common channel signaling networks such as Signaling System 7 and other Intelligent Network (IN) systems such as European Advanced Intelligent Network (AIN) systems.

Another embodiment of the present invention includes Packet over SONET (POS), and ATM over SONET (AOS) on the same fiber, but on different wavelengths.

Moreover, an embodiment of the present invention creates connection oriented communications at the network, socket or port, transport, session, presentation, and application process layers to implement Quality of Service (QoS) at these layers by monitoring and managing connections at these layers.

In addition, an embodiment of the present invention enables the automatic assignment of different wavelength DWDM channels to different data streams associated with software processes and services to implement recovery from failure and re-routing redundancy and back up communications extra capacity. The invention provides software to implement these features.

Furthermore, an embodiment of the present invention includes a Zero Latency Network Architecture (ZLNA) with very high performance and

independent communications between software process and services in computer systems.

Brief Description of the Figures

In the drawings, like reference numbers generally indicate identical, functionally similar, and/or structurally similar elements. The drawing in which an element first appears is indicated by the leftmost digit(s) in the reference number.

The present invention will be described with reference to the accompanying drawings, wherein:

FIG. 1 illustrates a computer communication system according to a preferred embodiment of the present invention; and

FIG. 2 illustrates an expanded network of computers according to a preferred embodiment.

Detailed Description of the Preferred Embodiments

Introduction

This invention relates to Dense Wavelength Division Multiplexing over fiber optic media to network computers at very fast speeds. In particular, this invention consists of a device, a method and a system for integrating software processes and services within computers for 'zero latency' communications between the processes and services using DWDM over fiber optic links. Examples of software processes and services that can establish and sustain zero latency communications between computers are distributed database access (DDA), remote procedure calls (RPC), file transfer protocol (FTP), telnet terminal access (telnet), simple mail transfer protocol (SMTP), other similar software daemons and sockets, user applications, and associated software tasks and threads.

Since computers were invented and came into use for information processing (circa 1955), they were enabled to communicate with one another in the following ways:

First, they were connected electrically by a data link, or using a modem over telephone lines, for transmitting data between them under a variety of protocols. These techniques evolved into modern local area networks and wide area networks. Because of the electro-magnetic phenomena associated with electrical transmission, these techniques were low to moderate in speeds, or limited in distance of the data link between computers.

Second, they were connected optically over optical fibers to send and receive data signals at faster rates under a variety of protocols. This resulted in communications at far higher speeds and over longer data link distances between computers. Additional advantages of fiber optic links include very low error rates in transmission, no interference from external signals, and enhanced information security.

Fiber optic communication technology initially used a single wavelength Laser light source over single or multi-mode optical fiber. The speed of fiber optic communications using single wavelength transmission are typically from 100 mega bits per second (MBPS) for fiber distributed data interface (FDDI) networks and Fiber Channels to 9.95 giga bits per second (GBPS) for synchronous optical network optical carrier 192 (SONET OC-192). Recently fiber optic communications using multiple wavelengths using a technology called Dense Wavelength Division Multiplexing (DWDM) have been introduced which has resulted in increasing the bandwidth on fiber optic links by a factor of up to 40 over the existing fiber optic cables. The DWDM technology has been implemented in fiber optic termination equipment such as fiber optic channel banks, cross-connects, and multiplexing equipment that combine and transmit a very large number of channels and circuits from telephone switching equipment such as central office switches, data communication equipment such as Internet Protocol (IP) routers and switches, television video switches, and asynchronous

transfer mode (ATM) switches. The DWDM technology has not been applied or implemented so far and incorporated in Network Interface Cards of computer systems to communicate between different software processes and services on different wavelength Laser signals.

The Invention

Reference will now be made in detail to an implementation of the present invention as illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used through out the drawings and the following description to refer to the same or like parts.

FIG. 1 depicts a computer communication system 100 using the device, the method, and the system consistent with the present invention. Computer communication system 100 includes first computer 101 connected to a High Performance Network Interface Card (HP-NIC) 102 via a bus interface. First computer 101 communicates to HP-NIC 102 via HP-NIC communication software (HP-NIC CSW), which is an integral part of HP-NIC 102 so that computer software (operating system as well as other software including application software) exchanges information with the HP-NIC communication software which in turn sends and receives computer data via HP-NIC 102, over fiber optic links 110 and 111. HP-NIC 102 receives and transmits computer data such as fiber optic signals encoded in different DWDM wavelengths, designated $\lambda 1, \lambda 2, \ldots, \lambda n$, of Lasers over the fiber optic link. At the other end of the fiber optic link, second computer 104 interfaces with fiber optic links 110 and 111 via its HP-NIC card 105. Second computer 104 thus sends and receives data encoded in different wavelengths to and from first computer 101 and the two computers communicate streams of data. By definition, a stream of data is the data associated with a software process or service, which is encoded in a selected wavelength, λi, of Laser from one computer to the other computer. It will be common and normal for the two computers to use the same wavelength Laser to

implement a full duplex circuit between an identical or complimentary software process or service in each computer. However, second computer 104 may communicate a stream of data for a given process or service using a different wavelength Laser signal to first computer 101.

Second computer 104 can have a second HP-NIC 106 connected to its bus and communicate over a fiber optic link to a third computer 107. First computer 101 may have a second HP-NIC 103 connected to its bus and communicate over a fiber optic link to third computer 107 using links 114 and 115 as shown in FIG. 1. Thus, first computer 101 can directly communicate to third computer 107 or can communicate via second computer 104 to third computer 107 in which case second computer 104 acts as a switch, a router or a gateway, depending on protocol layer at which data stream is processed and forwarded by second computer 104. By definition, if processing and forwarding is at the physical layer, the link layer or part of the network layer, second computer 104 works as a switch, if processing and forwarding is at the network layer, second computer 104 works as a router, and if processing and forwarding works at higher layers of communication protocol, then second computer 104 works as a gateway. This configuration becomes a network of computers and can be expanded by connecting multiple computers using multiplexers, switches, routers and gateways. This expanded embodiment of the invention is shown in FIG. 2

The invention includes expanding and extending the concept to a parallel Zero Latency Network Architecture (ZLNA) to route software processes and services in computers. A stream transported by a wavelength of Laser is associated with a specific software service, with a software process, or with a complimentary process (the term process is used as a general term and represents entities such as daemons, software tasks, software threads, etc). For example, all Remote Procedure Calls (RPC) will be transported over wavelength λr between one computer to another computer or even throughout the whole network so that all RPCs in the network will be associated with the designated λr. Thus RPCs have a dedicated bandwidth or capacity independent of any other kind of traffic

load. Similar associations can be made for FTPs, Distributed Database Access (DDA), Java downloads, and many other data streams. In highly time critical applications, even a single program thread communication or distributed access to an important object like a medical database can be streamed over a designated wavelength Laser signal.

The invention includes, for achieving robustness, that data streams can be assigned dynamically to different wavelength Laser signals to provide failure/recovery, redundancy and extra capacity for computer communications.

The invention enables distributed zero latency parallel computing for multi-processing, multi-threading, and multitasking computer platforms such as Windows NT, UNIX and other mainframe operating systems.

While various embodiments of the present invention have been described above, it should be understood that they have been presented by way of example only, and not limitation. Thus, the breadth and scope of the present invention should not be limited by any of the above-described exemplary embodiments, but should be defined only in accordance with the following claims and their equivalents.

What Is Claimed Is:

1. A high performance network interface card (HP-NIC) comprising:

a first interface that connects to a first computer;

a second interface that connects to a second computer via at least two fiber optic links;

HP-NIC communications software (HP-NIC SW), wherein said HP-NIC SW transfers information between said first computer and said second computer by sending and receiving Dense Wavelength Division Multiplex (DWDM) Laser signals across said at least two fiber optic links.

2. The system of claim 1, wherein said HP-NIC SW implements parallel independent communications of a plurality of software services and processes by transporting computer data bits and bytes across said at least two fiber optic links, wherein each of said plurality of software services and processes is mapped to a different wavelength Laser signal.

3. The system of claim 2, wherein each of said plurality of software services and processes are selected from the group consisting of software tasks, services, sockets, daemons, software object accesses, and software applications.

4. The system of claim 1, wherein said first computer hosts an operating system.

5. The system of claim 4, wherein said operating system is selected from the group consisting of Microsoft Windows NT, Microsoft Windows 95, Microsoft Windows 98, UNIX, IBM VM 370, and IBM MVS.

6. The system of claim 1, wherein said first computer hosts a distributed database management system.

7. The system of claim 6, wherein said distributed database management system is selected from the group consisting of Oracle, DB2, and Microsoft SQL.

8. The system of claim 1, wherein said HP-NIC SW implements a common channel signaling network.

9. The system of claim 1, wherein said information transferred by said HP-NIC SW comprises information stored in a memory system.

10. The system of claim 9, wherein said memory system is selected from the group consisting of high speed disk arrays, and CD juke boxes.

11. The system of claim 1, wherein said HP-NIC SW monitors and manages connections at a plurality of protocol layers;

whereby a quality of service (QOS) is implemented.

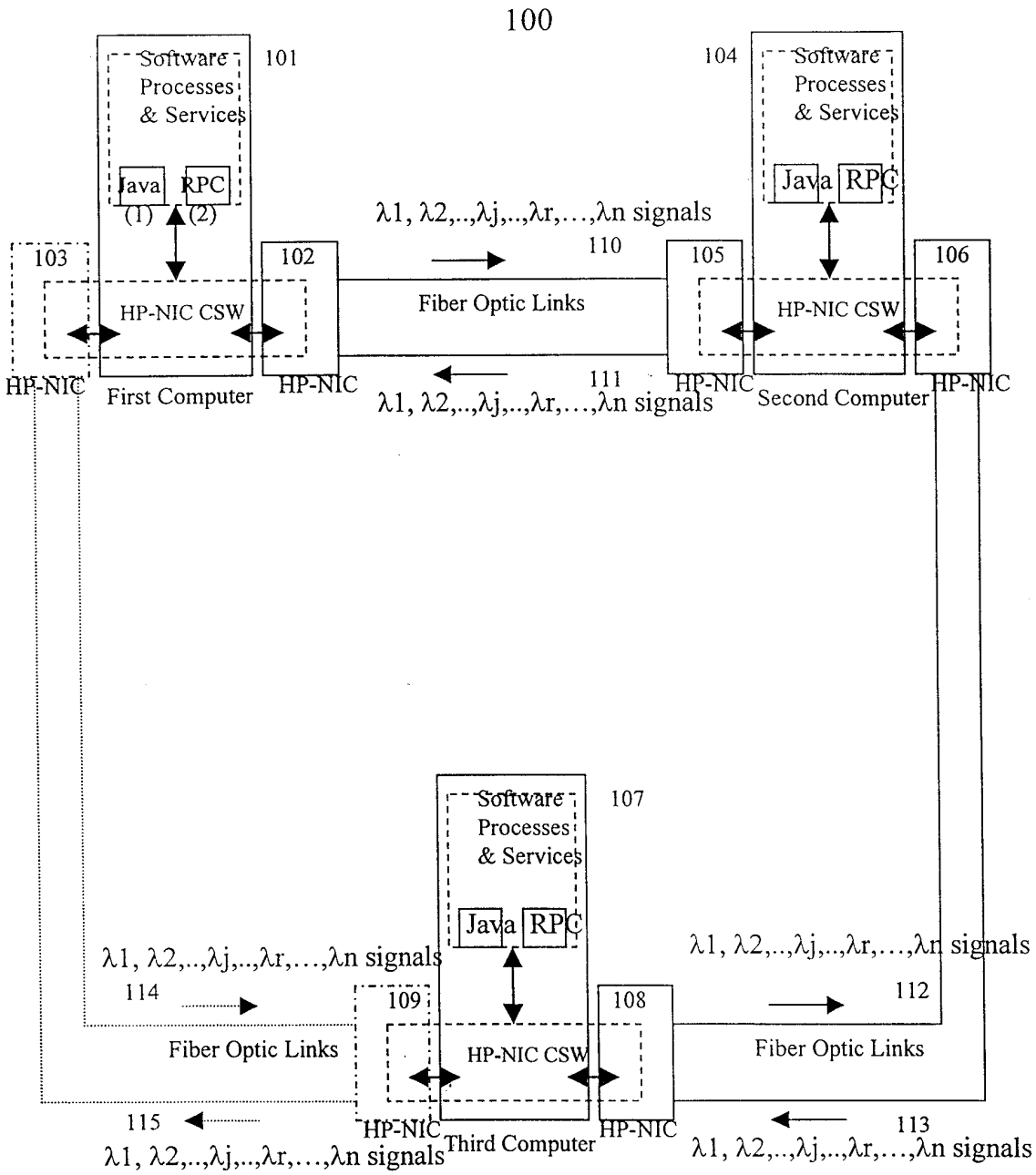
12. The system of claim 1, wherein said information transferred by said HP-NIC SW comprises:

Packet Over SONET (POS) transmissions; and

ATM over SONET (AOS) tranmsission;

wherein said POS transmissions and said AOS transmissions are transmitted over a single fiber at different wavelengths.

Figure 1: High Level Design



NOTES:
(Examples)
1. Java Code modules are transported using wavelength λj Laser signals
2. Remote Procedure Call (RPC) contents are transported using wavelength λr Laser signals

Figure 2: Network Diagram

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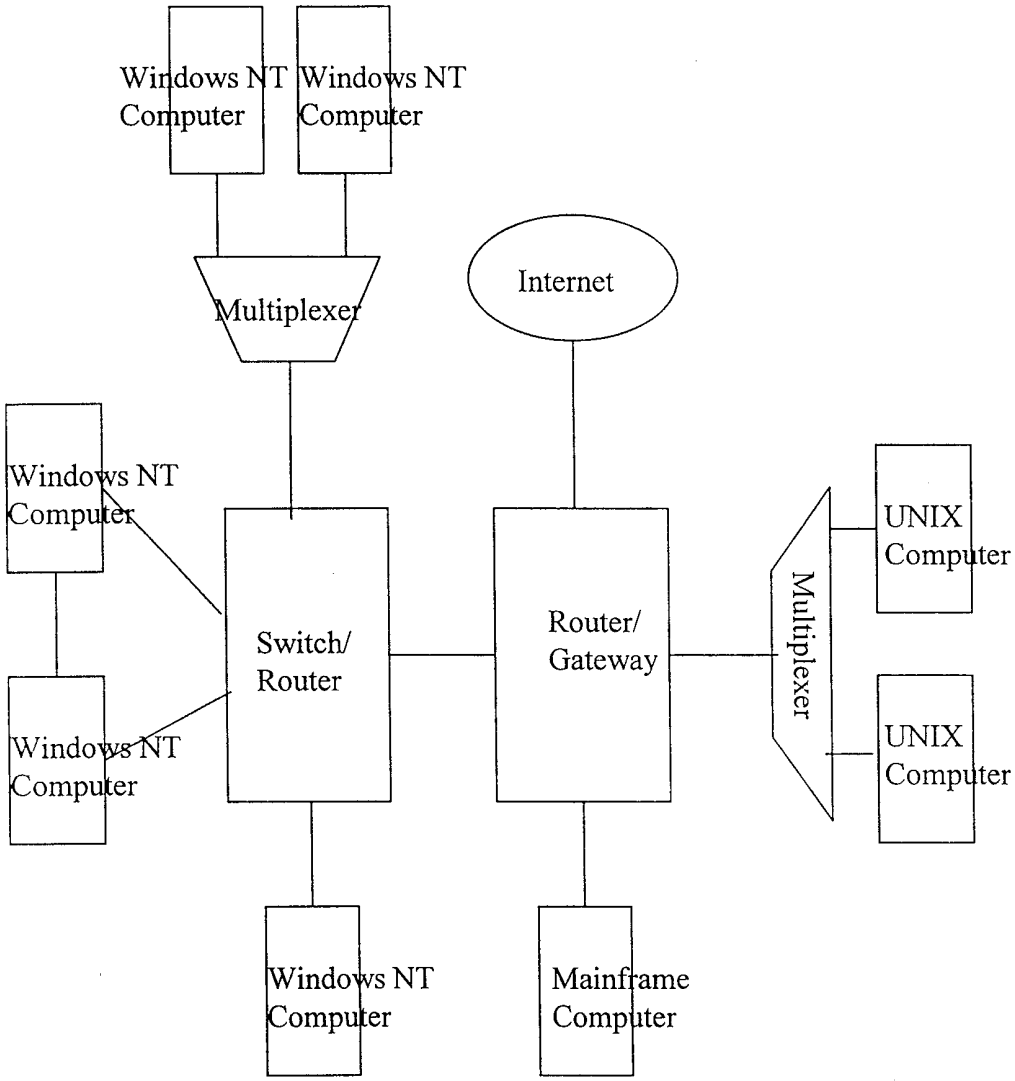

INTERNATIONAL SEARCH REPORT

International application No.
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A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :G06F 15/63; H04J 14/02; H04L 5/06; G02B 6/293
US CL :370/463,468; 709/250

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 370/463,468; 709/250

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EAST (BRS: JPO, EPO, USPAT)
wavelength multiplexing, fiber optic, network, interface card

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,808,767 A (WILLIAMS et al.) 15 SEPTEMBER 1998, col 9 lines 24-31, 65-68 ; col 10 lines 1-33; col 11 lines 21-36, 56-61; col 12 lines 7-67; col 16 lines 3-14	1-12
Y	US 5,309,564 A (BRADLEY et al.) 03 MAY 1994, col 7 lines 45-58; col 8 lines 14-23, 52-57; col 9 lines 8-10, 32-34, 50-60; col 10 lines 55-69; col 11 lines 24-30	1-12
Y	US 5,729,607 A (DEFRIES et al.) 17 MARCH 1998, col 16 lines 12-64	1-12
Y	US 5,781,320 A (BYERS) 14 JULY 1998, col 2 lines 5-51; col 3 lines 6-7, 23-46; col 4 lines 63-66	1-12

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,335,105 A (CARLTON) 02 AUGUST 1994, col 5 lines 1-6, 44, 54-57	1-12
Y	US 5,548,579 A (LEBRUN et al) 20 AUGUST 1996, col 6 lines 21-28	11