IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF DELAWARE

PALTALK HOLDINGS, INC.,	)	
	)	
Plaintiff,	)	
	)	
v.	)	C.A. No. _____________
	)	
RIOT GAMES, INC.,,	)	
	)	**JURY TRIAL DEMANDED**
Defendant.	)	

PLAINTIFF'S COMPLAINT FOR PATENT INFRINGEMENT

Plaintiff PalTalk Holdings, Inc. ("PalTalk") brings this action against Riot Games, Inc. ("Riot Games"), and for its causes of action alleges as follows:

THE PARTIES

1. PalTalk is a Delaware corporation with its principal place of business at 500 North Broadway, Suite 259 Jericho, NY 11753. PalTalk was incorporated in 2001 and is the owner of various patents relating to methods and systems for communicating over networks.

2. Upon information and belief, Riot Games, Inc. is a Delaware corporation having a principal place of business in Los Angeles, California and offering its products and services, including those accused herein of infringement, to customers and/or potential customers located in the District of Delaware. Riot Games may be served with process through its registered agent: The Corporation Trust Company (registered agent) Corporation Trust Center, 1209 Orange Street, Wilmington, DE 19801.

JURISDICTION AND VENUE

3. This is an action for patent infringement under the Patent Act, 35 U.S.C. § 271. Riot Games provides infringing services in the District of Delaware. This Court has personal jurisdiction over Riot Games, in part, because Riot Games provides infringing online services to subscribers who reside in this district. This Court has subject matter jurisdiction by virtue of Sections 1331 and 1338(a) of Title 28, United States Code.

4. Venue in this Court is proper by virtue of Sections 1391(b) and (c) and 1400(b) of Title 28, United States Code as the Court has personal jurisdiction over Riot Games.

BACKGROUND OF THE PATENTS

5. PalTalk's predecessor-in-interest, HearMe (formerly known as MPath Interactive Inc.), is one of the early pioneers of technology that allows users to participate in multiplayer games over the Internet. Multiplayer games conducted over wide area networks generally involve difficult technical issues because of the requirement that all players have the same view of the game environment in real-time. PalTalk's technology provides for efficient handling of communications between players necessary to maintain a consistent game environment for all players. PalTalk's technology covers a number of aspects of online gaming, including communications through a group messaging server as well as establishing groups for online game play.

6. PalTalk's predecessor-in-interest filed numerous patent applications that cover online gaming technology. On October 13, 1998, the United States Patent and Trademark Office issued the first of these utility patent applications. Specifically, United States Patent No. 5,822,523 (the "'523 Patent") was duly and legally issued to MPath Interactive Inc. as the legal assignee of the inventors, Jeffrey Rothschild, Marc Kwiatkowski, and Daniel Samuel. The title of the '523 Patent is "Server-Group Messaging System for Interactive Applications." A true and correct copy of the

’523 Patent is attached as Exhibit “A.”

7. Thereafter, the United States Patent Office issued other patents on HearMe’s technology, including U.S. Patent No. 6,226,686 (the “’686 Patent”), which issued on May 1, 2001. A true and correct copy of the’686 Patent is attached as Exhibit “B.” The ’686 Patent is a continuation of U.S. Patent No. 6,018,766, which is a continuation of the ’523 Patent. The ’523 Patent and the ’686 Patent collectively constitute the “PalTalk Patents.” In 2002, HearMe sold the PalTalk Patents to PalTalk Holdings, Inc.

8. On or around June 14, 2010, an ex-parte reexamination request no. 90/011,033 with respect to the ‘523 Patent was filed with the United States Patent and Trademark Office (USPTO). All claims of the ‘523 Patent were confirmed patentable without amendment. An additional 41 claims (claims 7–47) were added.

9. On or around June 14, 2010, an ex-parte reexamination request no. 90/011,036 with respect to the ‘686 Patent was filed with the United States Patent and Trademark Office (USPTO). Claims 1–4 and 7–19 were confirmed patentable without amendment. Claims 5 and 6 were canceled. An additional 51 claims (claims 20–70) were added.

10. Presumably, these reexamination requests stemmed from litigation that was ongoing at the time between PalTalk and various other companies including Sony Computer Entertainment America Inc., Activision Blizzard, Inc., and NCSOFT Corporation in the Eastern District of Texas. All of those prior litigations have been resolved, resulting in these former defendants taking licenses to the patents-in-suit.

TECHNOLOGY BACKGROUND

11. Before a group of players can form an online game, they must establish channels of communication between their respective computers. Each computer participating in the online

game play must be capable of transmitting its player's movements to the group such that all players have consistent views of the game environment. The transmissions must occur frequently in order to maintain consistency between the computers. The frequency requirement is particularly important in action-oriented video games with high resolution graphics. Such games require very frequent updates from most or all players in order to maintain a real-time consistent view of the game environment. The large number of communications necessary from a number of players can result in bandwidth or computer processing bottlenecks.

12. To alleviate these problems, the '523 Patent describes, as a preferred embodiment, using a group messaging server to receive the individual messages from each computer. The group messaging server maintains an accurate list of all members of the group, eliminating the need for each member of the group to maintain its own independent list. The group messaging server of the '523 Patent also is capable of aggregating the payload portions of the individual messages into an aggregated message, which the group messaging server may then send to each group member. Aggregation through the group messaging server simplifies the communications between computers by reducing the number of messages that each individual computer must send and receive.

13. The '686 Patent describes and claims forming a message group and maintaining consistency between the computers within the group. In particular, the '686 Patent describes receiving a create message specifying a message group to be created and receiving join messages from a first subset of host computers specifying the message group. The '686 Patent also describes receiving host messages from a second subset of the first subset of host computers within the message group and aggregating the payload portions of those host messages to form an aggregated message. The aggregated message is then sent to the first subset of host computers within the

message group. The method described in the ’686 Patent similarly facilitates efficient communications between host computers and reduces the burden of maintaining consistency between the host computers within the message group.

14. After MPath invented its technology, online game play became one of the most popular Internet activities.

PREVIOUS LITIGATION

15. In October of 1999, Hearme, f/k/a Mpath Interactive Inc. brought suit for patent infringement regarding the ‘523 Patent against Lipstream Networks, Inc. in California. The case settled around September of 2000.

16. In September of 2006, PalTalk brought suit against Microsoft Corporation in the Eastern District of Texas for its infringement of the ‘523 and ‘686 Patents. The case went to trial in March of 2009. During trial, evidence was discussed concerning how Microsoft wanted Mpath’s technology for itself and expressed how unique it was and discussed the significant advantages it offered. Microsoft employees made proposals to Bill Gates that Microsoft acquire Mpath in the mid-1990s. Facing powerful evidence of infringement and validity, Microsoft settled the case during trial in exchange for a license.

17. In September of 2009, PalTalk brought suit against Sony Corporation, Activision, Blizzard, NCSoft, Jagex, Turbine, and other related companies in the Eastern District of Texas. Similar to Microsoft, many of these entities settled on the brink of trial in September of 2011 in exchange for a license.

18. Leaders in the video gaming industry have paid, in total, many tens of millions of dollars to PalTalk in connection with the ‘523 and ‘686 Patents.

DIRECT INFRINGEMENT

19. PalTalk incorporates its previous allegations by the reference.

20. PalTalk is the assignee of the ‘523 and ‘686 Patents and has all rights, title, and interest in and to each of the PalTalk Patents, including all substantial rights in and to the PalTalk Patents, and including the right to sue and collect damages, including damages for past infringement.

21. Prior to filing this suit, PalTalk complied with the marking requirement pursuant to 35 U.S.C. § 287(a) and is thus entitled to recover past damages for the infringement of the PalTalk Patents, as more fully described below.

LEAGUE OF LEGENDS

22. League of Legends (“LoL”) is a multiplayer online battle arena (“MOBA”) video game developed and published by Riot Games.

23. Upon information and belief, LoL grossed in excess of $1 billion dollars for Riot Games in 2015, making it one of the most profitable online games in the world. This revenue comes in part at least from the sale of virtual goods and other game related benefits connected with LoL.

24. LoL has become one of the most popular games in the world, with peak simultaneous players in excess of 7,000,000 in many months.

25. Riot Games has servers that support LoL in multiple locations in the United States.

‘523 Patent Infringement

26. Riot Games has directly infringed at least Claim 1 of the ‘523 Patent, either literally or under the doctrine of equivalents, by and through its use of the methods claimed in the ‘523 Patent in this country in connection with at least LoL. This conduct constitutes infringement under 35 U.S.C. § 271(a). An exemplary claim chart is provided in Exhibit C.

27. Every step of the method of at least Claim 1 of the ‘523 Patent is attributable to Riot Games

by virtue of Riot Games' ownership and control of its own servers which perform various method steps, and through Riot Games' licensing and software agreements with its players.

28. With respect to the limitation in Claim 1 of "sending, by a plurality of host computers…," Riot Games expressly conditions participation in LoL, as well as receipt of benefits of having champions, upgrades, game items, influence points, riot points, virtual goods, and other game-related benefits, upon the performance of this step of the patented method.

29. By way of a non-limiting example, each player is required to download and install a valid copy of Riot Games' software (Exhibit D, Terms of Use Agreement ("TOU"), at Preamble, § 2), only use Riot Games' software to play the LoL game (TOU § V.J–K), and must not modify Riot Games' software (Exhibit D, End User License Agreement ("EULA") § III.C).

30. Riot Games can change and automatically update the software at any time for any reason at Riot Games' sole and absolute discretion. TOU § VII.B; EULA § VII.A, IX. The player does not own the software, has no rights to the software, and merely has a "limited, non-exclusive, non-transferable license" (revocable at anytime at Riot's sole discretion) to use the software for non-commercial, entertainment purposes, that is expressly conditioned on the player's compliance with the TOU, EULA, and other conditions. EULA § I, III; TOU § I, XVI.

31. Riot Games establishes the manner of the performance of this step through Riot Games' software which the player must download and install to play the game, must use to play the game, cannot modify, and must accept all changes imposed by Riot Games. *E.g.*, TOU § V.J–K, VII.B; EULA § III.C, VII.A, IX. The software must be used to perform this step, and the player has no choice as to the manner in which this step is performed. The entire organization of the claimed message(s) and their sending to Riot Games' servers is accomplished by Riot Games' software (that Riot Games owns, controls, and exercises dominion over) in the way that Riot Games

programmed the software to perform.

32. Riot Games establishes the timing of the performance of this step through its software that is programmed to immediately send the claimed message(s) directly or indirectly in response to player input and/or server information, commands, or authorization.

33. By virtue of Riot Games' agreement with each player, Riot Games has the complete right at any time and at Riot Games' sole discretion to stop and/or limit the performance of this infringing step by modifying the player's software. *E.g.*, TOU § III.E, V.J–K, VII.B; EULA § III.C, VII.A, IX.

34. Riot Games also establishes the manner and timing of the players' performance so that a player can only avail themselves of the game upon the performance of this claimed step. *Id.*

35. It is impossible to play the LoL game without the Riot Games software performing this step, the player cannot modify the software, and the player has no other ability to interact with the game except through the software.

36. Riot Games' employees also play the LoL game on behalf of Riot Games during development, beta testing, live testing, playtesting, demonstrations, and to advance their understanding of Riot Games' product offerings.

37. Accordingly, Riot Games is a direct infringer of at least Claims 1 of the '523 Patent.

<u>'686 Patent Infringement</u>

38. Riot Games has directly infringed at least Claim 7 of the '686 Patent, either literally or under the doctrine of equivalents, by and through its use of the methods claimed in the '686 Patent in this country in connection with at least LoL. This conduct constitutes infringement under 35 U.S.C. § 271(a). An exemplary claim chart is provided in Exhibit E.

39. Every step of the method of at least Claim 7 of the '686 Patent is attributable to Riot Games

by virtue of Riot Games' ownership and control of its own servers which perform the claimed method steps.

40. As a result of Riot Games' infringement of the PalTalk Patents, PalTalk has been damaged and as a result is entitled to recover damages which in no event can be less than a reasonable royalty, including its costs, and pre-judgment and post-judgment interest pursuant to 35 U.S.C. § 284.

DAMAGES

41. Riot Games' acts of infringement of PalTalk's Patents as alleged above has injured PalTalk and thus PalTalk is entitled to recover damages adequate to compensate it for that infringement, which in no event can be less than a reasonable royalty.

JURY DEMAND

42. PalTalk demands a trial by jury on all issues so triable, including the Defendant's counterclaims and affirmative defenses, if any.

PRAYER FOR RELIEF

WHEREFORE, PalTalk prays for entry of judgment:

A. That Defendant, Riot Games, has infringed one or more claims of the '523 Patent;

B. That Defendant, Riot Games, has infringed one or more claims of the '686 Patent;

C. That Defendant, Riot Games, account for and pay to '523 Patent all damages caused by the infringement of the '523 Patent, which by statute can be no less than a reasonable royalty;

D. That Defendant, Riot Games, account for and pay to '686 Patent all damages caused by the infringement of the '686 Patent, which by statute can be no less than a reasonable royalty;

E. That PalTalk be granted pre-judgment and post-judgment interest on the damages caused to it by reason of the Defendant Riot Games' infringement of the '523 Patent and the '686

Patent; and

F. That PalTalk be granted such other and further relief that is just and proper under the circumstances.

ASHBY & GEDDES

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Dated: December 16, 2016

EXHIBIT A

US005822523A

United States Patent [19]

Rothschild et al.

[11] **Patent Number: 5,822,523**

[45] **Date of Patent: Oct. 13, 1998**

[54] **SERVER-GROUP MESSAGING SYSTEM FOR INTERACTIVE APPLICATIONS**

[75] Inventors: **Jeffrey J. Rothschild**; **Marc P. Kwiatkowski**, both of Los Gatos; **Daniel J. Samuel**, Sunnyvale, all of Calif.

[73] Assignee: **Mpath Interactive, Inc.**, Mountain View, Calif.

[21] Appl. No.: **595,323**

[22] Filed: **Feb. 1, 1996**

[51] **Int. Cl.**[6] **H04H 1/02**

[52] **U.S. Cl.** **395/200.17**; 395/200.1; 395/200.09

[58] **Field of Search** 395/200.1, 200.01, 395/200.09, 200.17, 200.05, 793; 370/85.13, 60

[56] **References Cited**

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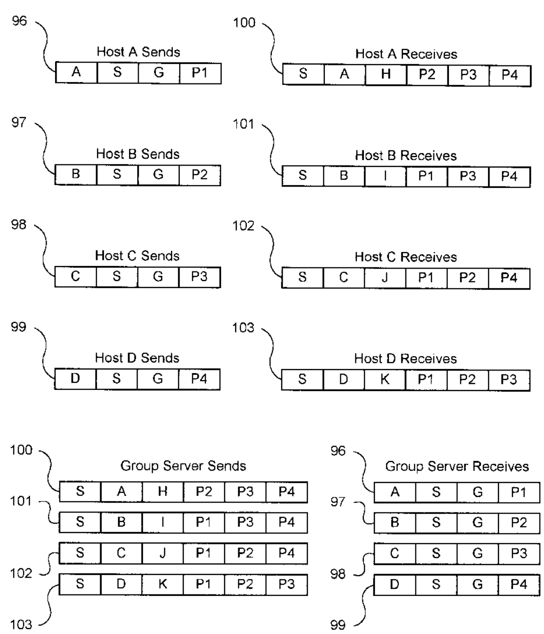
Primary Examiner—William M. Treat
Assistant Examiner—Zarni Maung
Attorney, Agent, or Firm—H. C. Chan; Wison Sonsini Goodrich & Rosati

[57] **ABSTRACT**

A method for deploying interactive applications over a network containing host computers and group messaging servers is disclosed. The method operates in a conventional unicast network architecture comprised of conventional network links and unicast gateways and routers. The hosts send messages containing destination group addresses by unicast to the group messaging servers. The group addresses select message groups maintained by the group messaging servers. For each message group, the group messaging servers also maintain a list of all of the hosts that are members of the particular group. In its most simple implementation, the method consists of the group server receiving a message from a host containing a destination group address. Using the group address, the group messaging server then selects a message group which lists all of the host members of the group which are the targets of messages to the group. The group messaging server then forwards the message to each of the target hosts. In an interactive application, many messages will be arriving at the group server close to one another in time. Rather than simply forward each message to its targeted hosts, the group messaging server aggregates the contents of each of messages received during a specified time period and then sends an aggregated message to the targeted hosts. The time period can be defined in a number of ways. This method reduces the message traffic between hosts in a networked interactive application and contributes to reducing the latency in the communications between the hosts.

6 Claims, 11 Drawing Sheets



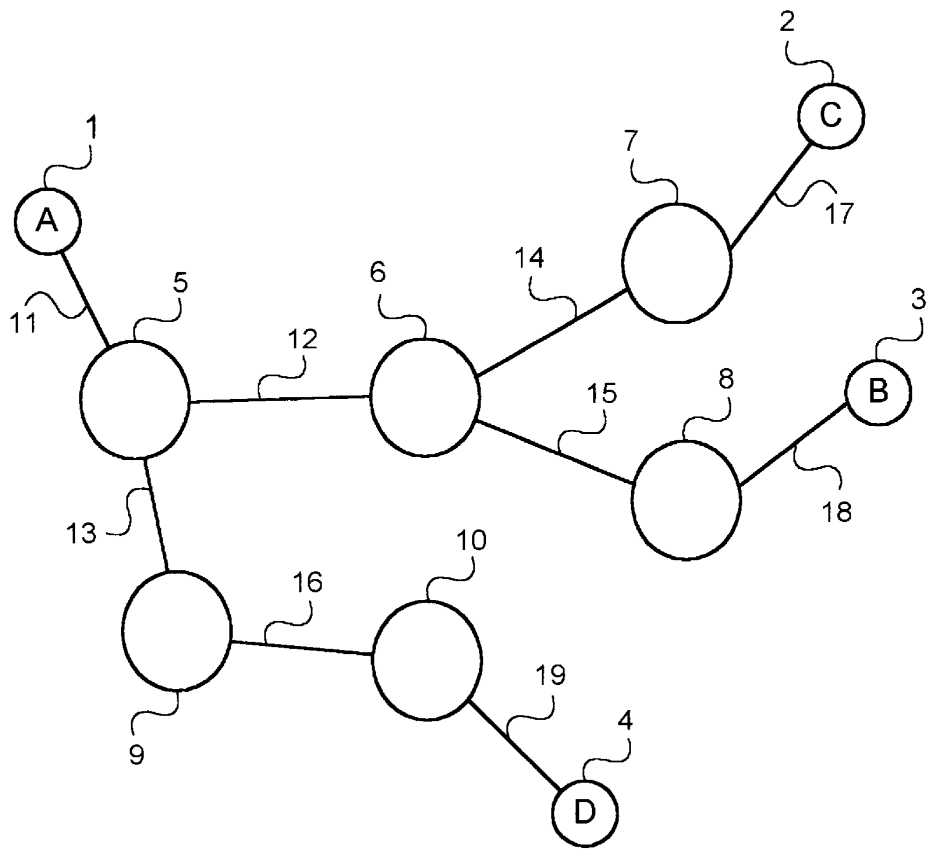


Figure 1
Prior Art

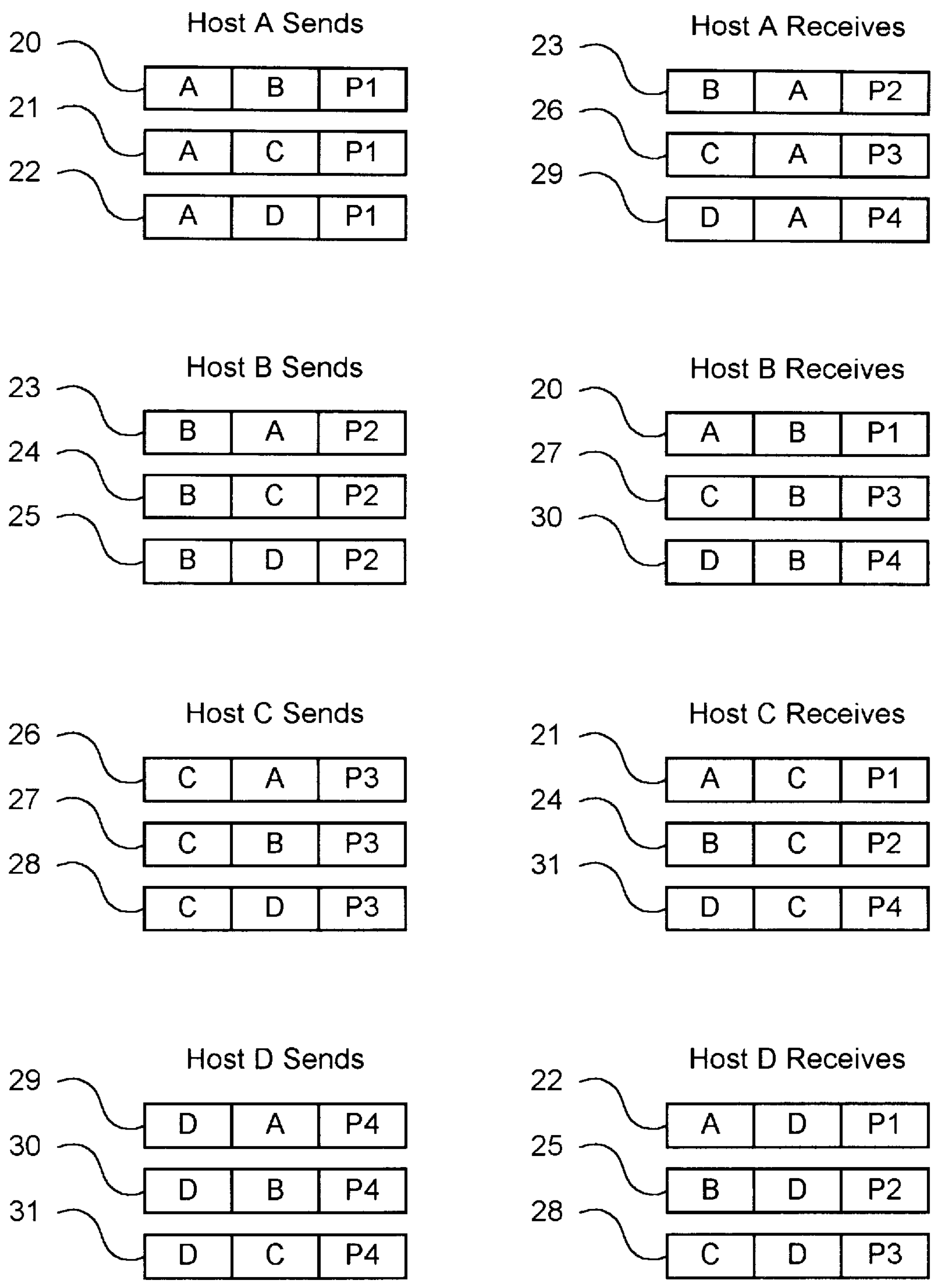


Figure 2
Prior Art

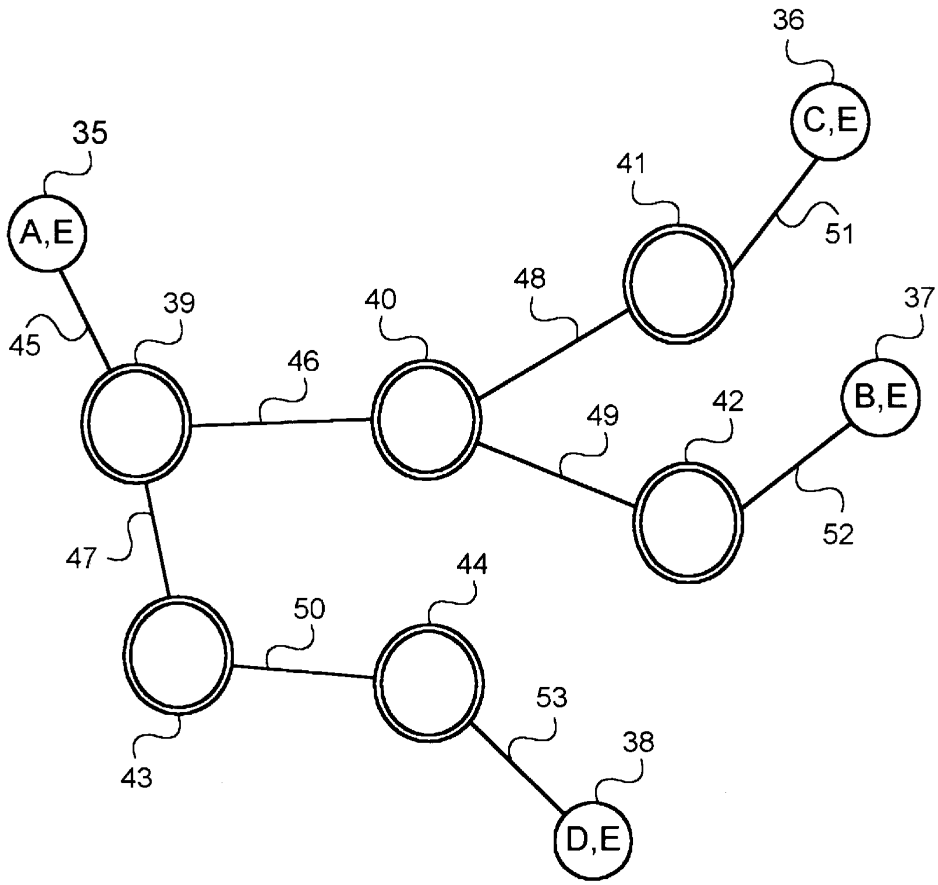


Figure 3
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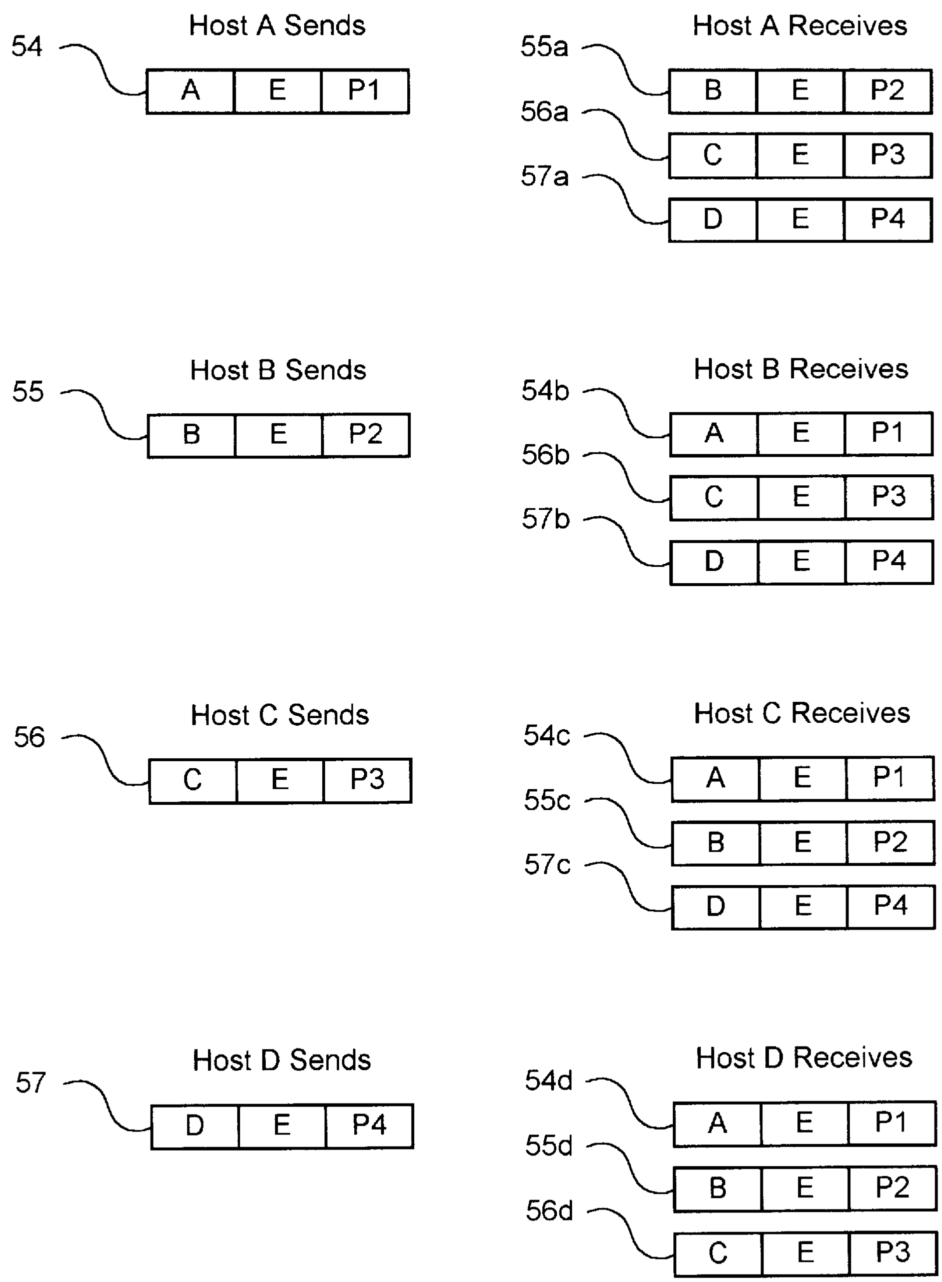


Figure 4
Prior Art

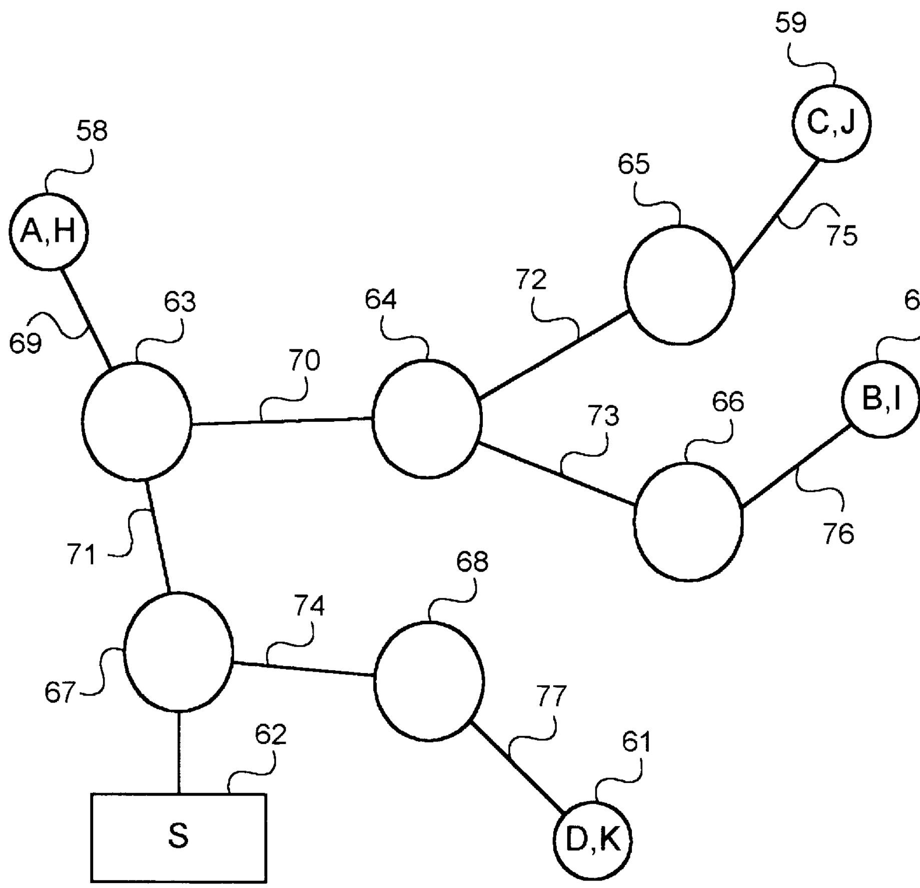
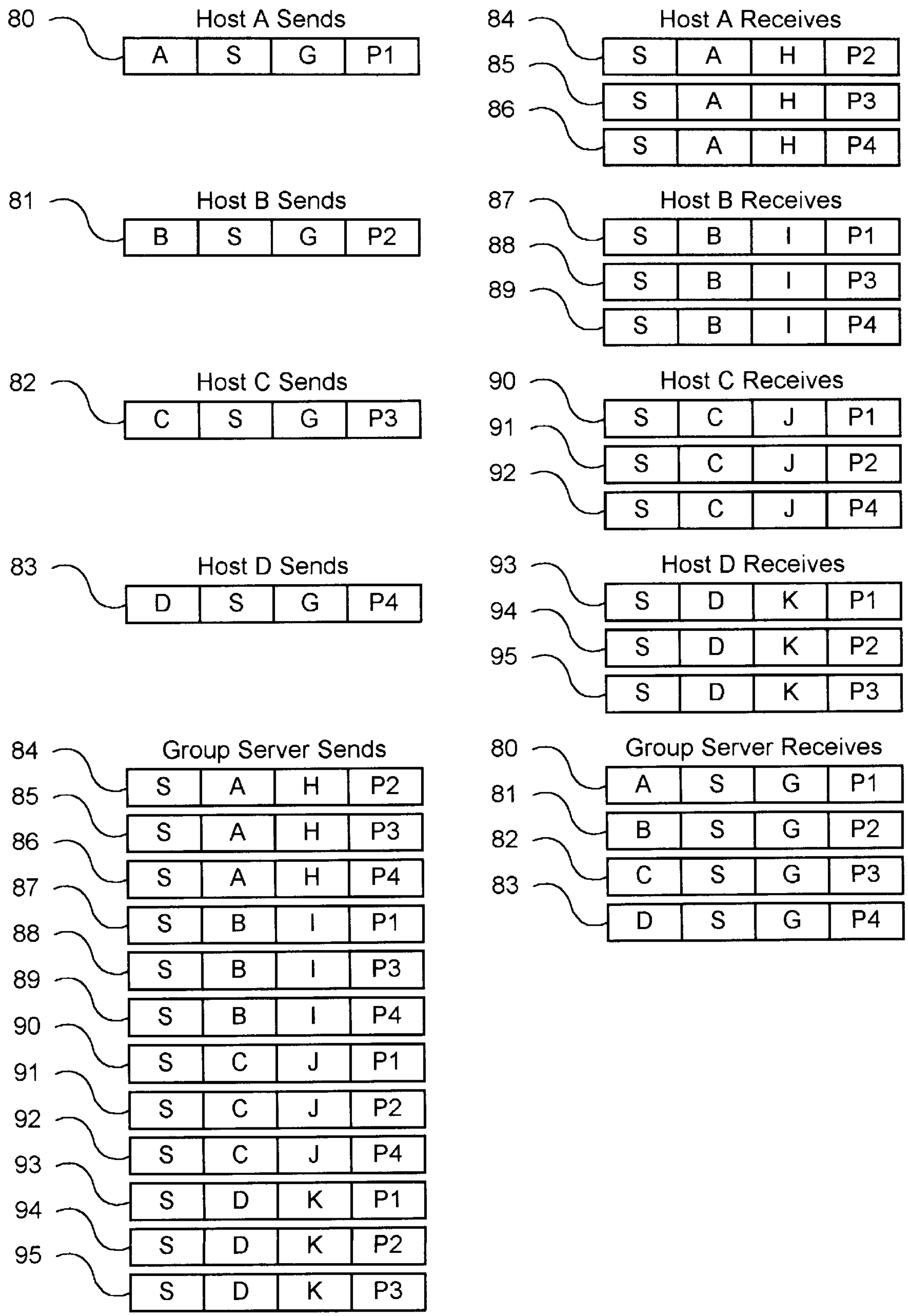


Figure 5



80
Host A Sends
A S G P1
84
85
86
Host A Receives
S A H P2
S A H P3
S A H P4
81
Host B Sends
B S G P2
87
88
89
Host B Receives
S B I P1
S B I P3
S B I P4
82
Host C Sends
C S G P3
90
91
92
Host C Receives
S C J P1
S C J P2
S C J P4
83
Host D Sends
D S G P4
93
94
95
Host D Receives
S D K P1
S D K P2
S D K P3
84
85
86
87
88
89
90
91
92
93
94
95
Group Server Sends
S A H P2
S A H P3
S A H P4
S B I P1
S B I P3
S B I P4
S C J P1
S C J P2
S C J P4
S D K P1
S D K P2
S D K P3
80
81
82
83
Group Server Receives
A S G P1
B S G P2
C S G P3
D S G P4

Figure 6

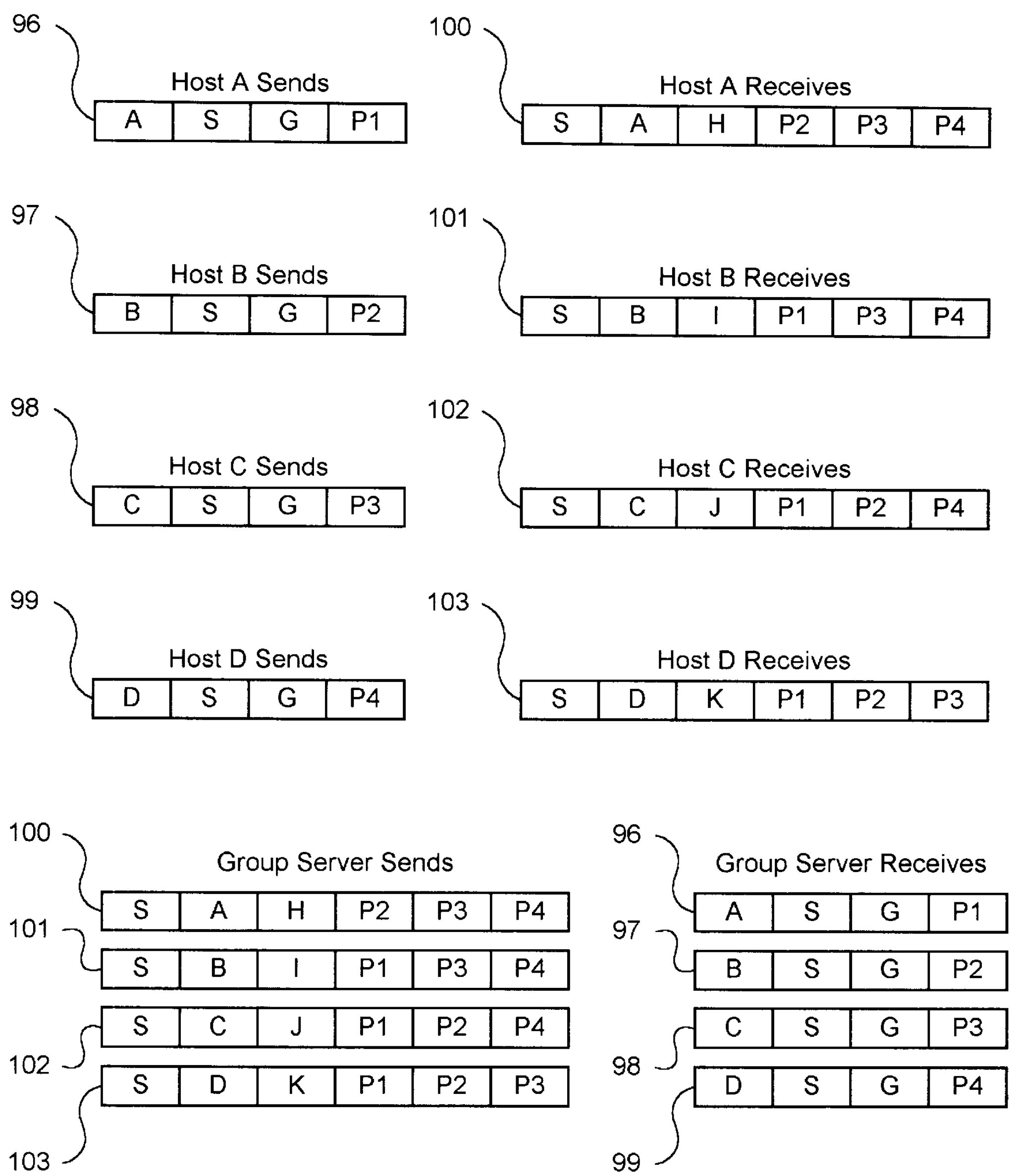

96
Host A Sends
A S G P1
100
Host A Receives
S A H P2 P3 P4
97
Host B Sends
B S G P2
101
Host B Receives
S B I P1 P3 P4
98
Host C Sends
C S G P3
102
Host C Receives
S C J P1 P2 P4
99
Host D Sends
D S G P4
103
Host D Receives
S D K P1 P2 P3
Group Server Sends
S A H P2 P3 P4
S B I P1 P3 P4
S C J P1 P2 P4
S D K P1 P2 P3
Group Server Receives
A S G P1
B S G P2
C S G P3
D S G P4

Figure 7

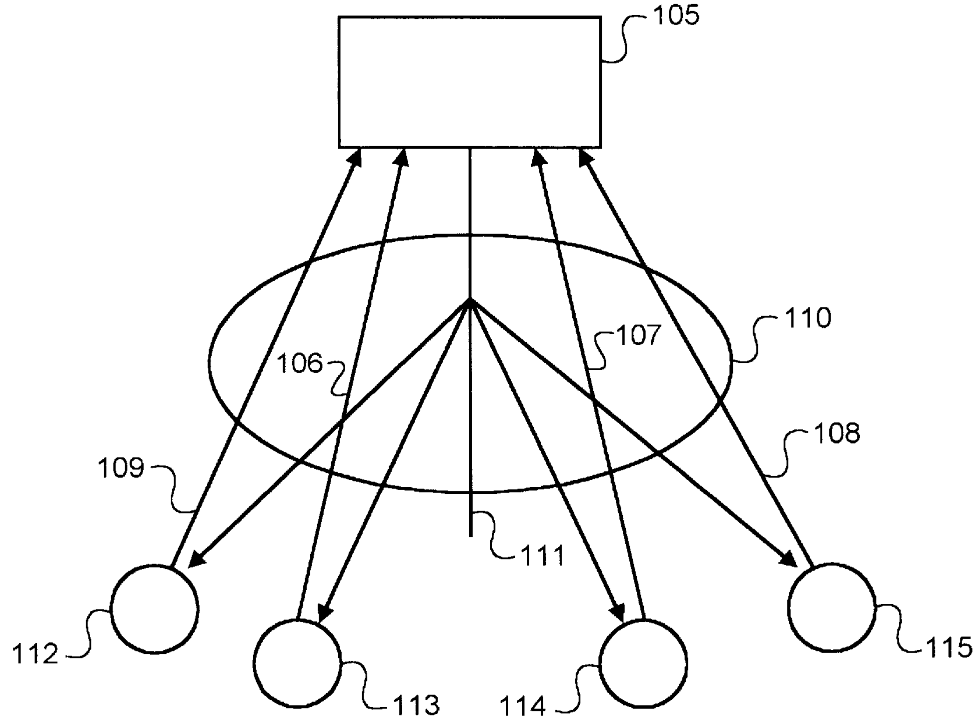


Figure 8
Prior Art

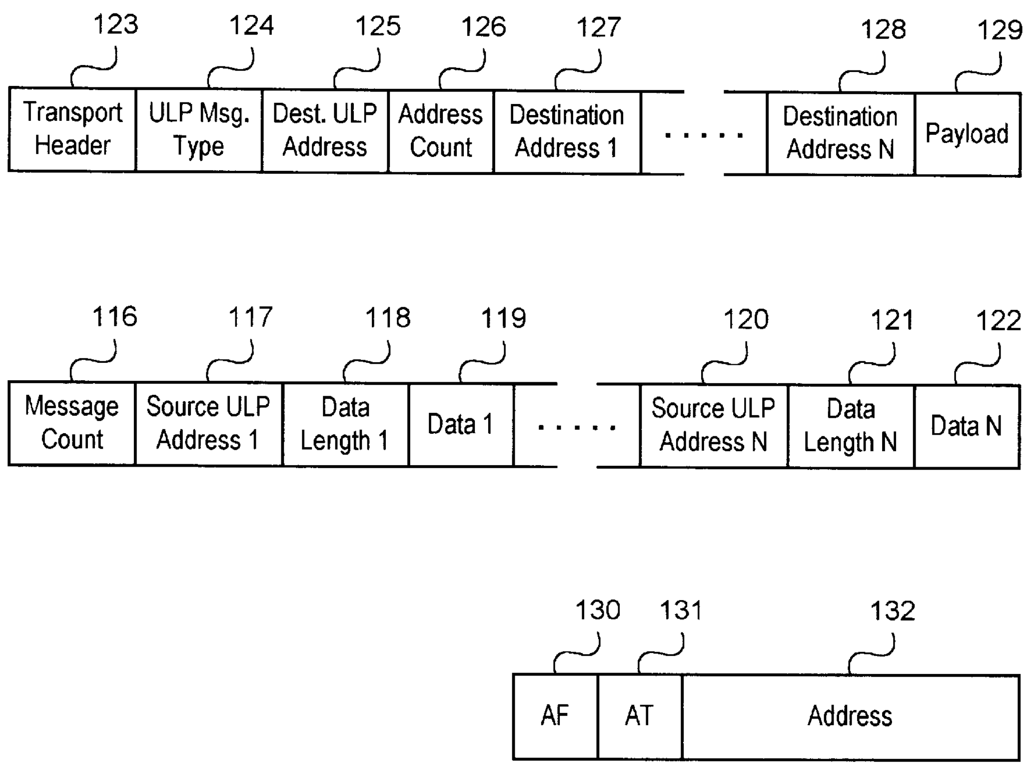

123
124
125
126
127
128
129
Transport Header
ULP Msg. Type
Dest. ULP Address
Address Count
Destination Address 1
. . . . .
Destination Address N
Payload
116
117
118
119
120
121
122
Message Count
Source ULP Address 1
Data Length 1
Data 1
. . . . .
Source ULP Address N
Data Length N
Data N
130
131
132
AF
AT
Address

Figure 9

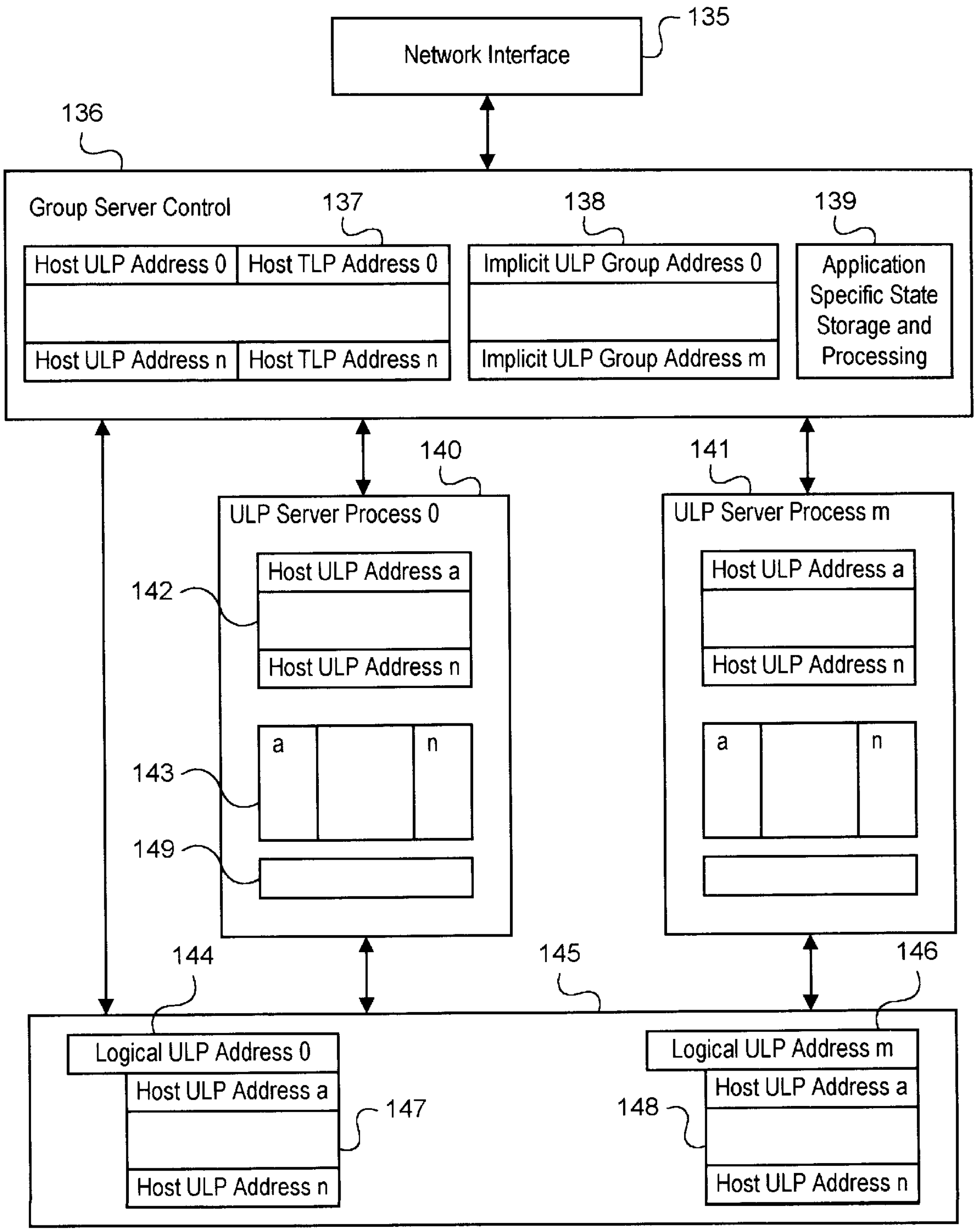

Network Interface
135
136
Group Server Control
137
138
139
Host ULP Address 0
Host TLP Address 0
Host ULP Address n
Host TLP Address n
Implicit ULP Group Address 0
Implicit ULP Group Address m
Application Specific State Storage and Processing
140
141
ULP Server Process 0
ULP Server Process m
142
Host ULP Address a
Host ULP Address n
143
a
n
149
144
145
146
Logical ULP Address 0
Host ULP Address a
Host ULP Address n
147
148
Logical ULP Address m
Host ULP Address a
Host ULP Address n

Figure 10

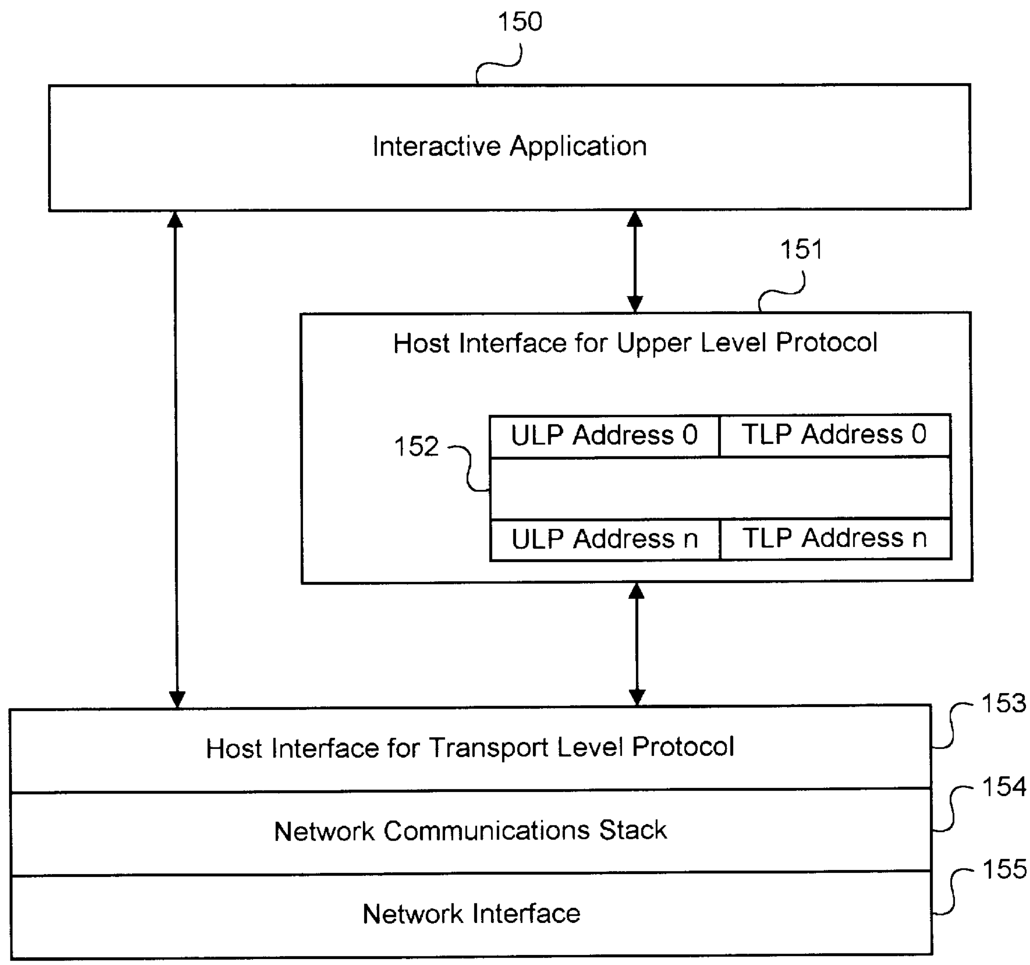

150
Interactive Application
151
Host Interface for Upper Level Protocol
152
ULP Address 0
TLP Address 0
ULP Address n
TLP Address n
153
Host Interface for Transport Level Protocol
154
Network Communications Stack
155
Network Interface

Figure 11

SERVER-GROUP MESSAGING SYSTEM FOR INTERACTIVE APPLICATIONS

FIELD OF THE INVENTION

The present invention relates to computer network systems, and particularly to server group messaging systems and methods for reducing message rate and latency.

BACKGROUND OF THE INVENTION

There are a wide range of interactive applications implemented on computer systems today. All are characterized by dynamic response to the user. The user provides input to the computer and the application responds quickly. One popular example of interactive applications on personal computers (PCs) are games. In this case, rapid response to the user may mean redrawing the screen with a new picture in between 30 ms and 100 ms. Interactive applications such as games control the speed of their interaction with the user through an internal time base. The application uses this time base to derive rates at which the user input is sampled, the screen is redrawn and sound is played.

As computers have become more powerful and common, it has become important to connect them together in networks. A network is comprised of nodes and links. The nodes are connected in such a way that there exists a path from each node over the links and through the other nodes to each of the other nodes in the network. Each node may be connected to the network with one or more links. Nodes are further categorized into hosts, gateways and routers. Hosts are computer systems that are connected to the network by one link. They communicate with the other nodes on the network by sending messages and receiving messages. Gateways are computer systems connected to the network by more than one link. They not only communicate with the other nodes as do hosts, but they also forward messages on one of their network links to other nodes on their other network links. This processing of forwarding messages is called routing. In addition to sending and receiving messages and their routing functions, gateways may perform other functions in a network. Routers are nodes that are connected to the network by more than one link and whose sole function is the forwarding of messages on one network link to the other network links to which it is connected. A network consisting of many network links can be thought of as a network of sub-networks with gateways and/or routers connecting the sub-networks together into what is called an internet. Today the widely known example of a world wide internet is the so called "Internet" which in 1995 has over 10 million computers connected full time world-wide.

With so many computers on a single world-wide network, it is desirable to create interactive networked applications that bring together many people in a shared, networked, interactive application. Unfortunately, creating such shared networked, interactive applications runs into the limitations of the existing network technology.

As an example, consider a game designed to be deployed over a network which is to be played by multiple players simultaneously. The game could be implemented in software on a PC connected to a network. A rate set by its internal time base, it would sample the inputs of the local user, receive messages from the network from the PCs of the other players and send messages out to the PCs of the other players. A typical rate will be ten time per second for a time period of 100 ms. The messages sent between the PCs would contain information that was needed to keep the game consistent between all of the PCs. In a game that created the illusion of a spatial environment where each player could move, the packets could contain information about the new positions of the players as they moved. Today there are many commercial example of PC games that can be played between multiple players on Local Area Networks (LANs) or by two players over dial-up phone lines using modems. The network messages sent by such games contain a wide variety of information specific to the game. This can include position and velocity information of the objects in the game along with special actions taken by a player that effect the other players in the game.

The case of a two player game played over a modem is particularly simple. If the message rate is 10 messages per second, each PC sends 10 messages per second to the other PC and receives 10 messages per second. The delay introduced by the modems and phone line is small and will not be noticed in most games. Unfortunately, the case of two players is uninteresting for networked interactive applications. With the same game played with 8 players on a LAN, the message rate increases. Each PC must send 7 messages, one to each of the other 7 players every time period and will receive 7 messages from the other players in the same time period. If the messaging time period is 100 ms, the total message rate will be 70 messages sent per second and 70 messages received per second. As can be seen the message rate increases linearly with the number of players in the game. The message rates and data rates supported by popular LANs are high enough to support a large number of players at reasonable message sizes. Unfortunately, LANs are only deployed in commercial applications and cannot be considered for deploying a networked interactive application to consumer users.

The wide area networks available today to consumer users all must be accessed through dial-up phone lines using modems. While modem speeds have increased rapidly, they have now reached a bit rate of 28.8 Kbits/sec which is close to the limit set by the signal-to-noise ratio of conventional phone lines. Further speed increases are possible with ISDN, but this technology is not ready for mass market use. Other new wide area networking technologies are being discussed that would provide much higher bandwidth, but none are close to commercial operation. Therefore, in deploying a networked, interactive application to consumers, it is necessary to do so in a way that operates with existing networking and communications infrastructures.

In the example of the 8 player networked game, consider a wide area network implementation where the PCs of each of the players is connected to the network with a 28.8 Kbit/sec modem. Assume that the network used in this example is the Internet so that all of the network protocols and routing behavior is well defined and understood. If the game uses TCP/IP to send its messages between the PCs in the game, the PPP protocol over the dial-up phone lines can be advantageously used to compress the TCP/IP headers. Even so, a typical message will be approximately 25 bytes in size. Sent through the modem, this is 250 bits. The messages are sent 10 times per second to each of the other PCs in the game and received 10 times per second from the other PCs. This is 35.0 Kbits/sec which exceeds the capabilities of the modem by 20%. If the messages are reduced to 20 bytes, just 8 players can be supported, but this approach clearly cannot support networked interactive applications with large numbers of participants. There are other problems beyond just the bandwidth of the network connection. There is the loading on each PC caused by the high packet rates and there is the latency introduced by the time needed to send all of the outbound packets. Each packet sent or received by a PC will require some amount of processing time. As the packet rate increases with the number of players in the game, less and less of the processor will be available for running the game software itself Latency is important in an interactive application because it defines the responsiveness of the system. When a player provides a new input on their system, it is desirable for that input to immediately affect the game on all of the other players systems. This is particularly important in any game where the game outcome depends on players shooting at targets that are moved by the actions of the other players. Latency in this case will be the time from when a player acts to move a target to the time that the target has moved on the screens of the other players in the game. A major portion of this latency will come from the time needed to send the messages to the other seven players in the game. In this example the time to send the messages to the other 7 players will be approximately 50 ms. While the first player of the seven will receive the message quickly, it will not be until 50 ms have passed that the last player of the seven will have received the message.

Internet Protocol Multicasting

As mentioned before, the Internet is a widely known example of a wide area network. The Internet is based on a protocol appropriately called the Internet Protocol (IP). In the OSI reference model for layers of network protocols, IP corresponds to a layer **3** or Network layer protocol. It provides services for transmission and routing of packets between two nodes in an internet. The addressing model provides a 32 bit address for all nodes in the network and all packets carry source and destination addresses. IP also defines the routing of packets between network links in an inter-network. Gateways and routers maintain tables that are used to lookup routing information based on the destination addresses of the packets they receive. The routing information tells the gateway/router whether the destination of the packet is directly reachable on a local network link connected to the gateway/router or if not, the address of another gateway/router on one of the local network links to which the packet should be forwarded. On top of IP are the layer **4** transport protocols TCP and UDP. UDP provides datagram delivery services to applications that does not guarantee reliable or in-order delivery of the datagrams. TCP is a connection oriented service to applications that does provide reliable delivery of a data stream. It handles division of the stream into packets and ensures reliable, in-order delivery. See the Internet Society RFCs: RFC-791 "Internet Protocol", RFC-793 "Transmission Control Protocol" and RFC-1180 "A TCP/IP Tutorial". IP, TCP and UDP are unicast protocols: packets, streams or datagrams are transmitted from a source to a single destination.

As an example, consider FIGS. **1** and **2**. FIG. **1** shows a conventional unicast network with hosts **1**, **2**, **3** and **4** and network links **11**, **12**, **13**, **14**, **15**,**16**,**17**, **18** and **19** and routers **5**, **6**, **7**, **8**, **9** and **10**. In this example, each host wants to send a data payload to each of the other hosts. Host **1** has network address A, host **2** has network address C, host **3** has network address B and host **4** has network address D. Existing network protocols are typically based on packet formats that contain a source address, destination address and a payload. This is representative of commonly used wide area network protocols such as IP. There are other components in an actual IP packet, but for sake of this example, only these items will be considered. FIG. **2** shows the example packets that are sent by the hosts to one another using a conventional unicast network protocol such as IP. Host **1** send packets **20**, to host

3, packet **21** to host **2** and packet **22** to host **4**. Host **1** wants to send the same data **P1** to each of the other three hosts, therefore the payload in all three packets is the same. Packet **20** travels over network links **11**, **12**, **15** and **18** and through routers **5**, **6**, and **8** to reach host **3**. In a similar fashion host **3** sends packets **23** to host **1**, packet **24** to host **2** and packet **25** to host **4**. Host **2** and host **4** send packets **26**, **27**, **28** and **29**, **30**, **31** respectively to the other three hosts. All of these packets are carried by the unicast network individually from the source host to the destination host. So in this example each host must send three packets and receive three packets in order for each host to send its payload to the other three hosts.

As can be seen, each host must send a packet to every other host that it wishes to communicate with in an interactive application. Further, it receives a packet from every other host that wishes to communicate with it. In an interactive application, this will happen at a regular and high rate. All of the hosts that wish to communicate with one another will need to send packets to each other eight to ten times per second. With four hosts communicating with one another as in this example, each host will send three messages and receive three messages eight to ten times per second. As the number of hosts in the application that need to communicate with one another grows, the message rate will reach a rate that cannot be supported by conventional dial-up lines. This makes unicast transport protocols unsuitable for delivering interactive applications for multiple participants since their use will result in the problem of high packet rates that grow with the number of participants.

Work has been done to attempt to extend the IP protocol to support multicasting. See RFC-1112 "Host Extensions for IP Multicasting". This document describes a set of extensions to the IP protocol that enable IP multicasting. IP multicasting supports the transmission of a IP datagram to a host group by addressing the datagram to a single destination address. Multicast addresses are a subset of the IP address space and identified by class DIP addresses—these are IP addresses with "1110" in the high order 4 bits. The host group contains zero or more IP hosts and the IP multicasting protocol transmits a multicast datagram to all members of the group to which it is addressed. Hosts may join and leave groups dynamically and the routing of multicast datagrams is supported by multicast routers and gateways. It is proper to describe this general approach to multicast messaging as "distributed multicast messaging". It is a distributed technique because the job of message delivery and duplication is distributed throughout the network to all of the multicast routers. For distributed multicast messaging to work in a wide area network, all of the routers handling datagrams for multicast hosts must support the routing of multicast datagrams. Such multicast routers must be aware of the multicast group membership of all of the hosts locally connected to the router in order to deliver multicast datagrams to local hosts. Multicast routers must also be able to forward multicast packets to routers on their local network links. Multicast routers must also decide to which if any local routers they must forward multicast datagrams. When a multicast datagram is received, by a multicast router, its group address is compared to a list for each local multicast router of group addresses. When there is a match, the datagram is then forwarded to that local multicast router. Therefore, the multicast routers in the network must maintain an accurate and up to date list of group addresses for which they are to forward datagrams to. These lists are updated when hosts join or leave multicast groups. Hosts do this by sending messages using Internet

Group Management Protocol (IGMP) to their immediately-neighboring multicast routers. A further attribute of distributed multicast messaging is that the routers must propagate the group membership information for a particular group throughout the network to all of the other routers that will be forwarding traffic for that group. RFC-1112 does not describe how this is to be done. Many different approaches have been defined for solving this problem that will be mentioned later in descriptions of related prior art. Despite their differences, all of these approaches are methods for propagation of multicast routing information between the multicast routers and techniques for routing the multicast datagrams in an inter-network supporting distributed multicast messaging.

The distributed multicast messaging approach has a number of undesirable side effects. The process of propagation of group membership information to all of the relevant routers is not instantaneous. In a large complex network it can even take quite a period of time depending on the number of routers that must receive that updated group membership information and how many routers the information for the group membership update must past through. This process can easily take many seconds and even minutes depending on the specifics of the algorithm that is used. RFC-1112 mentions this problem and some of the side effects that must be handled by an implementation of a practical routing algorithm for multicast messaging. One problem results when groups are dynamically created and destroyed. Since there is no central authority in the network for assigning group addresses, it is easily possible in a distributed network for there to be duplication of group address assignment. This will result in incorrect datagram delivery, where hosts will receive unwanted datagrams from the duplicate group. This requires a method at each host to filter out the unwanted datagrams. Another set of problems result from the time delay from when a group is created, destroyed or its membership changed to when all of the routers needed to route the datagrams to the member hosts have been informed of these changes. Imagine the case where Host N joins an existing group by sending a join message to its local router. The group already contains Host M which is a number of router hops away from Host N in the network. Shortly after Host N has sent it join message, Host M sends a datagram to the group, but the local router of Host M has not yet been informed of the change in group membership and as a result the datagram is not forwarded to one of the particular network links connected to the local router of Host M that is the only path in the network from that router that ultimately will reach Host N. The result is that Host N will receive no datagrams addressed to the group from Host M until the local router of M has its group membership information updated. Other related problems can also occur. When a host leaves a group, messages addressed to the group will continue for some time to be routed to that host up to the local router of that host. The local router will know at least not to route the datagram onto the local network of that host. This can still result in a great deal of unnecessary datagrams being carried in a large network when there are many active message groups with rapidly changing memberships.

Finally, distributed multicast messaging does not sufficiently reduce the message rate between the hosts. With distributed multicast messaging, each host need only send one message addressed to the message group in order to send a message to all of other hosts in the group. This is an improvement over conventional unicast messaging where one message would need to be sent to each of the other hosts in a group. However, distributed multicast messaging does nothing to reduce the received message rate at each of the hosts when multiple hosts in a group are sending messages to the group closely spaced in time. Let us return to the example of a group of ten hosts sending messages seven times per-second to the group. With conventional unicast messaging, each host will need to send 9 messages to the other hosts, seven times per-second and will receive 9 messages, seven times per-second. With distributed multicast messaging, each host will need to send only one message to the group containing all of the hosts seven times per-second, but will still receive 9 messages, seven times per-second. It is desirable to further reduce the number of received messages.

An example of distributed multicasting is shown in FIGS. **3** and **4**. FIG. **3** shows a network with multicast routers **39**, **40**, **41**, **42**, **43** and **44** and hosts **35**, **36**, **37**, **38** and network links **45**, **46**, **47**, **48**, **49**, **50**, **51**, **52** and **53**. The four hosts have unicast network addresses A, B, C, D and are also all members of a message group with address E. In advance the message group was created and each of the hosts joined the message group so that each of the multicast routers is aware of the message group and has the proper routing information. A network protocol such IP with multicast extensions is assumed to be used in this example. Host **35** sends packet **54** with source address A and destination multicast address E to the entire message group. In the same manner host **37** sends packet **55** to the group, host **36** sends packet **56** to the group and host **38** sends packet **57** to the group. As the packets are handled by the multicast routers they are replicated as necessary in order to deliver them to all the members of the group. Let us consider how a packets sent by host **35** is ultimately delivered to the other hosts. Packet **54** is carried over network link **45** to multicast router **39**. The router determines from its routing tables that the multicast packet should be sent onto network links **46** and **47** and duplicates the packet and sends to both of these network links. The packet is received by multicast routers **40** and **43**. Multicast router **43** sends the packet onto network link **50** and router **40** sends its onto links **48** and **49**. The packet is then received at multicast routers **44**, **42** and **41**. Router **41** sends the packet over network link **51** where it is received by host **36**. Router **42** sends the packet over network link **52** to host **37** and router **44** sends the packet over link **53** to host **38**. A similar process is followed for each of the other packets sent by the hosts to the multicast group E. The final packets received by each host are shown in FIG. **4**.

While distributed multicasting does reduce the number of messages that need to be sent by the hosts in a networked interactive application, it has no effect on the number of messages that they receive. It has the further disadvantages of poor behavior when group membership is rapidly changing and requires a special network infrastructure of multicast routers. It also has no support for message aggregation and cannot do so since message delivery is distributed. Distributed multicasting also has no support for messages that define logical operations between message groups and unicast host addresses.

All of these problems can be understood when placed in context of the design goals for distributed multicast messaging. Distributed multicast messaging was not designed for interactive applications where groups are rapidly created, changed and destroyed. Instead it was optimized for applications where the groups are created, changed and destroyed over relatively long time spans perhaps measured in many minutes or even hours. An example would be a video conference where all the participants agreed to connect the conference at a particular time for a conference that might last for an hour. Another would be the transmission of an audio or video program from one host to many receiving hosts, perhaps measured in the thousands or even millions. The multicast group would exist for the duration of the audio/video program. Host members would join and leave dynamically, but in this application it would be acceptable for there to be a significant time lag from joining or leaving before the connection was established or broken.

While IP and multicast extensions to IP are based on the routing of packets, another form of wide area networking technology called Asynchronous Transfer Mode (ATM) is based on switching fixed sized cells through switches. Unlike IP which supports both datagram and connection oriented services, ATM is fundamentally connection oriented. An ATM network consists of ATM switches interconnected by point-to-point links. The host systems are connected to the leaves of the network. Before any communication can occur between the hosts through the network, a virtual circuit must be setup across the network. Two forms of communication can be supported by an ATM network. Bi-directional point-to-point between two hosts and point-to-multipoint in one direction from one host to multiple hosts. ATM, however, does not directly support any form of multicasting. There are a number of proposals for layering multicasting on top of ATM. One approach is called a multicast server, shown in FIG. **8**. Host systems **112**, **113**, **114**, **115** setup point-to-point connections **106**, **107**,**108** and **109** to a multicast server **105**. ATM cells are sent by the hosts to the multicast server via these links. The multicast server sets up a point-to-multipoint connection **111** to the hosts which collectively constitute a message group. Cells sent to the server which are addressed to the group are forwarded to the point-to-multipoint link **111**. The ATM network **110** is responsible for the transport and switching for maintaining all of the connections between the hosts and the server. The cells carried by the point-to-multipoint connection are duplicated when necessary by the ATM switches at the branching points in the network tree between and forwarded down the branching network links. Therefore, the network is responsible for the replication of the cells and their payloads, not the server. This method has the same problems as distributed multicasting when used for an interactive application. Each host still receives individual cells from each of the other hosts, so there is no aggregation of the payloads of the cells targeted at a single host. There is no support for addressing cells to hosts based on logical operations on the sets of members of host groups.

Related Prior Art

There are a number of existing patents and European patent applications that are related to the area of the invention. These can be organized into two separate categories: multicast routing/distribution and source to destination multicast streams.

Multicast routing and distribution

These patents are U.S. Pat. No. 4,740,954 by Cotton et al, U.S. Pat. No. 4,864,559 by Perlman, U.S. Pat. No. 5,361,256 by Doeringer et al, U.S. Pat. No. 5,079,767 by Perlman and U.S. Pat. No. 5,309,433 by Cidon et al. Collectively these patents cover various algorithms for the routing and distribution of the datagrams in distributed multicast networks. None deal with the problems described previously for this class of multicast routing and message distribution such as poor behaviors when the message groups change rapidly. In all of these patents, messages are transmitted from a host via a distributed network of routers to a plurality of destination hosts which are members of a group. Since these patents deal only with variants of distributed multicasting they provide no means to reduce the received message rate, no method to aggregate messages and provide no method in the messages to perform logical operation on message groups.

Source to destination multicast streams

These are PCTs and a European patent application. They are EP 0 637 149 A2 by Perlman et al, PCT/US94/11282 by Danneels et al and PCT/US94/11278 by Sivakumar et al. These three patent applications deal with the transmission of data streams from a source to a group of destinations. In none of these patent applications, is a method described for transmitting data between multiple members of a group. In all of these applications, the data transmission is from a source to a plurality of designations. Since these patent applications deal only with point-to-multipoint messaging, they can provide no means to reduce the received message rate, no method to aggregate messages and provide no method in the messages to perform logical operation on message groups.

SUMMARY OF THE INVENTION

The present invention relates to facilitating efficient communications between multiple host computers over a conventional wide area communications network to implement an interactive application such as a computer game between multiple players. In such an application, the hosts will be dynamically sending to each other information that the other hosts need in order to keep the interactive application operating consistently on each of the hosts. The invention is comprised of a group messaging server connected to the network that maintains a set of message groups used by the hosts to communicate information between themselves. The invention further comprises a server-group messaging protocol used by the hosts and the server. The server-group messaging protocol is layered on top of the Transport Level Protocol (TLP) of the network and is called the Upper Level Protocol (or ULP). In the OSI reference model the ULP can be thought of as a session layer protocol built on top of a transport or applications layer protocol. The ULP protocol uses a server-group address space that is separate from the address space of the TLP. Hosts send messages to addresses in the ULP address space to a group messaging server using the underlying unicast transport protocol of the network. The ULP address space is segmented into unicast addresses, implicit group messaging addresses and logical group messaging addresses. The implicit and logical group messaging addresses are collectively called group messaging addresses.

Host systems must first establish connections to a group messaging server before sending messages to any ULP addresses. The process of establishing this connection is done by sending TLP messages to the server. The server establishes the connection by assigning a unicast ULP address to the host and returning this address in an acknowledgment message to the host. Once connected, hosts can inquire about existing message groups, join existing message groups, create new message groups, leave message groups they have joined and send messages to ULP addresses known by the server. Each message group is assigned either an implicit or logical ULP address depending on its type.

FIG. **5** shows an example of a wide area network with a group messaging server ("GMS"). Hosts **58** has TLP address A and ULP address H, host **59** has TLP address C and ULP address J, host **60** has TLP address B and ULP address I and host **61** has TLP address D and ULP address K. The network is a conventional unicast network of network links **69**, **70**, **71**, **72**, **73**, **74**, **75**, **76**, and **77** and unicast routers **63**, **64**, **65**,

66, **67**, and **68**. The group messaging server **62** receives messages from the hosts addressed to a message group and send the contents of the messages to the members of the message group. FIG. **6** shows an example of datagrams sent from the hosts to a message group that they are members of As before, a TLP such as IP (where the message header contain the source and destination TLP addresses) is assumed to be used here. Host **58** sends message **80** which contains the TLP source address A of the host and the destination TLP address S for the GMS **62**. The destination ULP address G is an implicit ULP address handled by the GMS and the payload **P1** contains both the data to be sent and the source ULP address H of the host. It is assumed that prior to sending their ULP messages to the GMS, that each host as already established a connection to the GMS and joined the message group G. Host **60** sends message **81** with payload **P2** containing data and source ULP address I. Hosts **59** sends message **82** with payload P3 containing data and source ULP address J. Host **61** sends message **83** with payload **P4** containing data and source ULP address K. The GMS receives all of these messages and sees that each message is addressed to implicit message group G with members H, I, J, and K. The GMS can either process the message with or without aggregating their payloads. FIG. **6** shows the case where there is no aggregation and FIG. **7** shows the case with aggregation.

Without aggregation, the GMS generates the outbound messages **84**, **85**, **86**, **87**, **88**, **89**, **90**, **91**, **92**, **93**, **94**, and **95** which it sends to the hosts. The datagrams have TLP headers with the source and destination TLP addresses of the GMS and the hosts respectively. The next field in the datagrams is the destination ULP of the datagram. Datagrams **84**, **85**, and sent to host **58** with TLP address A and ULP address H. Datagrams **87**, **88**, and **89** are sent to host **60** with TLP address B and ULP address I. Datagrams **90**, **91** and **92** are sent to host **59** with TLP address C and ULP address J. Datagrams **93**, **94** and **95** are sent to host **61** with TLP address D and ULP address K respectively. As can be seen from the payloads that each host has received, each host has received the payloads from the other three hosts. Note that each host has not received a copy of its own original message. This is because the GMS has performed echo suppression. This is selectable attribute of the GMS since in some applications it is useful for the hosts to receive and echo of each message that they send to a group that they are also members of In the example of FIG. **6**, it has been shown how the present invention can achieve the same message delivery as distributed multicasting without its disadvantages. Without aggregation, the present invention enables a host to send a single message to multiple other hosts that are members of a message group. It reduces the message traffic that a host must process in an interactive application by reducing the number of messages that each host must send to the others. Without aggregation, however, there is no reduction in the number of messages received by the hosts. Without aggregation we can achieve the same message rate as distributed multicasting without the need for a network with multicast routers, we can use a conventional unicast network such as the Internet. The present invention also avoids the problems that dynamic group membership causes for distributed multicasting. Group membership can be changed very rapidly. Groups can be created, joined and left by single unicast messages from hosts to the GMS. These messages will be point-to-point messages and will not have to propagate in throughout the network nor have to cause routing table changes in the routers. This ability to rapidly and accurately change group membership is critical to the

implementation of networked interactive applications. Consider a computer game for multiple players that supports hundreds of players that are spread throughout a three dimensional space created by the game. At any time only a few players will be able to see and effect one another in the game since other players will be in other areas that are out of sight. Using conventional phone lines to carry the data from each players computer to the network, it will not be possible to send all actions of each player to all of the other players, but because only a few players will be in close proximity at any one time, it will not be necessary to do so. It is only necessary to send data between the players that are in close proximity to one another. These "groups" of players naturally map onto the message groups of the invention. As players move about the three dimensional space of the game, game will cause them to join and leave message groups as necessary. If this does not happen rapidly it will limit the interactivity of the game or cause inconsistent results for the different players in the game.

The invention also allows aggregating message payloads of multiple messages destined to a single host into a single larger message. This can be done because of the GMS where all of the messages are received prior to being sent to the hosts. FIG. **7** shows an example of how this works. The hosts send their messages to the GMS in exactly the same fashion as in FIG. **6** using the same addresses previously defined in FIG. **5**. Host **58** sends message **96**, host **60** sends message **97**, host **59** sends message **98** and host **61** sends message **99**. The GMS receives all of these messages and creates four outbound messages **100**, **101**, **102** and **103**. The process by which these messages will be explained in detail in the detailed description of the invention. Each message is destined to a single host and contains an aggregated payload with multiple payload items. Message **100** has a destination ULP address H for host **58** and aggregated payload P**2**, P**3** and P**4** from the messages from hosts **59**, **60** and **61**. Message **101** is targeted at host **60**, message **102** is targeted at host **59** and message **103** is targeted at host **61**, As can be seen, each host sends one message and receives one message. The received message is longer and contains multiple payloads, but this is a significant improvement over receiving multiple messages with the wasted overhead of multiple message headers and message processing time. Overall the invention has dramatically reduced the amount of data that must be sent and received by each host. Since the bit rate over conventional phone lines using a modem is low, a reduction in the amount of data that must be sent and received directly translates into improved time and latency for message communications between the hosts.

Hosts create, join and leave message groups using control messages in the ULP protocol to the GMS. Hosts may also read and write application specific state information that is stored in the GMS. When hosts send messages to other hosts, the message must be at least addressed to an implicit group address. The ULP implicit address will always be the primary address in a message from one host to another. The message may optionally specify auxiliary destination addresses. In many cases the implicit ULP address will be the only destination ULP address in the message. The GMS will handle delivery of the ULP messages addressed to the implicit message group to all of the hosts that are members of the group. A ULP send message may optionally specify an address list of auxiliary addresses in addition to the primary destination of the implicit ULP address. This auxiliary address list can contain only unicast and logical ULP addresses. The address list can also specify set operators to be performed between the sets of host ULP addresses defined by the unicast addresses and logical groups. Once the address list has been processed to yield a set of hosts, this set is intersected with the set of hosts that are members of the implicit message group specified by the primary implicit ULP address in the message. This ability to perform logical set operators on message groups is very useful in interactive applications. It allows a single ULP message to selectively deliver a message to hosts that fit a set of computed criteria without the sending host having to know the anything about the members of the groups in the address list. Recall the example of a networked game with hundreds of players in a three dimensional environment created by the game. Consider an implicit message group consisting of all of the game players in a certain area of the game where all of the players can interact with one another. Consider that the players are organized into multiple teams. Logical message groups could be created for each team within the game. To send a message to all the players within the area that were on one team, a ULP message would be sent to the ULP implicit message group for all the players in the area with an auxiliary address of the logical message group for all the players on the selected team. The GMS would perform the proper set intersection prior to sending the resulting messages to the targeted hosts. The result of this will be that the message will only be delivered to the players on the selected team in the selected area of the game.

In summary, the present invention deals with the issues of deploying an interactive application for multiple participants on wide area networks by providing a method for reducing the overall message rate and reducing latency. This invention uses a server group messaging approach, as oppose to the above described "distributed multicast messaging" approach. The present invention overcomes the undesirable side effects of the distributed multicast messaging approach. Further, it reduces the message rate between the hosts. As pointed out in an example discussed above, with prior art distributed multicast messaging, each host will need to send only one message to the group containing all of the hosts seven times per-second, but will still receive 9 messages, seven times per-second. The present invention of server group messaging has each host sending one message, seven times per-second and receiving one message, seven times per-second.

The present invention is different from the multicast routing and distribution method disclosed in U.S. Pat. Nos. 4,740,954, 4,864,559, 5,361,256, 5,079,767 and 5,309,433. Since these patents deal only with variants of distributed multicasting they provide no means to reduce the received message rate, no method to aggregate messages and provide no method in the messages to perform logical operation on message groups. This differs from the present invention where messages from multiple hosts addressed to a message group are received by a group server which processes the contents of the messages and transmits the results to the destination hosts.

The present invention is also different from the source to destination multicast streams approach disclosed in EP 0 637 149 A2, PCT/US94/11282 and PCT/US94/11278. In all of these references, the data transmission is from a source to a plurality of designations, whereas the present invention describes data transmission from a sending host to a server host system and then from the server host to the destination hosts.

These and other features and advantages of the present invention can be understood from the following detailed description of the invention together with the accompanying drawings.

DESCRIPTION OF DRAWINGS

FIG. **1** shows a conventional unicast network consisting of hosts, network links and routers.

FIG. **2** shows the unicast datagrams on a conventional unicast network that would be needed to implement an interactive application between four hosts.

FIG. **3** shows a prior art multicast network consisting of hosts, network links and multicast routers.

FIG. **4** shows a multicast datagrams on a prior art multicast network that would be needed to implement an interactive application between four hosts.

FIG. **5** shows a unicast network equipped with a group messaging server in accordance with the present invention.

FIG. **6** shows the ULP datagrams without payload aggregation on a network according to the present invention that would be needed to implement an interactive application between four hosts.

FIG. **7** shows the ULP datagrams with payload aggregation on a network according to the present invention that would be needed to implement an interactive application between four hosts.

FIG. **8** shows a prior art ATM network with a multicast server.

FIG. **9** shows the detailed datagram format and address format for ULP messages in accordance with the present invention.

FIG. **10** shows the internal functions of the GMS according to the present invention.

FIG. **11** shows the host software interface and functions needed to support the ULP according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention provides a method for multiple host computers to efficiently communicate information to one another over a wide area network for the purposes of implementing an interactive application between multiple users. The method consists of three components: a host protocol interface, a protocol and a server. The protocol is between the host protocol interface and the server and is implemented on top of the network transport protocol of a wide area network. The protocol is called the Upper Level Protocol (ULP) since it is layered above the existing network Transport Level Protocol (TLP). In the OSI reference model the protocol can be described as a Session Layer protocol on top of the Transport Layer of the network. FIG. **11** shows the host protocol interface, **151**, relative to the interactive application, **150**, and the host interface for the Transport Level Protocol, **153**. The network interface, **155**, provides the physical connection for the host to the network. The network communications stack, **154**, is the communications protocol stack that provides network transport services for the host and the host interface for the Transport Level Protocol, **153**, is and interface between host application software and the network transport services of the network communications stack.

The interactive application can send and receive conventional network messages using the host interface to the TLP. The interactive application also can send and receive ULP messages through the host interface for the ULP. Internal to the host interface for the ULP is a table, **152**, of all ULP addresses which the host can send messages to. Each entry in the table contains a pair of addresses, a ULP address and its corresponding TLP address. When the host sends a message to a ULP address, that message is encapsulated in a TLP message sent to the TLP address corresponding to that ULP address. This allows the ULP messages to be handled transparently by the transport mechanisms of the existing network. A core function of the ULP is group messaging where hosts send messages to message groups populated by multiple hosts. This allows a host to send a message to multiple hosts with one ULP message. Since the ULP is layered on top of the TLP, the group messaging functions of the ULP operate on a conventional unicast network where TLP messages can only be sent from one host to only one other host.

The group based messaging is implemented through the use of a server called a group messaging server. All ULP messages from the hosts are sent from the hosts to a group messaging server using the TLP protocol. The server processes the ULP portion of the messages and takes the necessary required by the ULP message. Control ULP messages are processed locally by the server and may be acknowledged to the sending host. ULP messages addressed to other hosts are processed by the group messaging server and then re-transmitted to the proper ULP destination hosts, again using the TLP protocol to encapsulate and transport these messages.

In FIG. **5**, hosts **58**, **59**, **60** and **61** send messages to one another using the ULP over a conventional unicast network using a group messaging server **62**. The network consists of conventional routers **63**, **64**, **65**, **66**, **67** and **68** connected with conventional network links **69**, **70**, **71**, **72**, **73**, **74**, **75**, **76** and **77**. Host **58** can send a message to hosts **59**, **60** and **61** by sending a single ULP message to the group messaging server **62** where the ULP message specifies a destination address that is a ULP message group. The ULP message is encapsulated in a TLP message addressed to the group messaging server. This causes the message to be properly routed by router **63** to network link **71** to router **67** to the server **62**. The group messaging server receives the ULP message and determines that the message is addressed to a message group containing hosts **59**, **60** and **61** as members. The server sends the payload of the received message to each of the hosts in three new ULP messages individually sent to the three hosts. Since each message is encapsulated in a TLP message, the messages are properly carried over the conventional unicast network. The first ULP message is sent by the group messaging server to host **61**. This message is carried by network links **71**, **70**, **72** and **75** and routers **67**, **63**, **64** and **65**. The second ULP message is sent by the group messaging server to host **60**. This message is carried by network links **71**, **70**, **73** and **76** and routers **67**, **63**, **64** and **66**. The third ULP message is sent by the group messaging server to host **61**. This message is carried by network links **74** and **77** and routers **67** and **68**.

The invention can be implemented both in a datagram form and in a connection oriented form. To best understand the details of the invention, it is best to first consider a datagram implementation.

Datagram Transport Implementation

The ULP can be implemented as a datagram protocol by encapsulating addresses, message type information and the message payload within a datagram of the underlying network transport protocol. The general form of the ULP datagram message format is shown in FIG. **9** as elements **123**, **124**, **125**, **126**, **127**, **128** and **129**. The transport header **123** is the datagram header of the TLP that is encapsulating the ULP datagram. The ULP message type field **124** indicates whether it is a send or receive message, if it is a control

message or a state message. The following table shows the different message types. The ULP message type field must be present in a ULP datagram.

Message Types	
1	Send
2	Receive
3	Send Control
4	Receive Control
5	Send State
6	Receive State

Send messages are always sent from a host to a group messaging server. Messages from a group server to the hosts are always receive messages. Send Control messages are messages from hosts to a group messaging server requesting a control function be performed. Receive Control messages are acknowledgments from a group messaging server to the hosts in response to a prior Send Control messages. The Send and Receive State messages are special cases of the Send and Receive Control messages that allow hosts to read and write application specific state storage in the group messaging server. The specific control functions supported by the ULP will be explained later.

The destination ULP address **125** is required in ULP datagrams and specifies the primary destination of the ULP message. The address count field **126** is required in ULP send message types and is not present in ULP receive message types. When the address count field in a ULP send message is non-zero, it specifies the number of auxiliary destination addresses for the send message that follow the address count field. These auxiliary destination addresses are shown as items **127** and **128**, but it is understood that there are as many auxiliary ULP destination addresses as specified by the address count field. Finally there is the payload **129**.

The payload format for ULP datagrams is defined by items **116**, **117**, **118**, **119**, **120**, **121** and **122**. Item **116** is the message count and defines how many payload elements will be contained in the payload. A single payload element consists of a triplet of source ULP address, data length and data. Items **117**, **118** and **119** comprise the first payload element of the payload. Item **117** is the ULP address of the source of the payload element, item **118** is the data length for the data in the payload element and item **119** is the actual data. Items **120**, **121** and **122** comprise the last payload element in the payload. ULP send messages only support payloads with a single payload element, so the message count is required to be equal to one. ULP receive messages may have payloads with one or more payload elements.

ULP Address Space

The address space of the ULP is divided into three segments: unicast host addresses, implicit group addresses and logical group addresses. All source and destination addresses in ULP must be in this address space. The ULP address space is unique to a single group messaging server. Therefore each group messaging server has a unique ULP address space. Multiple group messaging servers may be connected to the network and hosts may communicate with multiple group messaging servers without confusion since each ULP datagram contains the header of the TLP. Different group messaging servers will have unique TLP addresses which can be used by the hosts to uniquely identify multiple ULP address spaces. The format for ULP addresses is shown in FIG. **9** comprised of items **130**, **131** and **132**. The address format field **130** is a variable length field used to allow multiple address lengths to be supported. The address type field **131** indicates the type of ULP address: unicast host, implicit group or logical group. The encoding is as follows:

Address Type Encoding	
0 0	Unicast Host Address
0 1	Unicast Host Address
1 0	Implicit Group Address
1 1	Logical Group Address

The address format encoding determines the length of the address field and therefore the total length of the ULP address. This encoding is shown below. Note that when the address type specifies a unicast host address, the low bit of the address type field is concatenated to the address field to become the most significant bit of the address. This doubles the size of the address space for unicast host addresses which is useful since there will generally be more hosts than group messaging servers.

Address Format Encoding	
0	29 Bit Address Field
1 0	4 Bit Address Field
1 1 0	11 Bit Address Field

ULP unicast host addresses are assigned to each host when it first connects to a group messaging server. When a host sends a message to other ULP address, the unicast ULP address of the host will appear as the source ULP address in the received payload element. Unicast ULP host addresses can also be used as destination addresses only as auxiliary addresses in a ULP send message. They are not allowed to be used to as the primary ULP destination address. This means that hosts cannot send ULP directly to one another, but always must send the messages to one another through a group messaging server.

Implicit group addresses are created by a group messaging server in response to a control message to the server requesting the creation of an implicit message group. The host requesting the creation of the implicit message group becomes a member of the message group when it is created. Other hosts can send inquiry control messages to the group messaging server to learn of its existence and then send a implicit group join message in order to join the group. The group messaging server maintains a list of ULP addresses of hosts that are members of the implicit message group. Implicit ULP group addresses are the only ULP addresses allowed to be the primary destination of a ULP send message. Implicit ULP addresses will never appear as ULP source addresses in a payload element.

Logical ULP addresses are used both to address logical message groups and for specifying set operations between the group members of the auxiliary ULP addresses in a ULP send message. Logical message groups are created and joined similarly to implicit message groups, however, logical ULP addresses may only be used as auxiliary ULP addresses in a ULP send message. Logical ULP addresses will also never appear as source ULP addresses in a payload element. The support of set operations between message groups as part of a ULP send message will be explained in a later section on ULP send messages.

Group Messaging Server Internal Functions

The internal components of the group messaging server are shown in FIG. **10**.

In the preferred embodiment, the group messaging server is a general purpose computer system with a network interface to connect it to a wide area network. Item **135** is the network interface for the group messaging server and includes not only the hardware connection to the network but the communications protocol stack used to implement the TLP on the server.

Item **136** is an overall control function for the group messaging server. This control function is responsible for all ULP messages that are sent or received by the GMS. Internal to this control function are several important storage and processing functions. Item **137** is an address map for all hosts currently connected to the GMS. This address map is a list of the ULP host address of each host connected to GMS and its corresponding TLP address. This enables the control function to construct the necessary TLP headers for sending ULP messages to the hosts connected to the GMS. Item **138** is a list of all of the currently active implicit ULP addresses currently recognized by the GMS. Item **139** is an application specific state storage and processing function. Many interactive applications deployed over a network will be able to be implemented solely with host based processing. In these cases all data that needs to be sent between the hosts can be transported using the ULP. However, some applications will need maintain a centrally stored and maintained repository of application state information. This is useful when hosts may join or leave the application dynamically. When hosts join such an application, they will need a place from which they can obtain a snapshot of the current state of the application in order to be consistent with the other hosts that already where part of the application. To read and write this state storage area, the ULP supports send and receive state message types. Within these messages, there is the ability to access a state address space so that different portions of the state can be individually accessed. Application specific processing of state written into this state storage area can also be implemented.

Items **140** and **141** are two of multiple ULP server processes running on the GMS. These are software processes that are at the heart of the ULP. Each implicit ULP addresses recognized by the GMS has a one-to-one correspondence to a ULP server process and to a message group maintained by the process. Since all ULP send messages must have an implicit ULP address as the primary destination address of the message, every ULP send message is sent to and processed by a ULP server process. These processes are created by the GMS control function in response to ULP control messages to create new implicit ULP addresses. They are destroyed when the last host which is a member of its message group has left the message group. Internal to a ULP server process is a list, **142**, of the ULP host addresses of the members of the message group, a set of message queues **143** for each host which is a member of the message group and a message aggregation function **149** which is used to aggregate multiple messages to a single host into a single message.

Item **145** maintains a list of all of the logical ULP addresses and message groups in the GMS. Items **144** and **146** represent two of multiple logical ULP addresses. For each logical ULP address, there is a corresponding list, **147** and **148** of the host ULP addresses of the members of the logical message group. The logical message groups are not tied to specific ULP server processes, but are global with a GMS to all of the ULP server processes.

Control Functions

The control functions consist of connect, disconnect, create group, close group, join group, leave group, query groups, query group members, query group attributes. These control functions are implemented by a ULP send and receive control messages. The control functions are initiated by a host sending a ULP send control message to a GMS. These messages only allow a primary ULP destination address in the message and do no allow auxiliary addresses. The primary ULP address is interpreted as a control address space with a unique fixed address assigned to each of the control functions enumerated above. The contents of data in the payload supplies any arguments needed by the control function. Returned values from the control function are returned in a ULP receive control message that is addressed to the host that sent the original control message for which data is being returned. The detailed operation of these control functions is described below.

Connect

This control function allows a host to connect to a GMS. The destination ULP address in the message is a fixed address that indicates the connect function. The source ULP address and any data in the payload are ignored.

Upon receiving this message, the GMS control function, **136**, creates a new host address and enters the host address in the host address map **136** along with the source TLP address from the TLP header of the message. Upon successful completion, the GMS control function responds with a receive control ULP message addressed to the host along with a function code in the data portion of the payload that indicates successful host connection. The destination ULP address in the message is the ULP address assigned to the host. The host saves this and uses it for any future messages to the GMS. If there is an error, the control function returns a message to the host with a function code in the data portion of the payload indicating failed host connection.

Disconnect

This function allows a host to disconnect from a GMS. The destination ULP address in the message is a fixed address that indicates the disconnect function. The source ULP address is used to remove the host from membership in any implicit or logical groups prior to disconnecting. Any data in the payload is ignored. The GMS control function also removes the entry for the host from the host address map. Upon successful completion, the GMS control function responds with a receive control ULP message addressed to the host along with a function code in the data portion of the payload that indicates successful host disconnection. The destination ULP address in the message is the ULP address assigned to the host. If there is an error, the control function returns a message to the host with a function code in the data portion of the payload indicating failed host disconnection.

Create implicit group

This function allows a host to create a new implicit message group and associated implicit ULP address and server process. The payload in the message may contain a single payload item whose data field holds attributes of the group. These attributes can be used to define any optional functions of the group. The destination ULP address in the message is a fixed address that indicates the create implicit group function. The GMS control function allocates a new implicit ULP address, adds it to the implicit ULP address list **138** and creates a new ULP server process **140**. The host that sends this message is added to the membership list of the implicit group. This is done by adding the source ULP address in the message to the group membership list **142** in the ULP server process. Upon successful completion, the GMS control function responds with a receive control ULP message addressed to the host along with a function code in the data portion of the payload that indicates successful implicit group creation. The source ULP address in the payload is the ULP address assigned to the new implicit group. If there is an error, the control function returns a message to the host with a function code in the data portion of the payload indicating failed implicit group creation.

Create logical group

This function allows a host to create a new logical message group and associated logical ULP address. The payload in the message may contain a single payload item whose data field holds attributes of the group. These attributes can be used to define any optional functions of the group The destination ULP address in the message is a fixed address that indicates the create logical group function. The GMS control function allocates a new logical ULP address and adds it to the logical ULP address list **145**. The host that sends this message is added to the membership list of the logical group. This is done by adding the source ULP address in the message to the group membership list **147** for the new logical message group **144**. Upon successful completion, the GMS control function responds with a receive control ULP message addressed to the host along with a function code in the data portion of the payload that indicates successful logical group creation. The source ULP address in the payload is the ULP address assigned to the new logical group. If there is an error, the control function returns a message to the host with a function code in the data portion of the payload indicating failed implicit group creation.

Join group

This function allows a host to join an existing logical or implicit message group. The destination ULP address in the message is a fixed address that indicates the join group function. The data portion of the payload contains the ULP address of the group that is to be joined. The GMS control function looks at this address and determines if it is an implicit or logical ULP address. If it is an implicit ULP address, the GMS control function finds the ULP server process selected by the address in the message payload and adds the source ULP host address from the message to the group membership list **142**. If it is a logical ULP address, the GMS control function finds the logical ULP address **144** selected by the address in the message payload and adds the source ULP host address from the message to the group membership list **147**. Upon successful completion, the GMS control function responds with a receive control ULP message addressed to the host along with a function code in the data portion of the payload that indicates successful group join. The source ULP address in the payload is the ULP address of the group that was joined. If there is an error, the control function returns a message to the host with a function code in the data portion of the payload indicating failed implicit group creation.

Leave group

This function allows a host to leave an existing logical or implicit message group that it is a member of The destination ULP address in the message is a fixed address that indicates the leave group function. The data portion of the payload contains the ULP address of the group that is to be left. The GMS control function looks at this address and determines if it is an implicit or logical ULP address. If it is an implicit ULP address, the GMS control function finds the ULP server process selected by the address in the message payload and removes from the group membership list **142** the source ULP host address from the message. If the host is the last member of the group, the ULP server process is terminated and the implicit ULP address is de-allocated. If it is a logical ULP address, the GMS control function finds the logical ULP address **144** selected by the address in the message payload and removes from the group membership list **147** the source ULP host address from the. If the host is the last member of the group, the ULP address is de-allocated. Upon successful completion, the GMS control function responds with a receive control ULP message addressed to the host along with a function code in the data portion of the payload that indicates successful group leave. If there is an error, the control function returns a message to the host with a function code in the data portion of the payload indicating failed implicit group creation.

Query groups

This function allows a host to get a list of all implicit and logical message groups currently active on a GMS. The destination ULP address in the message is a fixed address that indicates the query groups function. Any data portion of the payload is ignored. Upon successful completion, the GMS control function responds with a receive control ULP message addressed to the host along with a payload with multiple payload elements. The first payload element contains a function code indicating successful query groups. The source ULP address in the first payload element is ignored. Each of the subsequent payload elements contain a ULP group address in the source address field of the payload element that is one of the active group addresses on the GMS. There is no data field in these subsequent payload elements. If there is an error, the control function returns a message to the host with a function code in the data portion of a payload with a single payload element indicating failed query groups.

Query group members

This function allows a host to get a list of all hosts that are members of a message group. The destination ULP address in the message is a fixed address that indicates the query group members function. The data portion of the payload carries the address of the message group for the query. Upon successful completion, the GMS control function responds with a receive control ULP message addressed to the host along with a payload with multiple payload elements. The first payload element contains a function code indicating successful query group members. The source ULP address in the first payload element is ignored. Each of the subsequent payload elements contain a ULP host address in the source address field of the payload element that is one of the active group addresses on the GMS. There is no data field in these subsequent payload elements. If there is an error, the control function returns a message to the host with a function code in the data portion of a payload with a single payload element indicating failed query group members.

Query group attributes

This function allows a host to get a list of the attributes of a message group. The destination ULP address in the message is a fixed address that indicates the query group attributes function. The data portion of the payload carries the address of the message group for the query. Upon successful completion, the GMS control function responds with a receive control ULP message addressed to the host along with a payload with a two payload elements. The first payload element contains a function code indicating successful query group members. The second payload element contains the attributes of the message group. If there is an error, the control function returns a message to the host with a function code in the data portion of a payload with a single payload element indicating failed query group attributes.

Send Message Operation

In order to fully understand the operations of the send message function, a number of individual cases are worth considering.

Single implicit destination

The most simple case is a send message to a single implicit ULP address. In all send message datagrams, the destination ULP address **125** must be an implicit ULP address. In this case of a single implicit destination, this is the only destination address in the datagram. The auxiliary address count **126** is zero and there are no auxiliary destination addresses **127** or **128**. The payload consists of a message count **116** of one, the ULP of the host sending the message in the source ULP address **117** and the data length **118** and data **119**. Send message datagrams may only have a single payload item so their message count field **116** must always be one.

The host sends the send message onto the network with a TLP header addressing the data. The GMS the GMS that is the selected target of the message. The GMS receives the message and the GMS control function **136** determines that it is a send message datagram and looks up the implicit destination address in its implicit ULP address list **138**. If the address does not exist, an error message is returned to the sending host with a ULP receive message datagram. If the address is valid, the GMS control function removes the TLP header from the datagram and sends the ULP portion to the ULP server process corresponding to the destination implicit ULP address. Assume for discussion that this is the ULP server process **140**. The ULP server process **140** will extract the single payload item from the message **117**, **118** and **119** and place the payload item in each of the message queues **143**. There will be one message queue for each member of the message group served by the ULP server process **140**. The members of the group will have their host ULP addresses listed in the host address list **142**. Each message queue in a ULP server process will fill with payload items that are targeted at particular destination hosts. The mechanisms by which payload items are removed from the queues and sent to the hosts will be described later.

Auxiliary unicast destination

In this case in addition to an implicit destination **125**, there is also a single auxiliary address **127** in the datagram. The auxiliary address count **126** is one and the auxiliary destination addresses **127** is a unicast host ULP address. The payload consists of a message count **116** of one, the ULP of the host sending the message in the source ULP address **117** and the data length **118** and data **119**.

The host sends the send message onto the network with a TLP header addressing the datagram to the GMS that is the selected target of the message. The GMS receives the message and the GMS control function **136** determines that it is a send message datagram and looks up the implicit destination address in its implicit ULP address list **138** and the unicast host ULP auxiliary address in the host address map **137**. If either of addresses does not exist, an error message is returned to the sending host with a ULP receive message datagram. If the addresses are valid, the GMS control function removes the TLP header from the datagram and sends the ULP portion to the ULP server process corresponding to the destination implicit ULP address. Assume for discussion that this is the ULP server process **140**. The ULP server process extracts the auxiliary ULP address from the message and determines from the address that it is a unicast host ULP address. The server process then checks to see if this address is a member of the message group defined by the host address list **142**. If it is not, no further action is taken and the payload item in the message is not placed in any of the message queues **143**. If the host address is in the message group, the payload item in the message is placed in the single message queue corresponding to that host. The net effect is that the ULP server process has performed a set intersection operation on the members of the message group selected by the implicit ULP destination address and defined by the group membership list **142** with the members of the set of hosts defined by the auxiliary address. The payload item is them sent only to the hosts that are members of this set intersection.

Auxiliary logical destination

In this case in addition to an implicit destination **125**, there is also a single auxiliary address **127** in the datagram. The auxiliary address count **126** is one and the auxiliary destination addresses **127** is a logical ULP address. The payload consists of a message count **116** of one, the ULP of the host sending the message in the source ULP address **117** and the data length **118** and data **119**.

The host sends the send message onto the network with a TLP header addressing the datagram to the GMS that is the selected target of the message. The GMS receives the message and the GMS control function **136** determines that it is a send message datagram and looks up the implicit destination address in its implicit ULP address list **138** and the logical ULP auxiliary address in list of logical ULP addresses **145**. If either of addresses does not exist, an error message is returned to the sending host with a ULP receive message datagram. If the addresses are valid, the GMS control function removes the TLP header from the datagram and sends the ULP portion to the ULP server process corresponding to the destination implicit ULP address. Assume for discussion that this is the ULP server process **140**. The ULP server process extracts the auxiliary ULP address from the message and determines from the address that it is a logical ULP address. Assume for this example that this logical ULP address is the logical address **144**. The server process fetches the group membership list **147** corresponding to the logical address and performs a set intersection operation with the group membership list **142** of the server process. If there are no members of this set intersection, no further action is taken and the payload item in the message is not placed in any of the message queues **143**. If there are members of the set intersection operation, the payload item in the message is placed in the queues corresponding to the hosts that are members of the set intersection.

Multiple auxiliary addresses with logical operations

In its most sophisticated form, a send message can perform set operations between the implicit message group of the ULP server process and multiple logical and unicast ULP addresses. This is done by placing multiple auxiliary destination ULP addresses in the message with logical operators imbedded in the address list. The address count **126** holds a count of the total auxiliary addresses in the address list **127** and **128**. The auxiliary addresses are a mix of logical ULP addresses and unicast host ULP addresses. Two logical ULP addresses in the ULP address space are assigned the role of specifying set operations to be performed between the logical message groups and unicast host addresses in the message list. They are specially assigned addresses for the functions set intersection, set union. A third logical address is used to indicate set complement. The payload consists of a message count **116** of one, the ULP of the host sending the message in the source ULP address **117** and the data length **118** and data **119**.

The host sends the send message onto the network with a TLP header addressing the datagram to the GMS that is the selected target of the message. The GMS receives the message and the GMS control function **136** determines that it is a send message datagram and looks up the implicit ULP

message in the implicit ULP address list **138** and all of the addresses in the address list either in the host ULP address map **137** or in the logical ULP address list **145** as appropriate. If any of addresses does not exist, an error message is returned to the sending host with a ULP receive message datagram. If the addresses are valid, the GMS control function removes the TLP header from the datagram and sends the ULP portion to the ULP server process corresponding to the destination implicit ULP address. Assume for discussion that this is the ULP server process **140**. The ULP server process extracts the auxiliary ULP address list from the message and scans it from beginning to end. The scanning and processing of the set operators is done in post-fix fashion. This means that arguments are read followed by an operator that is then applied to the arguments. The result of the operator becomes the first argument of the next operation. Therefore at the start of scanning two addresses are read from the address list. The next address will be an operator that is applied to the arguments and the result of this operator is the first argument to be used by the next operator. From then on a single address is read from the address list followed by a logical ULP address which is operator on the two arguments consisting of the new argument and the results of the last operator. The logical address used to indicate set complement is not a set operator, by an argument qualifier since it can precede any address in the address list. The meaning of the set complement argument qualifier is relative to the group membership of implicit group address in the send message. If the set complement qualifier precedes a unicast host address which is not a member of the message group selected by the implicit ULP address in the send message, the effective argument is the set of all hosts that are members of the implicit message group. If the set complement qualifier precedes a unicast host address which is a member of the message group selected by the implicit ULJP address in the send message, the effective argument is the set of all hosts that are members of the implicit message group except for the original unicast host address qualified by the complement function. If the set complement qualifier precedes a logical ULP address the effective argument is the set of all hosts that are members of the implicit message group specified by the send message except hosts that are members of the logical message group preceded by the set complement modifier. Once the entire address list has been processed to a single result set of hosts, a set intersection operation is performed on this set and the set of members of the implicit message group **142** defined by the implicit address in the send message. If there are no members of this set intersection, no further action is taken and the payload item in the message is not placed in any of the message queues **143**. If there are members of the set intersection operation, the payload item in the message is placed in the queues corresponding to the hosts that are members of the set intersection.

Message Delivery and Aggregation

Once messages are entered into the message queues in the ULP server processes, there are a variety of ways that they can ultimately be delivered to the targeted hosts. In the invention, the delivery method is set on a per-ULP server process basis by attributes that are provided at the time that an implicit ULP message group and server process are created. It is important during the description of these methods to keep in mind that the invention is intended to provide an efficient means for a group of hosts to send messages to each other at a rapid rate during the implementation of a networked interactive application. Also assumed in the following description is that the GMS performs echo suppression when a host sends a message to a group that it belongs to. This means that the host will not receive a copy of its own message to the group either as a single un-aggregated message or as a payload item in an aggregated message. This is controlled by a ULP server process attribute that can be changed to stop echo suppression, but echo suppression is the default.

Immediate Delivery

The most simple delivery method is to immediately deliver the payload items to their targeted hosts as soon as they are placed in the message queues. Each payload item in a message queue will contain a ULP source address, a data length and the data to be sent. To implement immediate delivery, the ULP server process will remove a payload item from a message queue for a particular host **143**. The host address for this host will be obtained from the group membership list **142**. The payload item and the destination host address will be sent to the GMS control function **136** where it will be used to create a ULP receive message sent to the destination host. The GMS control function **136** will use the destination ULP host address to look up the TLP address of the host from the host address map **137**. This will be used to create a TLP header for the message **123**. The ULP message type **124** will be ULP receive, the destination ULP address **125** will be the destination host, the address count will be 0 and there will be no auxiliary addresses. The payload in this case will have a message count **116** of 1 and the payload item comprised of fields **117**, **118**, and **119** will be the payload element taken from the message queue.

Immediate delivery is useful when the message rate between a group of hosts is low. Consider four hosts that are members of an implicit message group where each member of the group sends a message to every other member of the group at a fixed rate. With immediate delivery, each host will send three messages to the other members of the group and receive three messages from the other members of the group at the fixed rate. This is acceptable is the size of the group is small and the message rate is low. However, it is obvious that total message rate is the product of the underlying message rate and the total number of members of the group minus one. Clearly this will result in unacceptably high message rates for large groups and highly interactive message rates. A group of 20 members that had an underlying message rate of 10 messages per second would yield a total message rate at each host of 190 messages sent and 190 messages received every second. This message rate will be unsupportable over a conventional dial-up connection to a conventional wide area network such as the internet.

Aggregation

A key concept in the present invention is the aggregation of multiple messages in a message queue into a single ULP receive message to a host that contains multiple payload items in the payload. The ULP server process **140** removes payload items from a message queue **143** for a host and accumulates them in an aggregation buffer **149**. The aggregation buffer has buffer areas for each host for which there is a message queue. These individual host areas within the aggregation buffer are called host aggregation buffers. The start and end of this aggregation period can be controlled in a number of ways that will be described in the next sections. At the end of the aggregation period, the each host aggregation buffer may hold multiple payload items. The host aggregation buffer will hold a message count of the payload items followed by the multiple payload items. The contents of a host aggregation buffer along with the ULP host address of the corresponding host are sent to the GMS control function **136** where it will be used to create a ULP receive

message sent to the destination host. The GMS control function **136** will use the destination ULP host address to look up the TLP address of the host from the host address map **137**. This will be used to create a TLP header for the message **123**. The ULP message type **124** will be ULP receive, the destination ULP address **125** will be the destination host, the address count will be 0 and there will be no auxiliary addresses. The payload in this case will have a message count **116** set by the message count value from the host aggregation buffer. The payload will contain all of the payload items from the host aggregation buffer.

The effect of aggregation will be to greatly reduce the total message rate received by the hosts. A single message to a host will be able to carry multiple payload items received from the other hosts during the aggregation period. This fits very well the interactive applications of this invention where groups of hosts will be sending messages to all the other hosts in the group at a periodic rate. Aggregation will be very effective in collecting together all of the messages from all of the other hosts into a single message for each member of the group. The reduces processing at each receiving host since a single message will be received rather than many separate messages. Aggregation will also reduce the total data rate to the hosts since aggregation eliminates the need for separate message headers for each payload item. The savings will be significant for small payload items since there will be only one message header comprising fields **123**, **124** and **125** for multiple payload items. In cases where a group of hosts are sending messages to the group at a periodic rate, it is often the case in many interactive applications that the data being sent by each host to the group is very similar to the messages sent by the other hosts. This affords the opportunity within an aggregated payload of multiple payload items to apply a data compression method across the multiple data elements of the payload elements. A wide variety of known data compression methods will lend themselves to this application. The first data element in the first payload item can be sent in uncompressed form with each subsequent data element being compressed using some form of difference coding method. A variety of known data compression methods use the concept of a predictor with differences from the predicted value being encoded. The first data element in an aggregated payload can be used as this predictor with the subsequent data elements coded using such a data compression method. These conventional data compression methods do not assume any knowledge of the internal structure or function of portions of a data element to compress. It is also possible to make use of application specific coding techniques that take advantage of such knowledge to potentially achieve much higher coding efficiency.

Server Isochronous

One method by which the aggregation time period can be defined is called Server Isochronous or SI. In this method, A ULP Server Process defines a uniform time base for defining the aggregation time period. This time base is defined by three parameters: the time period, the aggregation offset and the transmit offset. These parameters are set by the attributes provided in the create implicit group control function at the time the implicit group and the ULP server process are created. The time period is a fixed time interval during which the ULP server process will accumulate messages in the message queues, aggregate the messages in the queues and send the aggregated messages to the targeted hosts. The aggregation offset defines the point after the start of the time period after which arriving messages will be stored in the message queues for delivery in the next time period.

Therefore, at the aggregation offset after the start of the time period, a snapshot will be taken of all of the messages in each message queue. New messages will continue to arrive and be entered into the queues after the aggregation offset. Only those messages in the queues before the aggregation offset point will be aggregated into outbound messages. The resulting aggregated messages will then be sent to their targeted hosts at the point in time which is the transmit offset after the start of the time period. The result is that messages arrive continuously and are stored in the message queues. Once per time period the are aggregated into single messages to each host which is the target of messages and once per time period these aggregated messages are sent to the hosts.

Another embodiment of the SI method is to allow the ULP server process to dynamically vary the time period based on some criteria such as the received message rates, and/or received data rate. The ULP server could use a function to define the aggregation period based on the number of messages received per second or the total number of payload bytes received per second. One reasonable function would be to shorten the aggregation period as the rate or received messages or data rate of the received payloads increased. This would tend to keep the size of the outbound messages from growing too much as received messages and/or received data rate grew. Other possible functions could be used that varied the aggregation period based on received message rates, received payload data rates or other parameters available to the ULP server process.

Host Synchronous

The host synchronous or HS method of defining the aggregation time period allows the definition of a flexible time period that is controlled by the hosts. It is based on the concept of a turn which is a host sending a message to one or more members of the implicit message group which is operating is HS mode. Once every host in the message group has taken a turn, the aggregation period ends. A snapshot of the contents of the message queues is taken, the contents of each of the queues is aggregated and the aggregated messages are sent to the hosts targeted by each message queue. A refinement to this technique qualifies which of the three ULP send message types to the group constitute a host turn: a send only to the implicit address of the group, a send to a unicast host address within the group or a send to a logical ULP address which shares members with the group. The attributes of the group not only will define HS aggregation, but one or more ULP send message types that will be considered a host turn. A further refinement sets the total number of turns that a host can take in a single aggregation time period. The default will be one turn, but multiple turns can be allowed. If a host attempts to take more turns than allowed, the messages are ignored.

This aggregation technique has the additional benefit of causing the hosts which are member of an HS implicit message group to have their processing functions synchronized when they are executing the same interactive application. Many networked interactive applications are based on a simple overall three step operational model: wait for messages from other hosts, process the messages and the local users inputs to update the local application, send messages to the other hosts. This basic application loop is repeated at a rate fast enough to provide an interactive experience such as 5 to 30 times per second. It is desirable to keep such applications synchronized so that the states of the applications is consistent on the different host machines. When such applications communicate using the HS model of the present invention their operations will become naturally synchronized. The HS ULP server process will wait until all of the members of the message group has completed their turns and sent a message to the group before sending the aggregated messages to the members of the group. This will cause the applications on the hosts to wait until they have received the aggregated messages. They will all then start processing these messages along with the local user inputs. Even if they perform their processing at different speeds and send their next messages to the group at different times, the HS ULP server will wait until all have completed their processing and reported in with a message to the group. This will keep all of the host applications synchronized in that every host will be at the same application loop iteration as all of the others. This will keep the application state consistent on all of the hosts. Only network propagation delays from the GMS to the hosts and different processing speeds of the hosts will cause the start and completion of their processing to begin at different times. It is not a requirement in networked applications to keep all of the hosts precisely synchronized, only that that application state is consistent. The HS method provides a natural way to do this in the context of the present invention.

Preferred Embodiment

The detailed description of the invention has described a datagram implementation of the invention as the best way to explain the invention. The preferred embodiment of the invention is as follows.

In the preferred embodiment, the wide area network is the Internet and the TLP protocol is TCP/IP. The GMS is a general purpose computer system connected to the Internet and the hosts are personal computers connected to the Internet.

TCP/IP provides an number of advantages that provide for a more efficient applications interface on the hosts **151**. TCP/IP supports the concept of source and destination port numbers in its header. The ULP can make use of the port numbers to identify source and destination ULP connections. Most ULP send messages will be from hosts to a implicit ULP group addresses and most ULP receive messages will be from the implicit ULP addresses to the ULP host addresses. All of these and the ULP message type field can represented by source and destination port addresses within the TCP/IP header. This means that for most ULP messages, the ULP message encapsulated within the TCP/IP message need only contain the payload. There is the slight complication of the aggregated ULP receive messages sent from a ULP server process to a hosts. Here the destination port will be the host the source port will be for the implicit LJLP group address and the payload will still contain the source host ULP addresses in each the payload items.

TCP/IP also supports header compression for low speed dial-up lines which is also important in this application. See RFC 1144. TCP/IP is a connection oriented protocol which provides reliable end-to-end transport. It handles re-transmission on errors and fragmentation and reassembly of data transparently to upper level protocols. Header compression allows much of the TCP/IP header to be omitted with each packet to be replaced by a small connection identifier. This connection ID will uniquely define a connection consisting of a source and destination IP address and source and destination TCP/IP port numbers.

At the interface to the application on the hosts, the preferred embodiment of the ULP is as a session layer protocol. In the preferred embodiment the application on a host opens a session with a ULP server process. This session is identified with a unique session ID on the host. The host application then sends data to the ULP host interface **151** tagged with this session ID. The session ID defines a host and implicit ULP pair including the TCP/IP TLP address of the GMS server that is running the particular ULP server process for the implicit ULP address. By binding the transport address of the GMS of a ULP server process to the session ID, we can transparently to the application support multiple group messaging servers on the network and a single host can have multiple active sessions with different physical group messaging servers. This avoids any address space collision problems that could arise from the fact that the ULP address space is unique to each GMS.

Alternate Embodiments

One possible extension to the invention is to extend the ULP to support a common synchronized time base on the GMS and the hosts that are connected to it. This would be most interesting in context of the SI message aggregation mode. The SI time base on the GMS could be replicated on all of the hosts and all of the hosts and the GMS could lock these time bases together. There are known methods to synchronize time bases on multiple computer systems. One such method is called NTP.

Another extension to the invention is to define ULP server processes that perform specific application specific processing on the contents of the messages that are received. A variety of different application specific processing functions can be defined and implemented. A particular function would be selected by attributes provided in the create implicit group function. These functions could process the data in the message payloads and replace the data elements in the payloads with processed results. Separately, or in combination with processing the message payloads, the processing could store either raw message payload data in the application specific state storage area or could store processed results.

Clearly, the host system need not be personal computers, but could also be dedicated game consoles or television set top boxes or any other device with a programmable controller capable of implementing the ULP protocol. The wide area network used to transport the ULP protocol need not be the Internet or based on IP. Other networks with some means for wide area packet or datagram transport are possible including ATM networks or a digital cable television network.

The invention now being fully described, it will be apparent to one of ordinary skill in the art that any changes and modifications can be made thereto without departing from the spirit or scope of the invention as set forth herein.

Accordingly, the present invention is to be limited solely by the scope of the appended claims.

What is claimed is:

1. A method for providing group messages to a plurality of host computers connected over a unicast wide area communication network, comprising the steps of:

providing a group messaging server coupled to said network, said server communicating with said plurality of host computers using said unicast network and maintaining a list of message groups, each message group containing at least one host computer;

sending, by a plurality of host computers belonging to a first message group, messages to said server via said unicast network, said messages containing a payload portion and a portion for identifying said first message group;

aggregating, by said server in a time interval determined in accordance with a predefined criterion, said payload portions of said messages to create an aggregated payload;

forming an aggregated message using said aggregated payload; and

transmitting, by said server via said unicast network, said aggregated message to a recipient host computer belonging to said first message group.

2. The method of claim **1** wherein said time interval is a fixed period of time.

3. The method of claim **1** wherein said time interval corresponds to a time for said server to receive at least one message from each host computer belonging to said first message group.

4. The method of claim **1** further comprising the step of creating, by one of said plurality of host computers, said first message group by sending a first control message to said server via said unicast network.

5. The method of claim **4** further comprising the step of joining, by some of said plurality of host computers, said first message group by sending control messages via said unicast network to said server specifying said first message group.

6. The method of claim **1** wherein said network is Internet and said server communicates with said plurality of host computers using a session layer protocol.

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(54) **SERVER-GROUP MESSAGING SYSTEM FOR INTERACTIVE APPLICATIONS**

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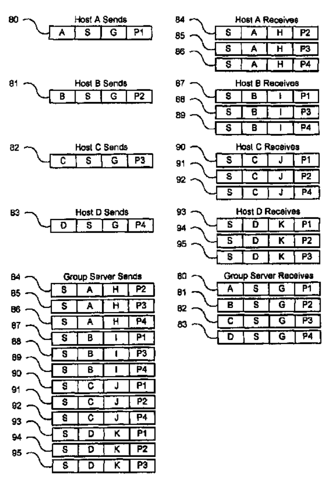
(57) **ABSTRACT**

A method for deploying interactive applications over a network containing host computers and group messaging servers is disclosed. The method operates in a conventional unicast network architecture comprised of conventional network links and unicast gateways and routers. The hosts send messages containing destination group addresses by unicast to the group messaging servers. The group addresses select message groups maintained by the group messaging servers. For each message group, the group message servers also maintain a list of all the hosts that are members of the particular group. In its most simple implementation, the method consists of the group server receiving a message from a host containing a destination group address. Using the group address, the group messaging server then selects a message group which lists all of the host members of the group which are the targets of messages to the group. The group messaging server then forwards the message to each of the target hosts. In an interactive application, many messages will be arriving at the group server close to one another in time. Rather than simply forward each message to its targeted hosts, the group messaging server aggregates the contents of each of messages received during a specified time period and then sends an aggregated message to the targeted hosts. The time period can be defined in a number of ways. This method reduces the message traffic between hosts in a networked interactive application and contributes to reducing the latency in the communications between the hosts.



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EX PARTE REEXAMINATION CERTIFICATE ISSUED UNDER 35 U.S.C. 307

THE PATENT IS HEREBY AMENDED AS INDICATED BELOW.

Matter enclosed in heavy brackets [ ] appeared in the patent, but has been deleted and is no longer a part of the patent; matter printed in italics indicates additions made to the patent.

AS A RESULT OF REEXAMINATION, IT HAS BEEN DETERMINED THAT:

The patentability of claims **1-6** is confirmed.

New claims **7-47** are added and determined to be patentable.

7. The method of claim 1, wherein said time interval is between 33 ms and 200 ms.

8. The method of claim 1, wherein said aggregating is performed 5 to 30 times a second.

9. The method of claim 1, wherein said server implements a group messaging protocol layered on top of a transport protocol of said unicast network, wherein said group messaging protocol uses an address space that is seperate from an address space of said transport protocol.

10. The method of claim 11, wherein said messaging protocol is performed at a session layer.

11. The method of claim 1, further comprising the step of performing, by said server, echo suppression.

12. The method of claim 1, wherein said plurality of host computers belonging to said first message group correspond to players that are in close proximity to one another within a three-dimentional space of a computer game.

13. The method of claim 1, further comprising the step of changing membership of said first message group based on activities of players within a computer game.

14. The method of claim 1, further comprising the step of changing membership of said first message group based on changes in player position within a three-dimentional space of a computer game.

15. The method of claim 1, wherein membership of said first message group changes dynamically over time.

16. The method of claim 1, wherein membership of said first message group changes over time based on control messages received from ones of said plurality of host computers.

17. The method of claim 1, wherein membership of said first message group changes over time based on indications received from ones of said plurality of host computers to join or leave said first message group.

18. The method of claim 1, wherein said messages comprise application specific state information.

19. The method of claim 1, wherein said unicast network is a wide area network.

20. The method of claim 19, wherein said group messaging server facilitates host computer-to-host computer communication.

21. The method of claim 19, wherein said group messaging server facilitates host computer-to-host computer communication usable by said plurality of host computers to maintain a consistent operating state.

22. The method of claim 19, wherein said group messaging server facilitates transmission of messages between ones of said plurality of host computers, wherein said transmitted messages are usable by said plurality of host computers to maintain a consistent operating state of an application.

23. The method of claim 22, wherein said application is a game.

24. The method of claim 19, wherein each message of said messages comprises information that other host computers in said first message group use to maintain a consistent application state.

25. The method of claim 19, wherein said messages are generated for transmission to host computers in said first message group.

26. The method of claim 19, wherein said messages are sent between said plurality of host computers in said first message group via said group messaging server.

27. The method of claim 1, wherein said aggregated message corresponds to a networked computer game, and wherein said first message group is only for players on a specified team within said game.

28. The method of claim 1, wherein said aggregated message corresponds to a networked computer game, and wherein said aggregated message is only for players on a specified team that are within a certain area of said game.

29. The method of claim 1, wherein said server is configured to receive a further message specifying said first message group and a second message group, and wherein said server is configured to transmit said further message to those of said plurality of host computers belonging to both said first and second message groups.

30. The method of claim 1, wherein said server is configured to receive a further message specifying a set of message groups and operations to be performed on said specified set of message groups to determine host computers to which said further message is to be delivered.

31. The method of claim 1, wherein said sending and said transmitting is implemented using a protocol that encapsulates message information within a datagram of a transport protocol of said unicast network.

32. The method of claim 1, wherein said sending and said transmitting are performed by an upper-level protocol implemented above a transport layer protocol of said unicast network, wherein said transport layer protocol is TCP/IP.

33. The method of claim 1, wherein said sending and said transmitting are performed by an upper-protocol implemented above a transport layer protocol of said unicast network, wherein said plurality of host computers are unable to send upper-level protocol messages to one another except through said group messaging server.

34. The method of claim 1, further comprising the steps of:

said server receiving, from one of said plurality of host computers, a control message to create said first message group; and

creating said first message group in response to receiving said control message.

35. The method of claim 1, further comprising the steps of:

said server receiving, from a first host computer of said plurality of host computers, a control message to join said first message group; and

adding said first host computer to said first message group in response to receiving said request.

36. The method of claim 1, further comprising the steps of:

said server receiving, from a first host computer of said plurality of host computers, a control message to leave said first message group; and

removing said first host computer from said first message group in response to receiving said request.

37. The method of claim 1, further comprising the steps of:

said server receiving a control message to close said first message group; and

removing said first message group in response to receiving said request.

38. The method of claim 1, further comprising the steps of:

said server receiving, from a first host computer of said plurality of host computers, a control message to query message groups of said server; and

providing said list of message groups to said first host computer in response to said receiving said control message.

39. The method of claim 1, further comprising the steps of:

said server receiving, from a first computer of said plurality of host computers, a control message to query members of said first message group; and

providing a list of members of said first message group to said first host computer in response to receiving said control message.

40. The method of claim 1, further comprising the steps of:

said server receiving, from a first host computer of said plurality of host computers, a control message to query attributes of said first message group; and

providing attributes of said first message group to said first host computer in response to receiving control message.

41. The method of claim 1, further comprising the steps of:

said server receiving, from a first host computer of said plurality of host computers, a control message to connect to said group messaging server; and

storing information regarding said first host computer in response to receiving said control message.

42. The method of claim 1, further comprising the steps of:

said server receiving, from a first host computer of said plurality of host computers, a control message to disconnect from said group messaging server; and

removing information regarding said first host computer in response to receiving said control message.

43. The method of claim 1, wherein said aggregated message comprises compressing said aggregated payload.

44. The method of claim 1, wherein said time period is dynamically varied according to the predefined criterion.

45. The method of claim 44, wherein said predefined criterion is based on message rates received by said server.

46. The method of claim 44, wherein said predefined criterion is based on data rates received by said server.

47. The method of claim 1, further comprising of:

processing said payload portions according to an application specific processing function to replace data elements in said payload portions with processed results.

* * * * *

EXHIBIT B

US006226686B1

(12) United States Patent
Rothschild et al.

(10) **Patent No.: US 6,226,686 B1**
(45) **Date of Patent: May 1, 2001**

(54) **SERVER-GROUP MESSAGING SYSTEM FOR INTERACTIVE APPLICATIONS**

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(73) Assignee: **HearMe**, Mountain View, CA (US)

(21) Appl. No.: **09/407,371**

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Related U.S. Application Data

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(51) **Int. Cl.**[7] **G06F 15/16**
(52) **U.S. Cl.** **709/245**; 709/218
(58) **Field of Search** 709/218, 206, 709/230, 236, 207, 231, 232, 204, 245; 370/389, 390

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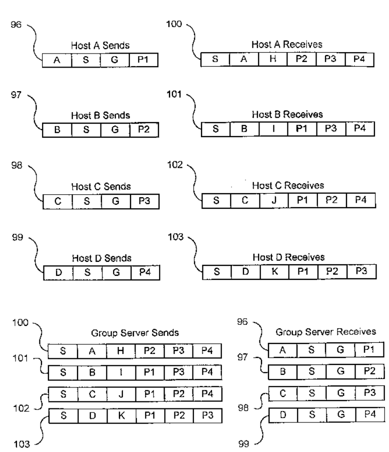
(57) **ABSTRACT**

A method for deploying interactive applications over a network containing host computers and group messaging servers is disclosed. The method operates in a conventional unicast network architecture comprised of conventional network links and unicast gateways and routers. The hosts send messages containing destination group addresses by unicast to the group messaging servers. The group addresses select message groups maintained by the group messaging servers. For each message group, the group messaging servers also maintain a list of all of the hosts that are members of the particular group. In its most simple implementation, the method consists of the group server receiving a message from a host containing a destination group address. Using the group address, the group messaging server then selects a message group which lists all of the host members of the group which are the targets of messages to the group. The group messaging server then forwards the message to each of the target hosts. In an interactive application, many messages will be arriving at the group server close to one another in time. Rather than simply forward each message to its targeted hosts, the group messaging server aggregates the contents of each of messages received during a specified time period and then sends an aggregated message to the targeted hosts. The time period can be defined in a number of ways. This method reduces the message traffic between hosts in a networked interactive application and contributes to reducing the latency in the communications between the hosts.

19 Claims, 11 Drawing Sheets



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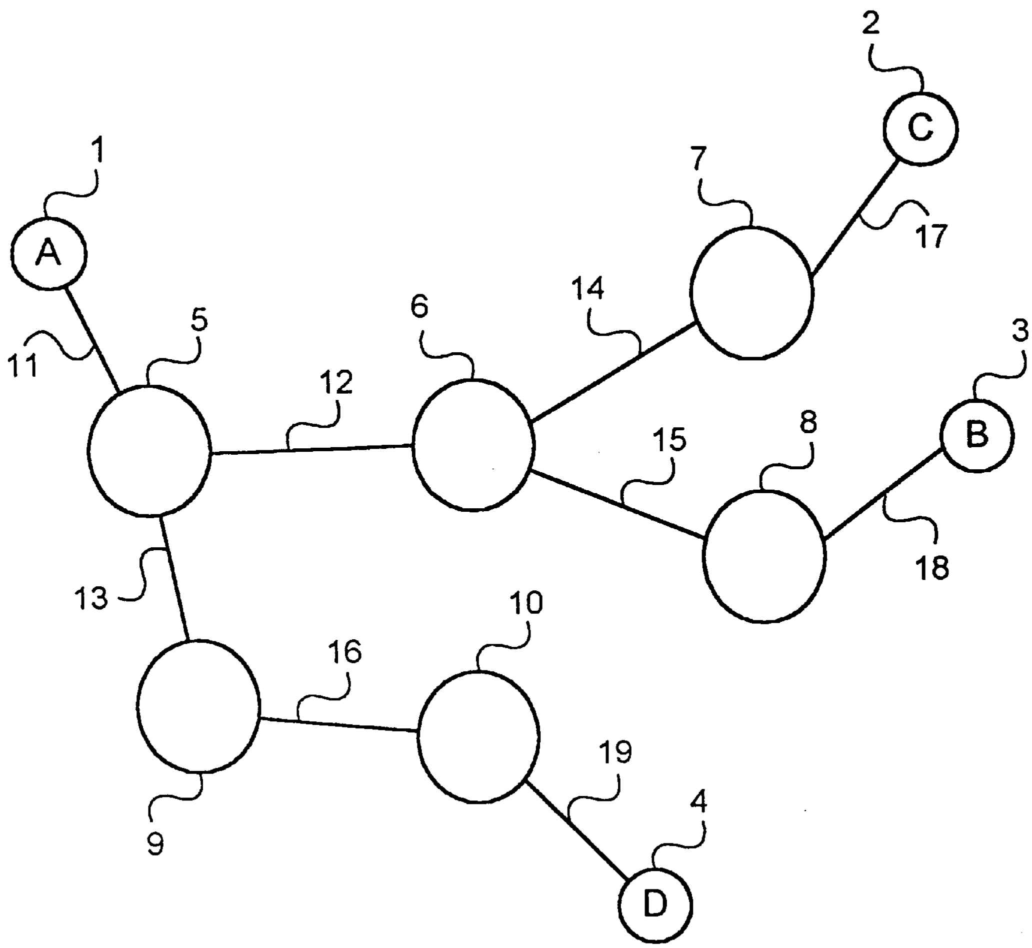

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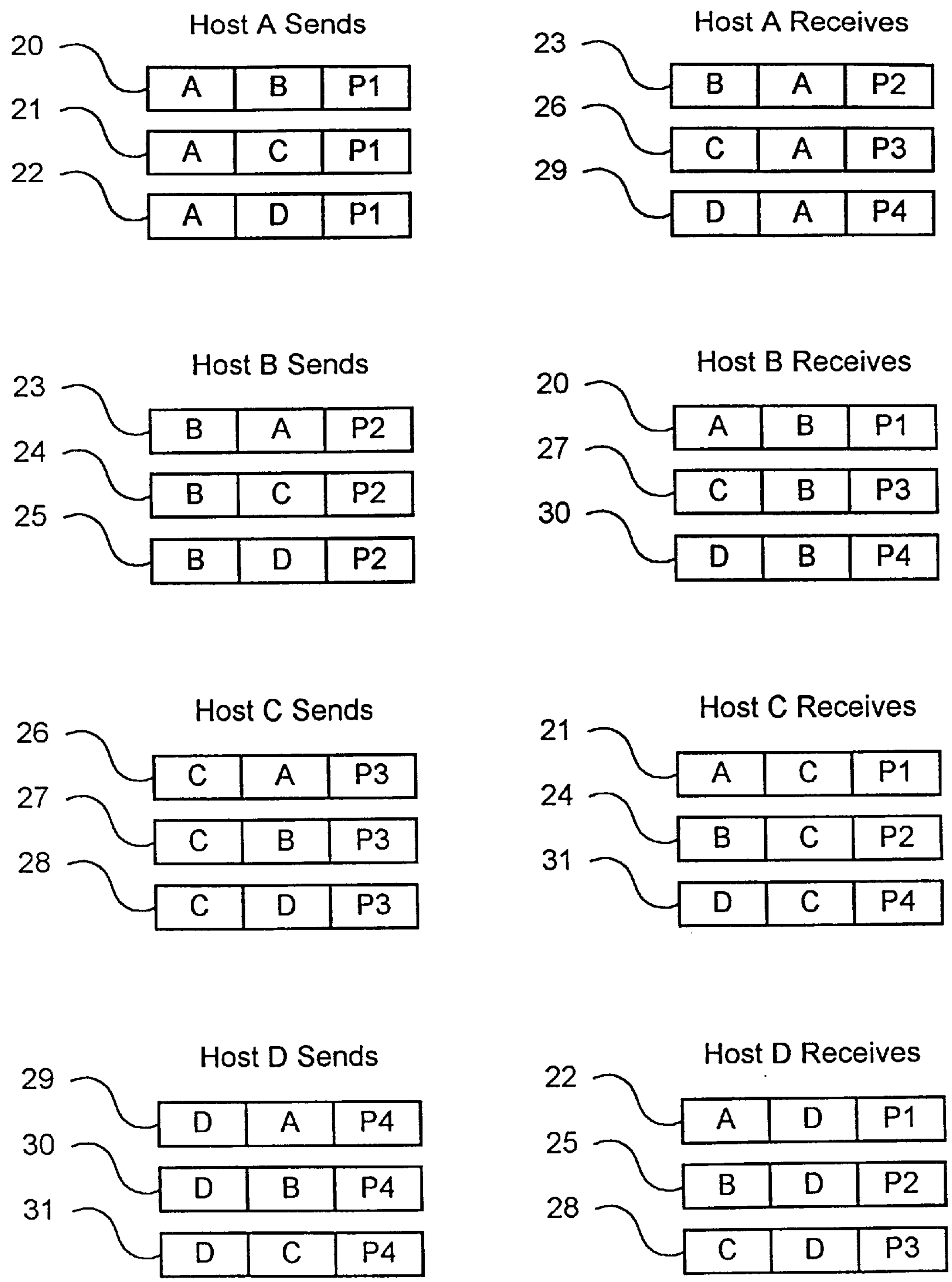

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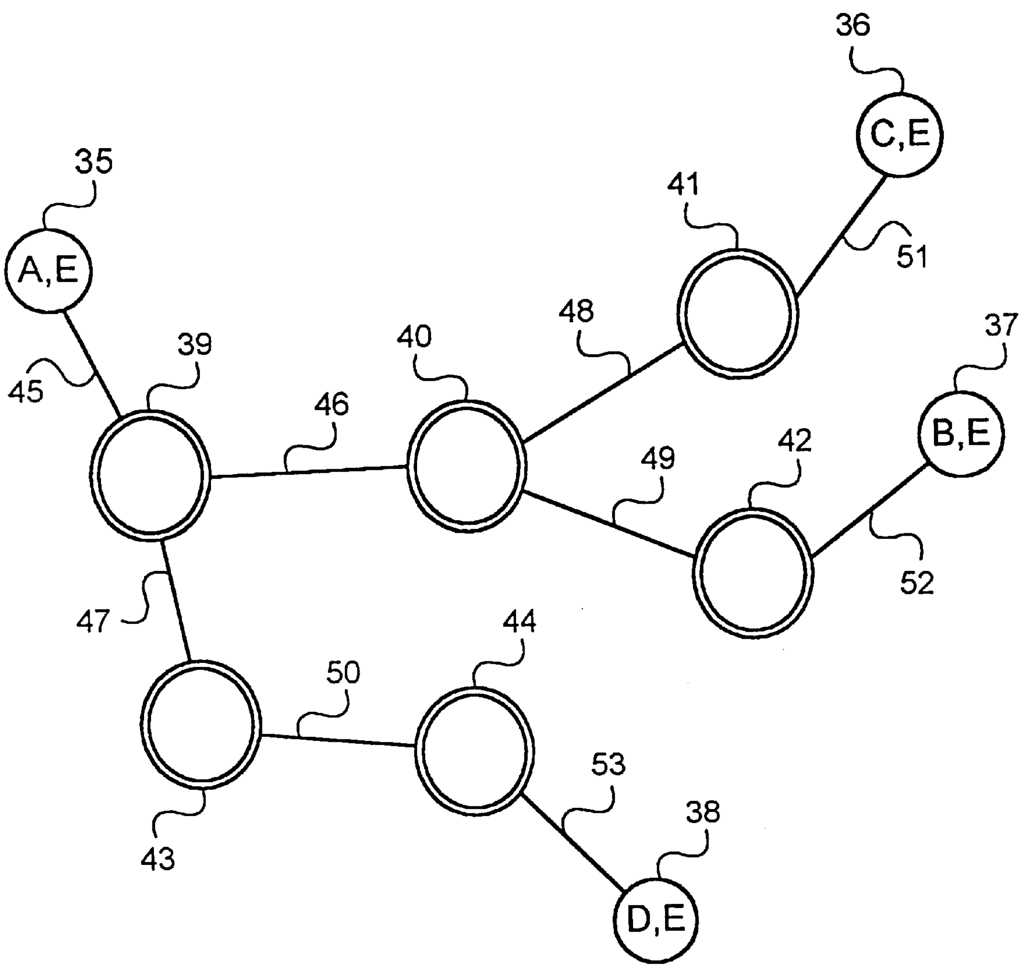
Prior Art



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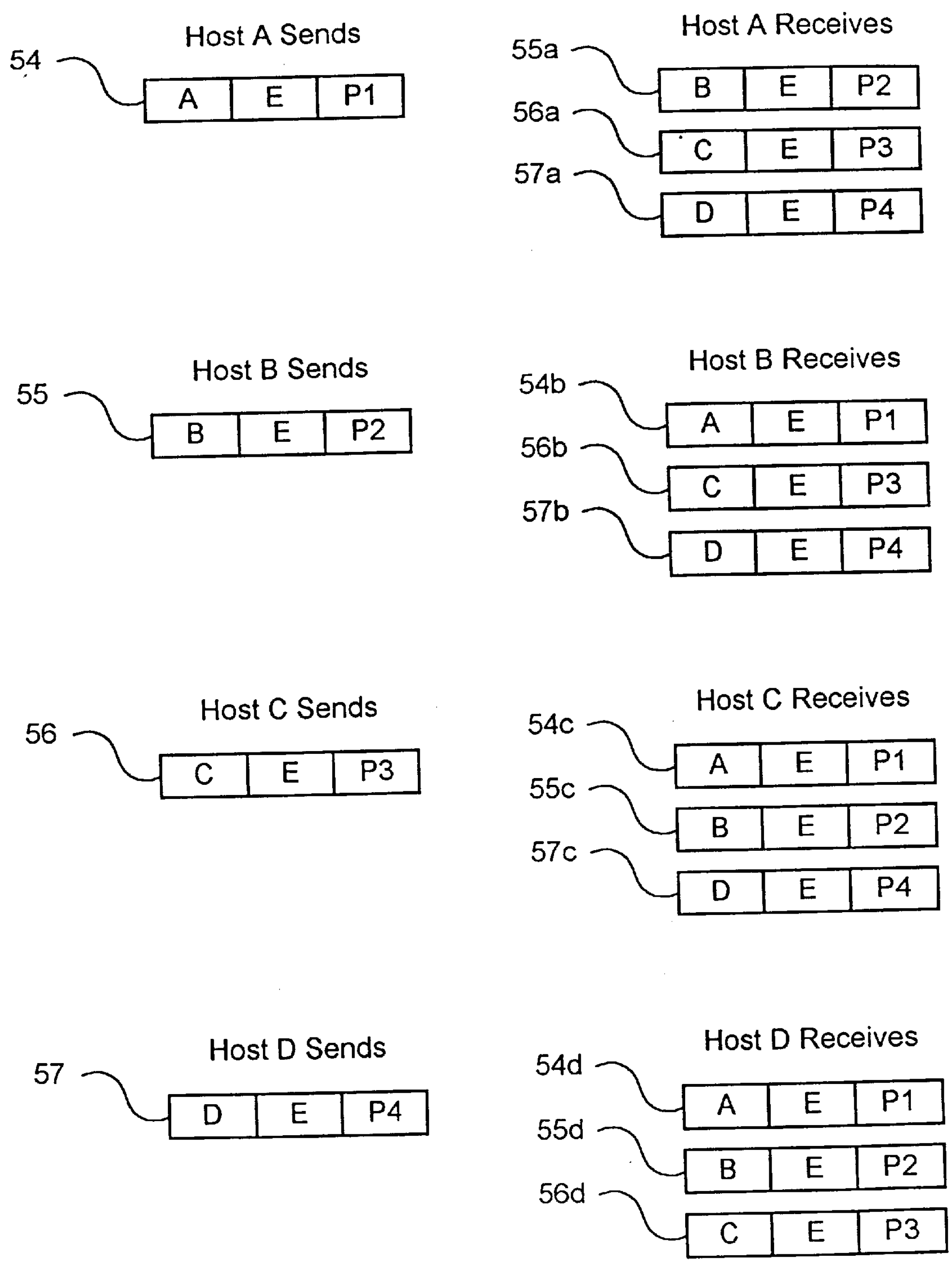

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Prior Art

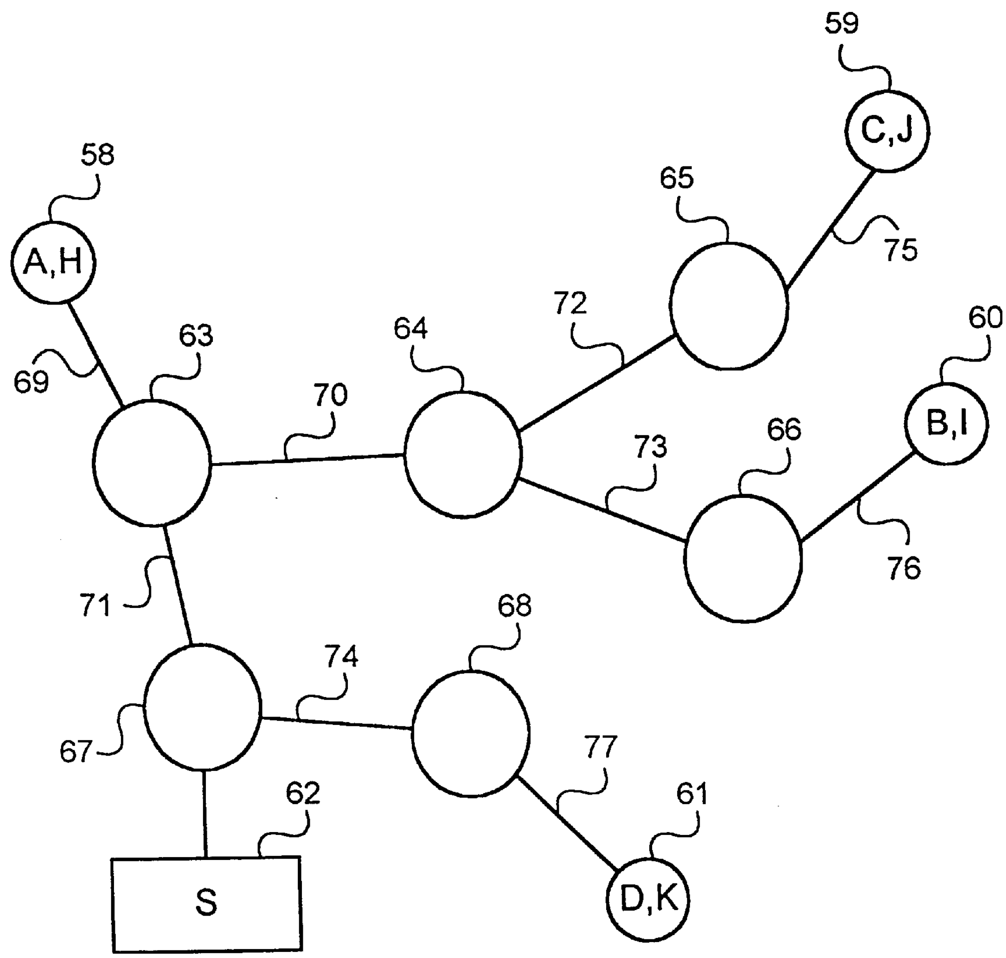

Figure 5

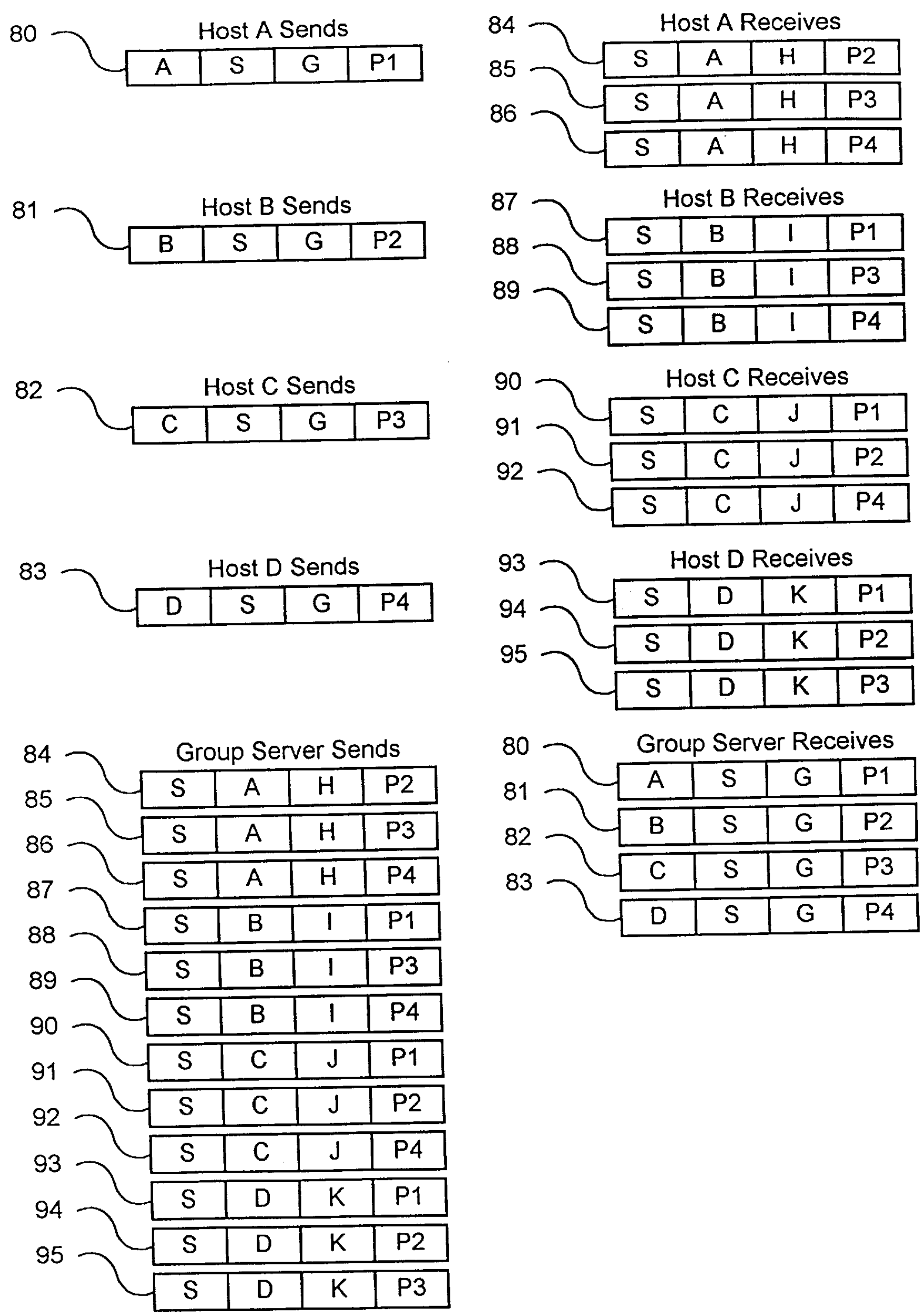
Host A Sends
80 A S G P1
Host A Receives
84 S A H P2
85 S A H P3
86 S A H P4
Host B Sends
81 B S G P2
Host B Receives
87 S B I P1
88 S B I P3
89 S B I P4
Host C Sends
82 C S G P3
Host C Receives
90 S C J P1
91 S C J P2
92 S C J P4
Host D Sends
83 D S G P4
Host D Receives
93 S D K P1
94 S D K P2
95 S D K P3
Group Server Sends
84 S A H P2
85 S A H P3
86 S A H P4
87 S B I P1
88 S B I P3
89 S B I P4
90 S C J P1
91 S C J P2
92 S C J P4
93 S D K P1
94 S D K P2
95 S D K P3
Group Server Receives
80 A S G P1
81 B S G P2
82 C S G P3
83 D S G P4

Figure 6

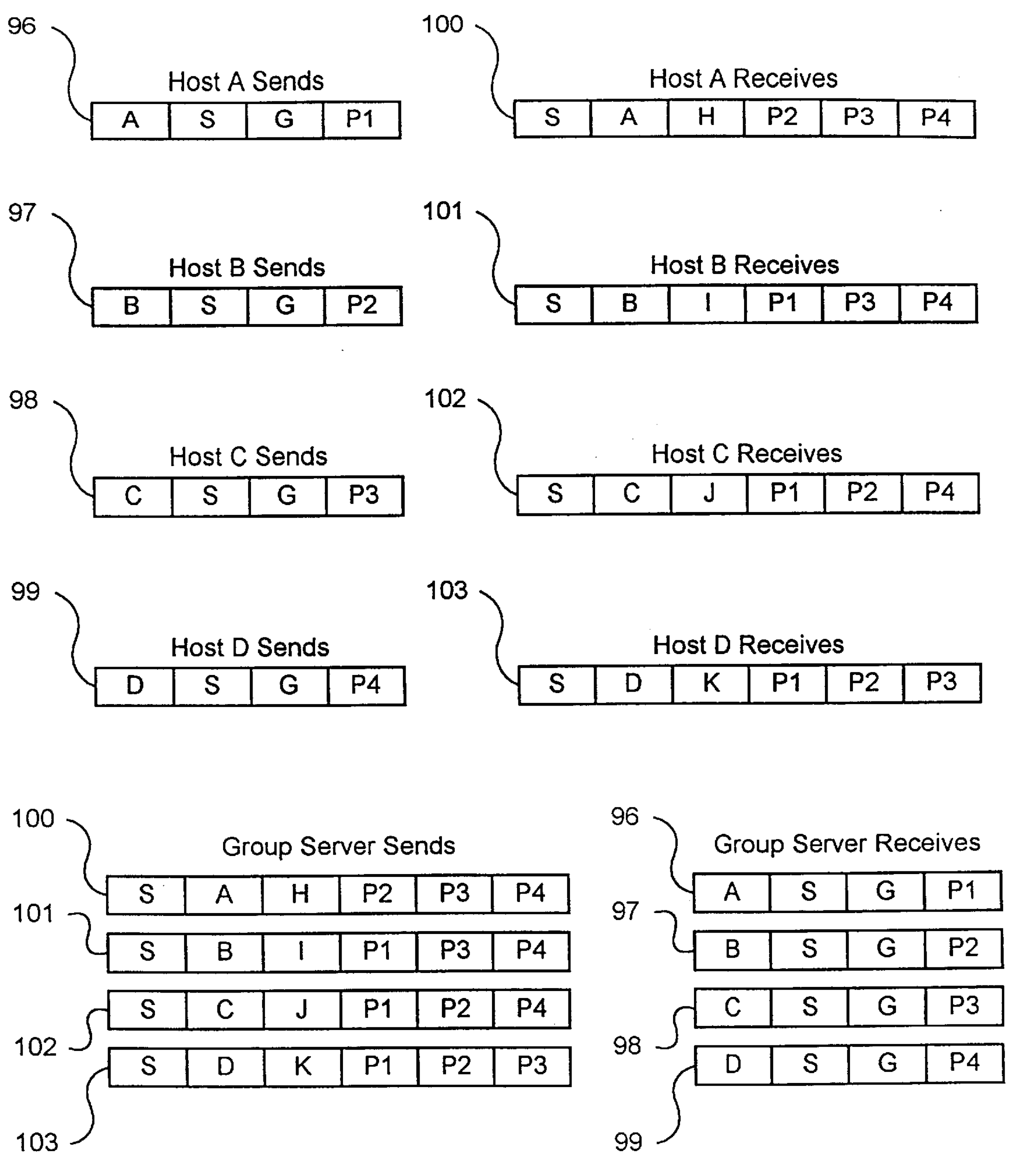
96
Host A Sends
A
S
G
P1
100
Host A Receives
S
A
H
P2
P3
P4
97
Host B Sends
B
S
G
P2
101
Host B Receives
S
B
I
P1
P3
P4
98
Host C Sends
C
S
G
P3
102
Host C Receives
S
C
J
P1
P2
P4
99
Host D Sends
D
S
G
P4
103
Host D Receives
S
D
K
P1
P2
P3
Group Server Sends
S A H P2 P3 P4
S B I P1 P3 P4
S C J P1 P2 P4
S D K P1 P2 P3
Group Server Receives
A S G P1
B S G P2
C S G P3
D S G P4

Figure 7

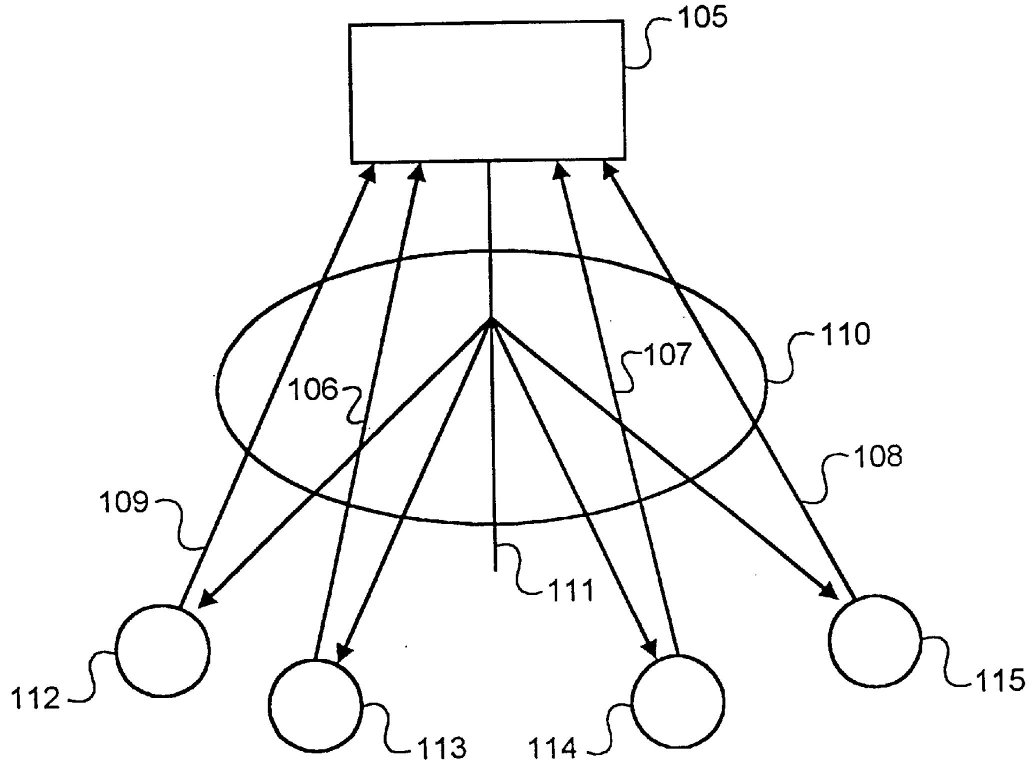

Figure 8
Prior Art

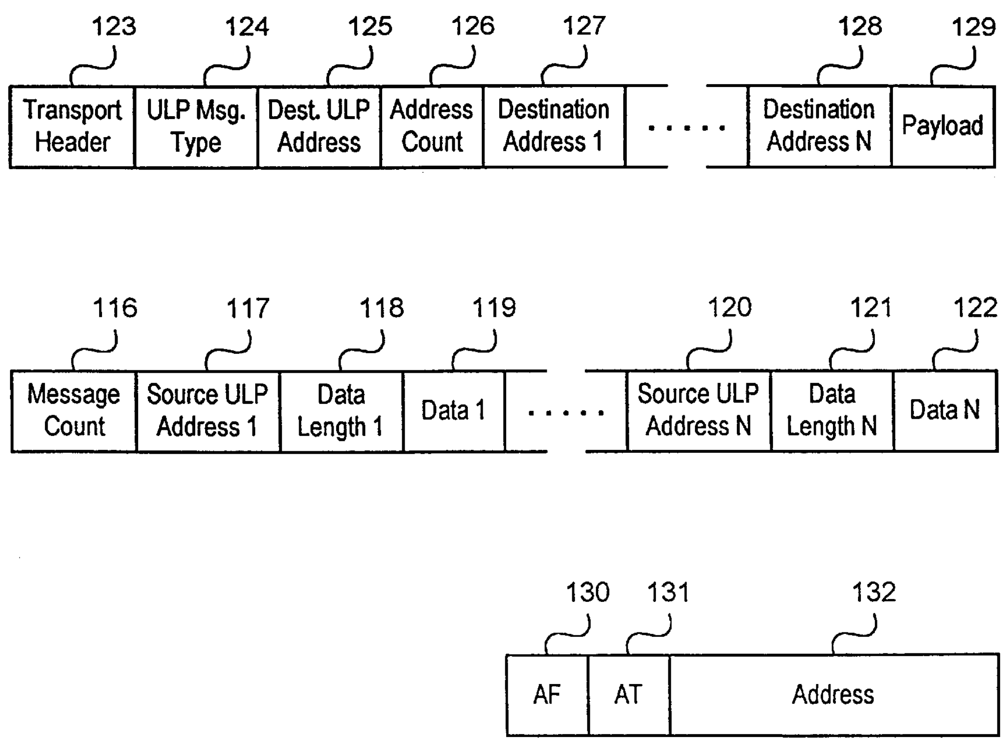
123
124
125
126
127
128
129
Transport Header
ULP Msg. Type
Dest. ULP Address
Address Count
Destination Address 1
.....
Destination Address N
Payload
116
117
118
119
120
121
122
Message Count
Source ULP Address 1
Data Length 1
Data 1
.....
Source ULP Address N
Data Length N
Data N
130
131
132
AF
AT
Address

Figure 9

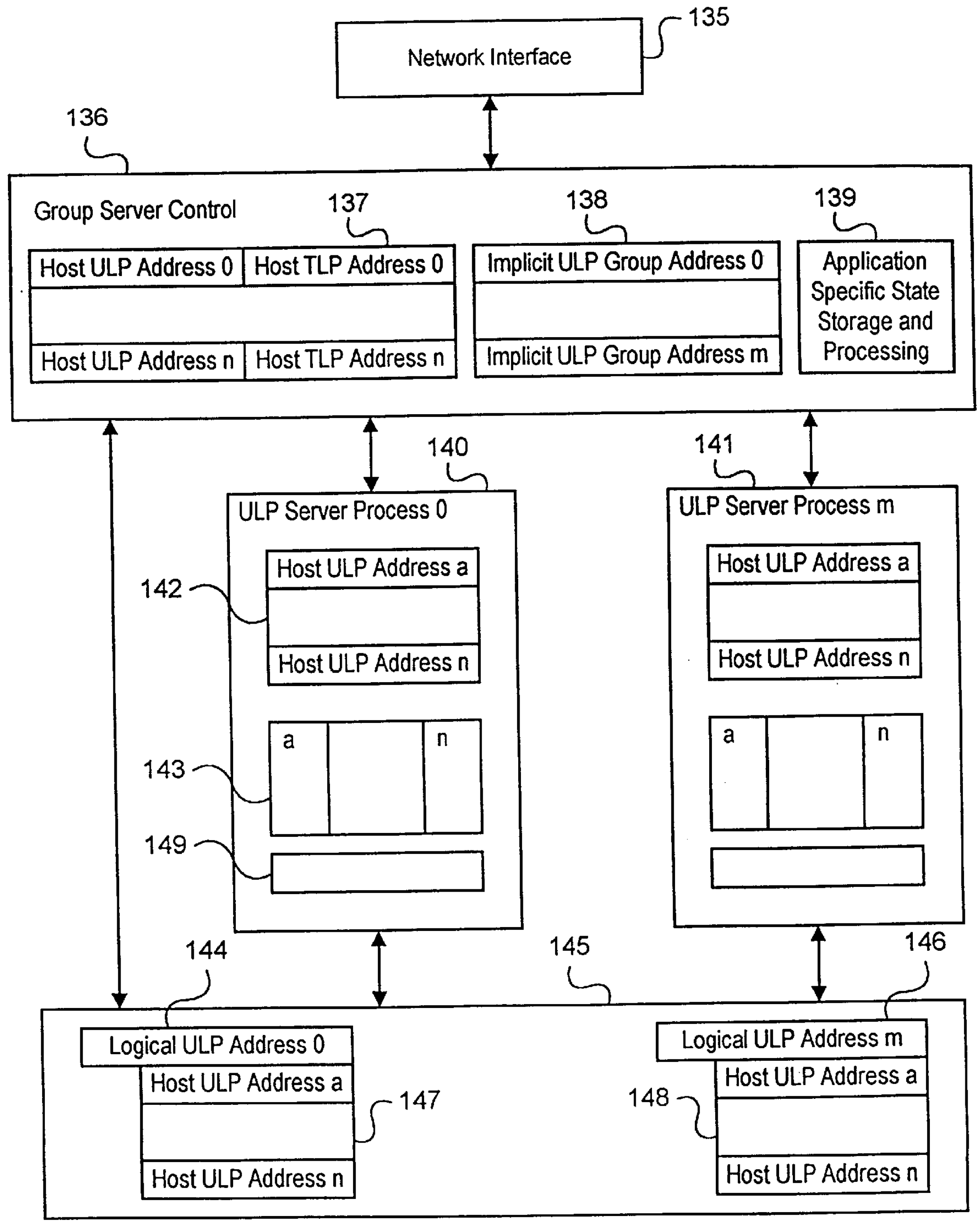
Network Interface
135
136
Group Server Control
137
138
139
Host ULP Address 0
Host TLP Address 0
Host ULP Address n
Host TLP Address n
Implicit ULP Group Address 0
Implicit ULP Group Address m
Application Specific State Storage and Processing
140
141
ULP Server Process 0
ULP Server Process m
Host ULP Address a
Host ULP Address n
142
a
n
143
149
144
145
146
Logical ULP Address 0
Host ULP Address a
Host ULP Address n
147
148
Logical ULP Address m
Host ULP Address a
Host ULP Address n

Figure 10

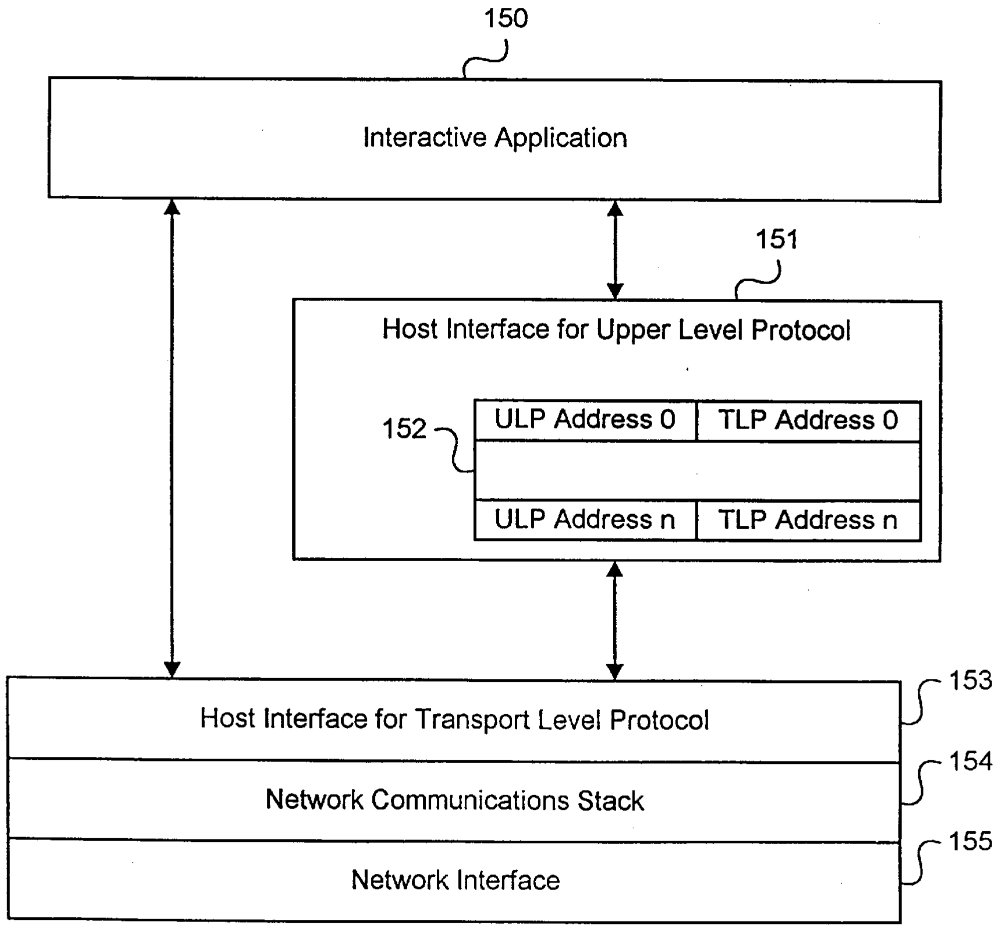
150
Interactive Application
151
Host Interface for Upper Level Protocol
152
ULP Address 0
TLP Address 0
ULP Address n
TLP Address n
153
Host Interface for Transport Level Protocol
154
Network Communications Stack
155
Network Interface

Figure 11

SERVER-GROUP MESSAGING SYSTEM FOR INTERACTIVE APPLICATIONS

This application is a continuation of Ser. No. 08/896,797, filed Jul. 18, 1997, now U.S. Pat. No. 6,018,766, which is a continuation of Ser. No. 08/595,323, filed Feb. 1, 1996, now U.S. Pat. No. 5,822,523.

FIELD OF THE INVENTION

The present invention relates to computer network systems, and particularly to server group messaging systems and methods for reducing message rate and latency.

BACKGROUND OF THE INVENTION

There are a wide range of interactive applications implemented on computer systems today. All are characterized by dynamic response to the user. The user provides input to the computer and the application responds quickly. One popular example of interactive applications on personal computers (PCs) are games. In this case, rapid response to the user may mean redrawing the screen with a new picture in between 30 ms and 100 ms. Interactive applications such as games control the speed of their interaction with the user through an internal time base. The application uses this time base to derive rates at which the user input is sampled, the screen is redrawn and sound is played.

As computers have become more powerful and common, it has become important to connect them together in networks. A network is comprised of nodes and links. The nodes are connected in such a way that there exists a path from each node over the links and through the other nodes to each of the other nodes in the network. Each node may be connected to the network with one or more links. Nodes are further categorized into hosts, gateways and routers. Hosts are computer systems that are connected to the network by one link They communicate with the other nodes on the network by sending messages and receiving messages. Gateways are computer systems connected to the network by more than one link They not only communicate with the other nodes as do hosts, but they also forward messages on one of their network links to other nodes on their other network links. This processing of forwarding messages is called routing. In addition to sending and receiving messages and their routing functions, gateways may perform other functions in a network. Routers are nodes that are connected to the network by more than one link and whose sole function is the forwarding of messages on one network link to the other network links to which it is connected. A network consisting of many network links can be thought of as a network of sub-networks with gateways and/or routers connecting the sub-networks together into what is called an internet. Today the widely known example of a world wide internet is the so called "Internet" which in 1995 has over 10 million computers connected full time world-wide.

With so many computers on a single world-wide network, it is desirable to create interactive networked applications that bring together many people in a shared, networked, interactive application. Unfortunately, creating such shared, networked, interactive applications runs into the limitations of the existing network technology.

As an example, consider a game designed to be deployed over a network which is to be played by multiple players simultaneously. The game could be implemented in software on a PC connected to a network. A rate set by its internal time base, it would sample the inputs of the local user, receive messages from the network from the PCs of the other

players and send messages out to the PCs of the other players. A typical rate will be ten times per second for a time period of 100 ms. The messages sent between the PCs would contain information that was needed to keep the game consistent between all of the PCs. In a game that created the illusion of a spatial environment where each player could move, the packets could contain information about the new positions of the players as they moved. Today there are many commercial examples of PC games that can be played between multiple players on Local Area Networks (LANs) or by two players over dial-up phone lines using modems. The network messages sent by such games contain a wide variety of information specific to the game. This can include position and velocity information of the objects in the game along with special actions taken by a player that effect the other players in the game.

The case of a two player game played over a modem is particularly simple. If the message rate is 10 messages per second, each PC sends 10 messages per second to the other PC and receives 10 messages per second. The delay introduced by the modems and phone line is small and will not be noticed in most games. Unfortunately, the case of two players is uninteresting for networked interactive applications. With the same game played with 8 players on a LAN, the message rate increases. Each PC must send 7 messages, one to each of the other 7 players every time period and will receive 7 messages from the other players in the same time period. If the messaging time period is 100 ms, the total message rate will be 70 messages sent per second and 70 messages received per second. As can be seen the message rate increases linearly with the number of players in the game. The message rates and data rates supported by popular LANs are high enough to support a large number of players at reasonable message sizes. Unfortunately, LANs are only deployed in commercial applications and cannot be considered for deploying a networked interactive application to consumer users.

The wide area networks available today to consumer users all must be accessed through dial-up phone lines using modems. While modem speeds have increased rapidly, they have now reached a bit rate of 28.8 Kbit/sec which is close to the limit set by the signal-to-noise ratio of conventional phone lines. Further speed increases are possible with ISDN, but this technology is not ready for mass market use. Other new wide area networking technologies are being discussed that would provide much higher bandwidth, but none are close to commercial operation. Therefore, in deploying a networked, interactive application to consumers, it is necessary to do so in a way that operates with existing networking and communications infrastructures.

In the example of the 8 player networked game, consider a wide area network implementation where the PCs of each of the players is connected to the network with a 28.8 Kbit/sec modem. Assume that the network used in this example is the Internet so that all of the network protocols and routing behavior is well defined and understood. If the game uses TCP/IP to send its messages between the PCs in the game, the Point-to-Point Protocol/(PPP) protocol over the dial-up phone lines can be advantageously used to compress the TCP/IP headers. Even so, a typical message will be approximately 25 bytes in size. Sent through the modem, this is 250 bits. The messages are sent 10 times per second to each of the other PCs in the game and received 10 times per second from the other PCs. This is 35.0 Kbits/sec which exceeds the capabilities of the modem by 20%. If the messages are reduced to 20 bytes, just 8 players can be supported, but this approach clearly cannot support networked interactive applications with large numbers of participants. There are other problems beyond just the bandwidth of the network connection. There is the loading on each PC caused by the high packet rates and there is the latency introduced by the time needed to send all of the outbound packets. Each packet sent or received by a PC will require some amount of processing time. As the packet rate increases with the number of players in the game, less and less of the processor will be available for running the game software itself. Latency is important in an interactive application because it defines the responsiveness of the system. When a player provides a new input on their system, it is desirable for that input to immediately affect the game on all of the other players systems. This is particularly important in any game where the game outcome depends on players shooting at targets that are moved by the actions of the other players. Latency in this case will be the time from when a player acts to move a target to the time that the target has moved on the screens of the other players in the game. A major portion of this latency will come from the time needed to send the messages to the other seven players in the game. In this example the time to send the messages to the other 7 players will be approximately 50 ms. While the first player of the seven will receive the message quickly, it will not be until 50 ms have passed that the last player of the seven will have received the message.

Internet Protocol Multicasting

As mentioned before, the Internet is a widely known example of a wide area network. The Internet is based on a protocol appropriately called the Internet Protocol (IP). In the OSI reference model for layers of network protocols, IP corresponds to a layer **3** or Network layer protocol. It provides services for transmission and routing of packets between two nodes in an internet. The addressing model provides a 32 bit address for all nodes in the network and all packets carry source and destination addresses. IP also defines the routing of packets between network links in an inter-network. Gateways and routers maintain tables that are used to lookup routing information based on the destination addresses of the packets they receive. The routing information tells the gateway/router whether the destination of the packet is directly reachable on a local network link connected to the gateway/router or if not, the address of another gateway/router on one of the local network links to which the packet should be forwarded. On top of IP are the layer **4** transport protocols TCP and UDP. UDP provides datagram delivery services to applications that does not guarantee reliable or in-order delivery of the datagramns. TCP is a connection oriented service to applications that does provide reliable delivery of a data stream. It handles division of the stream into packets and ensures reliable, in-order delivery. See the Internet Society RFCs: RFC-791 "Internet Protocol", RFC-793 "Transmission Control Protocol" and RFC-1180 "A TCP/IP Tutorial". IP, TCP and UDP are unicast protocols: packets, streams or datagrams are transmitted from a source to a single destination.

As an example, consider FIGS. **1** and **2**. FIG. **1** shows a conventional unicast network with hosts **1**, **2**, **3** and **4** and network links **11**, **12**, **13**, **14**, **15**, **16**, **17**, **18** and **19** and routers **5**, **6**, **7**, **8**, **9** and **10**. In this example, each host wants to send a data payload to each of the other hosts. Host **1** has network address A, host **2** has network address C, host **3** has network address B and host **4** has network address D. Existing network protocols are typically based on packet formats that contain a source address, destination address and a payload. This is representative of commonly used wide area network protocols such as IP. There are other components in an actual IP packet, but for sake of this example, only these items will be considered. FIG. **2** shows the example packets that are sent by the hosts to one another using a conventional unicast network protocol such as IP. Host **1** send packets **20**, to host **3**, packet **21** to host **2** and packet **22** to host **4**. Host **1** wants to send the same data **P1** to each of the other three hosts, therefore the payload in all three packets is the same. Packet **20** travels over network links **11**, **12**, **15** and **18** and through routers **5**, **6**, and **8** to reach host **3**. In a similar fashion host **3** sends packets **23** to host **1**, packet **24** to host **2** and packet **25** to host **4**. Host **2** and host **4** send packets **26**, **27**, **28** and **29**, **30**, **31** respectively to the other three hosts. All of these packets are carried by the unicast network individually from the source host to the destination host. So in this example each host must send three packets and receive three packets in order for each host to send its payload to the other three hosts.

As can be seen, each host must send a packet to every other host that it wishes to communicate with in an interactive application. Further, it receives a packet from every other host that wishes to communicate with it. In an interactive application, this will happen at a regular and high rate. All of the hosts that wish to communicate with one another will need to send packets to each other eight to ten times per second. With four hosts communicating with one another as in this example, each host will send three messages and receive three messages eight to ten times per second. As the number of hosts in the application that need to communicate with one another grows, the message rate will reach a rate that cannot be supported by conventional dial-up lines. This makes unicast transport protocols unsuitable for delivering interactive applications for multiple participants since their use will result in the problem of high packet rates that grow with the number of participants.

Work has been done to attempt to extend the IP protocol to support multicasting. See RFC-1112 "Host Extensions for IP Multicasting". This document describes a set of extensions to the IP protocol that enable IP multicasting. IP multicasting supports the transmission of a IP datagram to a host group by addressing the datagram to a single destination address. Multicast addresses are a subset of the IP address space and identified by class D IP addresses—these are IP addresses with "1110" in the high order 4 bits. The host group contains zero or more IP hosts and the IP multicasting protocol transmits a multicast datagram to all members of the group to which it is addressed. Hosts may join and leave groups dynamically and the routing of multicast datagrams is supported by multicast routers and gateways. It is proper to describe this general approach to multicast messaging as "distributed multicast messaging". It is a distributed technique because the job of message delivery and duplication is distributed throughout the network to all of the multicast routers. For distributed multicast messaging to work in a wide area network, all of the routers handling datagrams for multicast hosts must support the routing of multicast datagrams. Such multicast routers must be aware of the multicast group membership of all of the hosts locally connected to the router in order to deliver multicast datagrams to local hosts. Multicast routers must also be able to forward multicast packets to routers on their local network links. Multicast routers must also decide to which if any local routers they must forward multicast datagrams. When a multicast datagram is received, by a multicast router, its group address is compared to a list for each local multicast router of group addresses. When there is a match, the datagram is then forwarded to that local multicast router. Therefore, the multicast routers in the network must maintain an accurate and up to date list of group addresses for which they are to forward datagrams to. These lists are updated when hosts join or leave multicast groups. Hosts do this by sending messages using Internet Group Management Protocol (IGMP) to their immediately-neighboring multicast routers. A further attribute of distributed multicast messaging is that the routers must propagate the group membership information for a particular group throughout the network to all of the other routers that will be forwarding traffic for that group. RFC-1112 does not describe how this is to be done. Many different approaches have been defined for solving this problem that will be mentioned later in descriptions of related prior art. Despite their differences, all of these approaches are methods for propagation of multicast routing information between the multicast routers and techniques for routing the multicast datagrams in an inter-network supporting distributed multicast messaging.

The distributed multicast messaging approach has a number of undesirable side effects. The process of propagation of group membership information to all of the relevant routers is not instantaneous. In a large complex network it can even take quite a period of time depending on the number of routers that must receive that updated group membership information and how many routers the information for the group membership update must past through. This process can easily take many seconds and even minutes depending on the specifics of the algorithm that is used. RFC-1112 mentions this problem and some of the side effects that must be handled by an implementation of a practical routing algorithm for multicast messaging. One problem results when groups are dynamically created and destroyed. Since there is no central authority in the network for assigning group addresses, it is easily possible in a distributed network for there to be duplication of group address assignment. This will result in incorrect datagram delivery, where hosts will receive unwanted datagrams from the duplicate group. This requires a method at each host to filter out the unwanted datagrams. Another set of problems result from the time delay from when a group is created, destroyed or its membership changed to when all of the routers needed to route the datagrams to the member hosts have been informed of these changes. Imagine the case where Host N joins an existing group by sending a join message to its local router. The group already contains Host M which is a number of router hops away from Host N in the network. Shortly after Host N has sent it join message, Host M sends a datagram to the group, but the local router of Host M has not yet been informed of the change in group membership and as a result the datagram is not forwarded to one of the particular network links connected to the local router of Host M that is the only path in the network from that router that ultimately will reach Host N. The result is that Host N will receive no datagrams addressed to the group from Host M until the local router of M has its group membership information updated. Other related problems can also occur. When a host leaves a group, messages addressed to the group will continue for some time to be routed to that host up to the local router of that host. The local router will know at least not to route the datagram onto the local network of that host. This can still result in a great deal of unnecessary datagrams being carried in a large network when there are many active message groups with rapidly changing memberships.

Finally, distributed multicast messaging does not sufficiently reduce the message rate between the hosts. With distributed multicast messaging, each host need only send one message addressed to the message group in order to send a message to all of other hosts in the group. This is an improvement over conventional unicast messaging where one message would need to be sent to each of the other hosts in a group. However, distributed multicast messaging does nothing to reduce the received message rate at each of the hosts when multiple hosts in a group are sending messages to the group closely spaced in time. Let us return to the example of a group often hosts sending messages seven times per-second to the group. With conventional unicast messaging, each host will need to send 9 messages to the other hosts, seven times per-second and will receive 9 messages, seven times per-second. With distributed multicast messaging, each host will need to send only one message to the group containing all of the hosts seven times per-second, but will still receive 9 messages, seven times per-second. It is desirable to further reduce the number of received messages.

An example of distributed multicasting is shown in FIGS. **3** and **4**. FIG. **3** shows a network with multicast routers **39**, **40**, **41**, **42**, **43** and **44** and hosts **35**, **36**, **37**, **38** and network links **45**, **46**, **47**, **48**, **49**, **50**, **51**, **52** and **53**. The four hosts have unicast network addresses A, B, C, D and are also all members of a message group with address E. In advance the message group was created and each of the hosts joined the message group so that each of the multicast routers is aware of the message group and has the proper routing information. A network protocol such IP with multicast extensions is assumed to be used in this example. Host **35** sends packet **54** with source address A and destination multicast address E to the entire message group. In the same manner host **37** sends packet **55** to the group, host **36** sends packet **56** to the group and host **38** sends packet **57** to the group. As the packets are handled by the multicast routers they are replicated as necessary in order to deliver them to all the members of the group. Let us consider how a packets sent by host **35** is ultimately delivered to the other hosts. Packet **54** is carried over network link **45** to multicast router **39**. The router determines from its routing tables that the multicast packet should be sent onto network links **46** and **47** and duplicates the packet and sends to both of these network links. The packet is received by multicast routers **40** and **43**. Multicast router **43** sends the packet onto network link **50** and router **40** sends its onto links **48** and **49**. The packet is then received at multicast routers **44**, **42** and **41**. Router **41** sends the packet over network link **51** where it is received by host **36**. Router **42** sends the packet over network link **52** to host **37** and router **44** sends the packet over link **53** to host **38**. A similar process is followed for each of the other packets sent by the hosts to the multicast group E. The final packets received by each host are shown in FIG. **4**.

While distributed multicasting does reduce the number of messages that need to be sent by the hosts in a networked interactive application, it has no effect on the number of messages that they receive. It has the further disadvantages of poor behavior when group membership is rapidly changing and requires a special network infrastructure of multicast routers. It also has no support for message aggregation and cannot do so since message delivery is distributed. Distributed multicasting also has no support for messages that define logical operations between message groups and unicast host addresses.

All of these problems can be understood when placed in context of the design goals for distributed multicast messaging. Distributed multicast messaging was not designed for interactive applications where groups are rapidly created, changed and destroyed. Instead it was optimized for applications where the groups are created, changed and destroyed over relatively long time spans perhaps measured in many minutes or even hours. An example would be a video conference where all the participants agreed to connect the conference at a particular time for a conference that might last for an hour. Another would be the transmission of an audio or video program from one host to many receiving hosts, perhaps measured in the thousands or even millions. The multicast group would exist for the duration of the audio/video program. Host members would join and leave dynamically, but in this application it would be acceptable for there to be a significant time lag from joining or leaving before the connection was established or broken.

While IP and multicast extensions to IP are based on the routing of packets, another form of wide area networking technology called Asynchronous Transfer Mode (ATM) is based on switching fixed sized cells through switches. Unlike IP which supports both datagram and connection oriented services, ATM is fundamentally connection oriented. An ATM network consists of ATM switches interconnected by point-to-point links. The host systems are connected to the leaves of the network. Before any communication can occur between the hosts through the network, a virtual circuit must be setup across the network. Two forms of communication can be supported by an ATM network. Bi-directional point-to-point between two hosts and point-to-multipoint in one direction from one host to multiple hosts. ATM, however, does not directly support any form of multicasting. There are a number of proposals for layering multicasting on top of ATM. One approach is called a multicast server, shown in FIG. **8**. Host systems **112**, **113**, **114**, **115** setup point-to-point connections **106**, **107**,**108** and **109** to a multicast server **105**. ATM cells are sent by the hosts to the multicast server via these links. The multicast server sets up a point-to-multipoint connection **111** to the hosts which collectively constitute a message group. Cells sent to the server which are addressed to the group are forwarded to the point-to-multipoint link **111**. The ATM network **110** is responsible for the transport and switching for maintaining all of the connections between the hosts and the server. The cells carried by the point-to-multipoint connection are duplicated when necessary by the ATM switches at the branching points in the network tree between and forwarded down the branching network links. Therefore, the network is responsible for the replication of the cells and their payloads, not the server. This method has the same problems as distributed multicasting when used for an interactive application. Each host still receives individual cells from each of the other hosts, so there is no aggregation of the payloads of the cells targeted at a single host. There is no support for addressing cells to hosts based on logical operations on the sets of members of host groups.

Related Prior Art

There are a number of existing patents and European patent applications that are related to the area of the invention. These can be organized into two separate categories: multicast routing/distribution and source to destination multicast streams.

Multicast Routing and Distribution

These patents are U.S. Pat. No. 4,740,954 by Cotton et al, U.S. Pat. No. 4,864,559 by Perlman, U.S. Pat. No. 5,361,256 by Doeringer et al, U.S. Pat. No. 5,079,767 by Perlman and U.S. Pat. No. 5,309,433 by Cidon et al. Collectively these patents cover various algorithms for the routing and distribution of the datagrams in distributed multicast networks. None deal with the problems described previously for this class of multicast routing and message distribution such as poor behaviors when the message groups change rapidly. In all of these patents, messages are transmitted from a host via a distributed network of routers to a plurality of destination hosts which are members of a group. Since these patents deal only with variants of distributed multicasting they provide no means to reduce the received message rate, no method to aggregate messages and provide no method in the messages to perform logical operation on message groups.

Source to Destination Multicast Streams

These are PCTs and a European patent application. They are EP 0 637 149 A2 by Perlman et al, PCT/US94/11282 by Danneels et al and PCT/US94/11278 by Sivakumar et al. These three patent applications deal with the transmission of data streams from a source to a group of destinations. In none of these patent applications, is a method described for transmitting data between multiple members of a group. In all of these applications, the data transmission is from a source to a plurality of designations. Since these patent applications deal only with point-to-multipoint messaging, they can provide no means to reduce the received message rate, no method to aggregate messages and provide no method in the messages to perform logical operation on message groups.

SUMMARY OF THE INVENTION

The present invention relates to facilitating efficient communications between multiple host computers over a conventional wide area communications network to implement an interactive application such as a computer game between multiple players. In such an application, the hosts will be dynamically sending to each other information that the other hosts need in order to keep the interactive application operating consistently on each of the hosts. The invention is comprised of a group messaging server connected to the network that maintains a set of message groups used by the hosts to communicate information between themselves. The invention further comprises a server-group messaging protocol used by the hosts and the server. The server-group messaging protocol is layered on top of the Transport Level Protocol (TLP) of the network and is called the Upper Level Protocol (or ULP). In the OSI reference model the ULP can be thought of as a session layer protocol built on top of a transport or applications layer protocol. The ULP protocol uses a server-group address space that is separate from the address space of the TLP. Hosts send messages to addresses in the ULP address space to a group messaging server using the underlying unicast transport protocol of the network. The ULP address space is segmented into unicast addresses, implicit group messaging addresses and logical group messaging addresses. The implicit and logical group messaging addresses are collectively called group messaging addresses.

Host systems must first establish connections to a group messaging server before sending messages to any ULP addresses. The process of establishing this connection is done by sending TLP messages to the server. The server establishes the connection by assigning a unicast ULP address to the host and returning this address in an acknowledgment message to the host. Once connected, hosts can inquire about existing message groups, join existing message groups, create new message groups, leave message groups they have joined and send messages to ULP addresses known by the server. Each message group is assigned either an implicit or logical ULP address depending on its type.

FIG. **5** shows an example of a wide area network with a group messaging server ("GMS"). Hosts **58** has TLP address A and ULP address H, host **59** has TLP address C and ULP address J, host **60** has TLP address B and ULP address I and host **61** has TLP address D and ULP address K. The network is a conventional unicast network of network links **69**, **70**, **71**, **72**, **73**, **74**, **75**, **76**, and **77** and unicast routers **63**, **64**, **65**, **66**, **67**, and **68**. The group messaging server **62** receives messages from the hosts addressed to a message group and sends the contents of the messages to the members of the message group. FIG. **6** shows an example of datagrams sent from the hosts to a message group that they are members of. As before, a TLP such as IP (where the message header contain the source and destination TLP addresses) is assumed to be used here. Host **58** sends message **80** which contains the TLP source address A of the host and the destination TLP address S for the GMS **62**. The destination ULP address G is an implicit ULP address handled by the GMS and the payload P**1** contains both the data to be sent and the source ULP address H of the host. It is assumed that prior to sending their ULP messages to the GMS, that each host as already established a connection to the GMS and joined the message group G. Host **60** sends message **81** with payload P**2** containing data and source ULP address I. Hosts **59** sends message **82** with payload P**3** containing data and source ULP address J. Host **61** sends message **83** with payload P**4** containing data and source ULP address K. The GMS receives all of these messages and sees that each message is addressed to implicit message group G with members H, I, J, and K. The GMS can either process the message with or without aggregating their payloads. FIG. **6** shows the case where there is no aggregation and FIG. **7** shows the case with aggregation.

Without aggregation, the GMS generates the outbound messages **84**, **85**, **86**, **87**, **88**, **89**, **90**, **91**, **92**, **93**, **94**, and **95** which it sends to the hosts. The datagramns have TLP headers with the source and destination TLP addresses of the GMS and the hosts respectively. The next field in the datagrams is the destination ULP of the datagram. Datagrams **84**, **85**, and sent to host **58** with TLP address A and ULP address H. Datagrams **87**, **88**, and **89** are sent to host **60** with TLP address B and ULP address I. Datagrams **90**, **91** and **92** are sent to host **59** with TLP address C and ULP address J. Datagrams **93**, **94** and **95** are sent to host **61** with TLP address D and ULP address K respectively. As can be seen from the payloads that each host has received, each host has received the payloads from the other three hosts. Note that each host has not received a copy of its own original message. This is because the GMS has performed echo suppression. This is selectable attribute of the GMS since in some applications it is useful for the hosts to receive and echo of each message that they send to a group that they are also members of. In the example of FIG. **6**, it has been shown how the present invention can achieve the same message delivery as distributed multicasting without its disadvantages. Without aggregation, the present invention enables a host to send a single message to multiple other hosts that are members of a message group. It reduces the message traffic that a host must process in an interactive application by reducing the number of messages that each host must send to the others. Without aggregation, however, there is no reduction in the number of messages received by the hosts. Without aggregation we can achieve the same message rate as distributed multicasting without the need for a network with multicast routers, we can use a conventional unicast network such as the Internet. The present invention also avoids the problems that dynamic group membership causes for distributed multicasting. Group membership can be changed very rapidly. Groups can be created, joined and left by single unicast messages from hosts to the GMS.

These messages will be point-to-point messages and will not have to propagate in throughout the network nor have to cause routing table changes in the routers. This ability to rapidly and accurately change group membership is critical to the implementation of networked interactive applications. Consider a computer game for multiple players that supports hundreds of players that are spread throughout a three dimensional space created by the game. At any time only a few players will be able to see and effect one another in the game since other players will be in other areas that are out of sight. Using conventional phone lines to carry the data from each players computer to the network, it will not be possible to send all actions of each player to all of the other players, but because only a few players will be in close proximity at any one time, it will not be necessary to do so. It is only necessary to send data between the players that are in close proximity to one another. These "groups" of players naturally map onto the message groups of the invention. As players move about the three dimensional space of the game, the game will cause them to join and leave message groups as necessary. If this does not happen rapidly it will limit the interactivity of the game or cause inconsistent results for the different players in the game.

The invention also allows aggregating message payloads of multiple messages destined to a single host into a single larger message. This can be done because of the GMS where all of the messages are received prior to being sent to the hosts. FIG. **7** shows an example of how this works. The hosts send their messages to the GMS in exactly the same fashion as in FIG. **6** using the same addresses previously defined in FIG. **5**. Host **58** sends message **96**, host **60** sends message **97**, host **59** sends message **98** and host **61** sends message **99**. The GMS receives all of these messages and creates four outbound messages **100**, **101**, **102** and **103**. The process by which these messages will be explained in detail in the detailed description of the invention. Each message is destined to a single host and contains an aggregated payload with multiple payload items. Message **100** has a destination ULP address H for host **58** and aggregated payload P**2**, P**3** and P**4** from the messages from hosts **59**, **60** and **61**. Message **101** is targeted at host **60**, message **102** is targeted at host **59** and message **103** is targeted at host **61**. As can be seen, each host sends one message and receives one message. The received message is longer and contains multiple payloads, but this is a significant improvement over receiving multiple messages with the wasted overhead of multiple message headers and message processing time. Overall the invention has dramatically reduced the amount of data that must be sent and received by each host. Since the bit rate over conventional phone lines using a modem is low, a reduction in the amount of data that must be sent and received directly translates into improved time and latency for message communications between the hosts.

Hosts create, join and leave message groups using control messages in the ULP protocol to the GMS. Hosts may also read and write application specific state information that is stored in the GMS. When hosts send messages to other hosts, the message must be at least addressed to an implicit group address. The ULP implicit address will always be the primary address in a message from one host to another. The message may optionally specify auxiliary destination addresses. In many cases the implicit ULP address will be the only destination ULP address in the message. The GMS will handle delivery of the ULP messages addressed to the implicit message group to all of the hosts that are members of the group. A ULP send message may optionally specify an address list of auxiliary addresses in addition to the primary destination of the implicit ULP address. This auxiliary address list can contain only unicast and logical ULP addresses. The address list can also specify set operators to be performed between the sets of host ULP addresses defined by the unicast addresses and logical groups. Once the address list has been processed to yield a set of hosts, this set is intersected with the set of hosts that are members of the implicit message group specified by the primary implicit ULP address in the message. This ability to perform logical set operators on message groups is very useful in interactive applications. It allows a single ULP message to selectively deliver a message to hosts that fit a set of computed criteria without the sending host having to know anything about the members of the groups in the address list. Recall the example of a networked game with hundreds of players in a three dimensional environment created by the game. Consider an implicit message group consisting of all of the game players in a certain area of the game where all of the players can interact with one another. Consider that the players are organized into multiple teams. Logical message groups could be created for each team within the game. To send a message to all the players within the area that were on one team, a ULP message would be sent to the ULP implicit message group for all the players in the area with an auxiliary address of the logical message group for all the players on the selected team. The GMS would perform the proper set intersection prior to sending the resulting messages to the targeted hosts. The result of this will be that the message will only be delivered to the players on the selected team in the selected area of the game.

In summary, the present invention deals with the issues of deploying an interactive application for multiple participants on wide area networks by providing a method for reducing the overall message rate and reducing latency. This invention uses a server group messaging approach, as oppose to the above described "distributed multicast messaging" approach. The present invention overcomes the undesirable side effects of the distributed multicast messaging approach. Further, it reduces the message rate between the hosts. As pointed out in an example discussed above, with prior art distributed multicast messaging, each host will need to send only one message to the group containing all of the hosts seven times per-second, but will still receive 9 messages, seven times per-second. The present invention of server group messaging has each host sending one message, seven times per-second and receiving one message, seven times per-second.

The present invention is different from the multicast routing and distribution method disclosed in U.S. Pat. Nos. 4,740,954, 4,864,559, 5,361,256, 5,079,767 and 5,309,433. Since these patents deal only with variants of distributed multicasting they provide no means to reduce the received message rate, no method to aggregate messages and provide no method in the messages to perform logical operation on message groups. This differs from the present invention where messages from multiple hosts addressed to a message group are received by a group server which processes the contents of the messages and transmits the results to the destination hosts. The present invention is also different from the source to destination multicast streams approach disclosed in EP 0 637 149 A2, PCT/US94/11282 and PCT/US94/11278. In all of these references, the data transmission is from a source to a plurality of designations, whereas the present invention describes data transmission from a sending host to a server host system and then from the server host to the destination hosts.

These and other features and advantages of the present invention can be understood from the following detailed description of the invention together with the accompanying drawings.

DESCRIPTION OF DRAWINGS

FIG. **1** shows a conventional unicast network consisting of hosts, network links and routers.

FIG. **2** shows the unicast datagrams on a conventional unicast network that would be needed to implement an interactive application between four hosts.

FIG. **3** shows a prior art multicast network consisting of hosts, network links and multicast routers.

FIG. **4** shows a multicast datagrams on a prior art multicast network that would be needed to implement an interactive application between four hosts.

FIG. **5** shows a unicast network equipped with a group messaging server in accordance with the present invention.

FIG. **6** shows the ULP datagrams without payload aggregation on a network according to the present invention that would be needed to implement an interactive application between four hosts.

FIG. **7** shows the ULP datagrams with payload aggregation on a network according to the present invention that would be needed to implement an interactive application between four hosts.

FIG. **8** shows a prior art ATM network with a multicast server.

FIG. **9** shows the detailed datagram format and address format for ULP messages in accordance with the present invention.

FIG. **10** shows the internal functions of the GMS according to the present invention.

FIG. **11** shows the host software interface and functions needed to support the ULP according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention provides a method for multiple host computers to efficiently communicate information to one another over a wide area network for the purposes of implementing an interactive application between multiple users. The method involves three components: a host protocol interface, a protocol and a server. The protocol is between the host protocol interface and the server and is implemented on top of the network transport protocol of a wide area network. The protocol is called the Upper Level Protocol (ULP) since it is layered above the existing network Transport Level Protocol (TLP). In the OSI reference model the protocol can be described as a Session Layer protocol on top of the Transport Layer of the network. FIG. **11** shows the host protocol interface, **151**, relative to the interactive application, **150**, and the host interface for the Transport Level Protocol, **153**. The network interface, **155**, provides the physical connection for the host to the network. The network communications stack, **154**, is the communications protocol stack that provides network transport services for the host and the host interface for the Transport Level Protocol, **153**, is an interface between host application software and the network transport services of the network communications stack.

The interactive application can send and receive conventional network messages using the host interface to the TLP. The interactive application also can send and receive ULP messages through the host interface for the ULP. Internal to the host interface for the ULP is a table, **152**, of all ULP addresses which the host can send messages to. Each entry in the table contains a pair of addresses, a ULP address and its corresponding TLP address. When the host sends a message to a ULP address, that message is encapsulated in a TLP message sent to the TLP address corresponding to that ULP address. This allows the ULP messages to be handled transparently by the transport mechanisms of the existing network. A core function of the ULP is group messaging where hosts send messages to message groups populated by multiple hosts. This allows a host to send a message to multiple hosts with one ULP message. Since the ULP is layered on top of the TLP, the group messaging functions of the ULP operate on a conventional unicast network where TLP messages can only be sent from one host to only one other host.

The group based messaging is implemented through the use of a server called a group messaging server. AU ULP messages from the hosts are sent from the hosts to a group messaging server using the TLP protocol. The server processes the ULP portion of the messages and takes the necessary steps required by the ULP message. Control ULP messages are processed locally by the server and may be acknowledged to the sending host. ULP messages addressed to other hosts are processed by the group messaging server and then re-transmitted to the proper ULP destination hosts, again using the TLP protocol to encapsulate and transport these messages.

In FIG. **5**, hosts **58**, **59**, **60** and **61** send messages to one another using the ULP over a conventional unicast network using a group messaging server **62**. The network consists of conventional routers **63**, **64**, **65**, **66**, **67** and **68** connected with conventional network links **69**, **70**, **71**, **72**, **73**, **74**, **75**, **76** and **77**. Host **58** can send a message to hosts **59**, **60** and **61** by sending a single ULP message to the group messaging server **62** where the ULP message specifies a destination address that is a ULP message group. The ULP message is encapsulated in a TLP message addressed to the group messaging server. This causes the message to be properly routed by router **63** to network link **71** to router **67** to the server **62**. The group messaging server receives the ULP message and determines that the message is addressed to a message group containing hosts **59**, **60** and **61** as members. The server sends the payload of the received message to each of the hosts in three new ULP messages individually sent to the three hosts. Since each message is encapsulated in a TLP message, the messages are properly carried over the conventional unicast network. The first ULP message is sent by the group messaging server to host **61**. This message is carried by network links **71**, **70**, **72** and **75** and routers **67**, **63**, **64** and **65**. The second ULP message is sent by the group messaging server to host **60**. This message is carried by network links **71**, **70**, **73** and **76** and routers **67**, **63**, **64** and **66**. The third ULP message is sent by the group messaging server to host **61**. This message is carried by network links **74** and **77** and routers **67** and **68**.

The invention can be implemented both in a datagram form and in a connection oriented form. To best understand the details of the invention, it is best to first consider a datagram implementation

Datagram Transport Implementation

The ULP can be implemented as a datagram protocol by encapsulating addresses, message type information and the message payload within a datagram of the underlying network transport protocol. The general form of the ULP datagram message format is shown in FIG. **9** as elements **123**, **124**, **125**, **126**, **127**, **128** and **129**. The transport header **123** is the datagram header of the TLP that is encapsulating the ULP datagram. The ULP message type field **124** indicates whether it is a send or receive message, if it is a control

message or a state message. The following table shows the different message types. The ULP message type field must be present in a ULP datagram.

Message Types	
1	Send
2	Receive
3	Send Control
4	Receive Control
5	Send State
6	Receive State

Send messages are always sent from a host to a group messaging server. Messages from a group server to the hosts are always receive messages. Send Control messages are messages from hosts to a group messaging server requesting a control function be performed. Receive Control messages are acknowledgments from a group messaging server to the hosts in response to a prior Send Control messages. The Send and Receive State messages are special cases of the Send and Receive Control messages that allow hosts to read and write application specific state storage in the group messaging server. The specific control functions supported by the ULP will be explained later.

The destination ULP address **125** is required in ULP datagrams and specifies the primary destination of the ULP message. The address count field **126** is required in ULP send message types and is not present in ULP receive message types. When the address count field in a ULP send message is non-zero, it specifies the number of auxiliary destination addresses for the send message that follow the address count field. These auxiliary destination addresses are shown as items **127** and **128**, but it is understood that there are as many auxiliary ULP destination addresses as specified by the address count field. Finally there is the payload **129**.

The payload format for ULP datagrams is defined by items **116**, **117**, **118**, **119**, **120**, **121** and **122**. Item **116** is the message count and defines how many payload elements will be contained in the payload. A single payload element consists of a triplet of source ULP address, data length and data. Items **117**, **118** and **119** comprise the first payload element of the payload. Item **117** is the ULP address of the source of the payload element, item **118** is the data length for the data in the payload element and item **119** is the actual data. Items **120**, **121** and **122** comprise the last payload element in the payload. ULP send messages only support payloads with a single payload element, so the message count is required to be equal to one. ULP receive messages may have payloads with one or more payload elements.

ULP Address Space

The address space of the ULP is divided into three segments: unicast host addresses, implicit group addresses and logical group addresses. All source and destination addresses in ULP must be in this address space. The ULP address space is unique to a single group messaging server. Therefore each group messaging server has a unique ULP address space. Multiple group messaging servers may be connected to the network and hosts may communicate with multiple group messaging servers without confusion since each ULP datagram contains the header of the TLP. Different group messaging servers will have unique TLP addresses which can be used by the hosts to uniquely identify multiple ULP address spaces. The format for ULP addresses is shown in FIG. **9** comprised of items **130**, **131** and **132**. The address format field **130** is a variable length field used to allow multiple address lengths to be supported. The address type field **131** indicates the type of ULP address: unicast host, implicit group or logical group. The encoding is as follows:

Address Type Encoding	
00	Unicast Host Address
01	Unicast Host Address
10	Implicit Group Address
11	Logical Group Address

The address format encoding determines the length of the address field and therefore the total length of the ULP address. This encoding is shown below. Note that when the address type specifies a unicast host address, the low bit of the address type field is concatenated to the address field to become the most significant bit of the address. This doubles the size of the address space for unicast host addresses which is useful since there will generally be more hosts than group messaging servers.

Address Format Encoding	
0	29 Bit Address Field
10	4 Bit Address Field
110	11 Bit Address Field

ULP unicast host addresses are assigned to each host when it first connects to a group messaging server. When a host sends a message to other ULP address, the unicast ULP address of the host will appear as the source ULP address in the received payload element. Unicast ULP host addresses can also be used as destination addresses only as auxiliary addresses in a ULP send message. They are not allowed to be used to as the primary ULP destination address. This means that hosts cannot send ULP directly to one another, but always must send the messages to one another through a group messaging server.

Implicit group addresses are created by a group messaging server in response to a control message to the server requesting the creation of an implicit message group. The host requesting the creation of the implicit message group becomes a member of the message group when it is created. Other hosts can send inquiry control messages to the group messaging server to learn of its existence and then send a implicit group join message in order to join the group. The group messaging server maintains a list of ULP addresses of hosts that are members of the implicit message group. Implicit ULP group addresses are the only ULP addresses allowed to be the primary destination of a ULP send message. Implicit ULP addresses will never appear as ULP source addresses in a payload element.

Logical ULP addresses are used both to address logical message groups and for specifying set operations between the group members of the auxiliary ULP addresses in a ULP send message. Logical message groups are created and joined similarly to implicit message groups, however, logical ULP addresses may only be used as auxiliary ULP addresses in a ULP send message. Logical ULP addresses will also never appear as source ULP addresses in a payload element. The support of set operations between message groups as part of a ULP send message will be explained in a later section on ULP send messages.

Group Messaging Server Internal Functions

The internal components of the group messaging server are shown in FIG. **10**.

In the preferred embodiment, the group messaging server is a general purpose computer system with a network interface to connect it to a wide area network. Item **135** is the network interface for the group messaging server and includes not only the hardware connection to the network but the communications protocol stack used to implement the TLP on the server.

Item **136** is an overall control function for the group messaging server. This control function is responsible for all ULP messages that are sent or received by the GMS. Internal to this control function are several important storage and processing functions. Item **137** is an address map for all hosts currently connected to the GMS. This address map is a list of the ULP host address of each host connected to GMS and its corresponding TLP address. This enables the control function to construct the necessary TLP headers for sending ULP messages to the hosts connected to the GMS. Item **138** is a list of all of the currently active implicit ULP addresses currently recognized by the GMS. Item **139** is an application specific state storage and processing function. Many interactive applications deployed over a network will be able to be implemented solely with host based processing. In these cases all data that needs to be sent between the hosts can be transported using the ULP. However, some applications will need maintain a centrally stored and maintained repository of application state information. This is useful when hosts may join or leave the application dynamically. When hosts join such an application, they will need a place from which they can obtain a snapshot of the current state of the application in order to be consistent with the other hosts that already where part of the application. To read and write this state storage area, the ULP supports send and receive state message types. Within these messages, there is the ability to access a state address space so that different portions of the state can be individually accessed. Application specific processing of state written into this state storage area can also be implemented.

Items **140** and **141** are two of multiple ULP server processes running on the GMS. These are software processes that are at the heart of the ULP. Each implicit ULP addresses recognized by the GMS has a one-to-one correspondence to a ULP server process and to a message group maintained by the process. Since all ULP send messages must have an implicit ULP address as the primary destination address of the message, every ULP send message is sent to and processed by a ULP server process. These processes are created by the GMS control function in response to ULP control messages to create new implicit ULP addresses. They are destroyed when the last host which is a member of its message group has left the message group. Internal to a ULP server process is a list, **142**, of the ULP host addresses of the members of the message group, a set of message queues **143** for each host which is a member of the message group and a message aggregation function **149** which is used to aggregate multiple messages to a single host into a single message.

Item **145** maintains a list of all of the logical ULP addresses and message groups in the GMS. Items **144** and **146** represent two of multiple logical ULP addresses. For each logical ULP address, there is a corresponding list, **147** and **148** of the host ULP addresses of the members of the logical message group. The logical message groups are not tied to specific ULP server processes, but are global with a GMS to all of the ULP server processes.

Control Functions

The control functions consist of connect, disconnect, create group, close group, join group, leave group, query groups, query group members, query group attributes. These control functions are implemented by a ULP send and receive control messages. The control functions are initiated by a host sending a ULP send control message to a GMS. These messages only allow a primary ULP destination address in the message and do no allow auxiliary addresses. The primary ULP address is interpreted as a control address space with a unique fixed address assigned to each of the control functions enumerated above. The contents of data in the payload supplies any arguments needed by the control function. Returned values from the control function are returned in a ULP receive control message that is addressed to the host that sent the original control message for which data is being returned. The detailed operation of these control functions is described below.

Connect

This control function allows a host to connect to a GMS. The destination ULP address in the message is a fixed address that indicates the connect function. The source ULP address and any data in the payload are ignored.

Upon receiving this message, the GMS control function, **136**, creates a new host address and enters the host address in the host address map **136** along with the source TLP address from the TLP header of the message. Upon successful completion, the GMS control function responds with a receive control ULP message addressed to the host along with a function code in the data portion of the payload that indicates successful host connection. The destination ULP address in the message is the ULP address assigned to the host. The host saves this and uses it for any future messages to the GMS. If there is an error, the control function returns a message to the host with a function code in the data portion of the payload indicating failed host connection.

Disconnect

This function allows a host to disconnect from a GMS. The destination ULP address in the message is a fixed address that indicates the disconnect function. The source ULP address is used to remove the host from membership in any implicit or logical groups prior to disconnecting. Any data in the payload is ignored. The GMS control function also removes the entry for the host from the host address map. Upon successful completion, the GMS control function responds with a receive control ULP message addressed to the host along with a function code in the data portion of the payload that indicates successful host disconnection. The destination ULP address in the message is the ULP address assigned to the host. If there is an error, the control function returns a message to the host with a function code in the data portion of the payload indicating failed host disconnection.

Create Implicit Group

This function allows a host to create a new implicit message group and associated implicit ULP address and server process. The payload in the message may contain a single payload item whose data field holds attributes of the group. These attributes can be used to define any optional functions of the group. The destination ULP address in the message is a fixed address that indicates the create implicit group function. The GMS control function allocates a new implicit ULP address, adds it to the implicit ULP address list **138** and creates a new ULP server process **140**. The host that sends this message is added to the membership list of the implicit group. This is done by adding the source ULP address in the message to the group membership list **142** in the ULP server process. Upon successful completion, the GMS control function responds with a receive control ULP message addressed to the host along with a function code in the data portion of the payload that indicates successful implicit group creation. The source ULP address in the payload is the ULP address assigned to the new implicit group. If there is an error, the control function returns a message to the host with a function code in the data portion of the payload indicating failed implicit group creation.

Create Logical Group

This function allows a host to create a new logical message group and associated logical ULP address. The payload in the message may contain a single payload item whose data field holds attributes of the group. These attributes can be used to define any optional functions of the group The destination ULP address in the message is a fixed address that indicates the create logical group function. The GMS control function allocates a new logical ULP address and adds it to the logical ULP address list **145**. The host that sends this message is added to the membership list of the logical group. This is done by adding the source ULP address in the message to the group membership list **147** for the new logical message group **144**. Upon successful completion, the GMS control function responds with a receive control ULP message addressed to the host along with a function code in the data portion of the payload that indicates successful logical group creation. The source ULP address in the payload is the ULP address assigned to the new logical group. If there is an error, the control function returns a message to the host with a function code in the data portion of the payload indicating failed implicit group creation.

Join Group

This function allows a host to join an existing logical or implicit message group. The destination ULP address in the message is a fixed address that indicates the join group function. The data portion of the payload contains the ULP address of the group that is to be joined. The GMS control function looks at this address and determines if it is an implicit or logical ULP address. If it is an implicit ULP address, the GMS control function finds the ULP server process selected by the address in the message payload and adds the source ULP host address from the message to the group membership list **142**. If it is a logical ULP address, the GMS control function finds the logical ULP address **144** selected by the address in the message payload and adds the source ULP host address from the message to the group membership list **147**. Upon successful completion, the GMS control function responds with a receive control ULP message addressed to the host along with a function code in the data portion of the payload that indicates successful group join. The source ULP address in the payload is the ULP address of the group that was joined. If there is an error, the control function returns a message to the host with a function code in the data portion of the payload indicating failed implicit group creation.

Leave Group

This function allows a host to leave an existing logical or implicit message group that it is a member of The destination ULP address in the message is a fixed address that indicates the leave group function. The data portion of the payload contains the ULP address of the group that is to be left. The GMS control function looks at this address and determines if it is an implicit or logical ULP address. If it is an implicit ULP address, the GMS control function finds the ULP server process selected by the address in the message payload and removes from the group membership list **142** the source ULP host address from the message. If the host is the last member of the group, the ULP server process is terminated and the implicit ULP address is de-allocated. If it is a logical ULP address, the GMS control function finds the logical ULP address **144** selected by the address in the message payload and removes from the group membership list **147** the source ULP host address from the. If the host is the last member of the group, the ULP address is de-allocated. Upon successful completion, the GMS control function responds with a receive control ULP message addressed to the host along with a function code in the data portion of the payload that indicates successful group leave. If there is an error, the control function returns a message to the host with a function code in the data portion of the payload indicating failed implicit group creation.

Query Groups

This function allows a host to get a list of all implicit and logical message groups currently active on a GMS. The destination ULP address in the message is a fixed address that indicates the query groups function. Any data portion of the payload is ignored. Upon successful completion, the GMS control function responds with a receive control ULP message addressed to the host along with a payload with multiple payload elements. The first payload element contains a function code indicating successful query groups. The source ULP address in the first payload element is ignored. Each of the subsequent payload elements contain a ULP group address in the source address field of the payload element that is one of the active group addresses on the GMS. There is no data field in these subsequent payload elements. If there is an error, the control function returns a message to the host with a function code in the data portion of a payload with a single payload element indicating failed query groups.

Query Group Members

This function allows a host to get a list of all hosts that are members of a message group. The destination ULP address in the message is a fixed address that indicates the query group members function. The data portion of the payload carries the address of the message group for the query. Upon successful completion, the GMS control function responds with a receive control ULP message addressed to the host along with a payload with multiple payload elements. The first payload element contains a function code indicating successful query group members. The source ULP address in the first payload element is ignored. Each of the subsequent payload elements contain a ULP host address in the source address field of the payload element that is one of the active group addresses on the GMS. There is no data field in these subsequent payload elements. If there is an error, the control function returns a message to the host with a function code in the data portion of a payload with a single payload element indicating failed query group members.

Query Group Attributes

This function allows a host to get a list of the attributes of a message group. The destination ULP address in the message is a fixed address that indicates the query group attributes function. The data portion of the payload carries the address of the message group for the query. Upon successful completion, the GMS control function responds with a receive control ULP message addressed to the host along with a payload with a two payload elements. The first payload element contains a function code indicating successful query group members. The second payload element contains the attributes of the message group. If there is an error, the control function returns a message to the host with a function code in the data portion of a payload with a single payload element indicating failed query group attributes.

Send Message Operation

In order to fully understand the operations of the send message function, a number of individual cases are worth considering.

Single Implicit Destination

The most simple case is a send message to a single implicit ULP address. In all send message datagrams, the destination ULP address **125** must be an implicit ULP address. In this case of a single implicit destination, this is the only destination address in the datagram. The auxiliary address count **126** is zero and there are no auxiliary destination addresses **127** or **128**. The payload consists of a message count **116** of one, the ULP of the host sending the message in the source ULP address **117** and the data length **118** and data **119**. Send message datagrams may only have a single payload item so their message count field **116** must always be one.

The host sends the send message onto the network with a TLP header addressing the datagram to the GMS that is the selected target of the message. The GMS receives the message and the GMS control function **136** determines that it is a send message datagram and looks up the implicit destination address in its implicit ULP address list **138**. If the address does not exist, an error message is returned to the sending host with a ULP receive message datagram. If the address is valid, the GMS control function removes the TLP header from the datagram and sends the ULP portion to the ULP server process corresponding to the destination implicit ULP address. Assume for discussion that this is the ULP server process **140**. The ULP server process **140** will extract the single payload item from the message **117**, **118** and **119** and place the payload item in each of the message queues **143**. There will be one message queue for each member of the message group served by the ULP server process **140**. The members of the group will have their host ULP addresses listed in the host address list **142**. Each message queue in a ULP server process will fill with payload items that are targeted at particular destination hosts. The mechanisms by which payload items are removed from the queues and sent to the hosts will be described later.

Auxiliary Unicast Destination

In this case in addition to an implicit destination **125**, there is also a single auxiliary address **127** in the datagram. The auxiliary address count **126** is one and the auxiliary destination addresses **127** is a unicast host ULP address. The payload consists of a message count **116** of one, the ULP of the host sending the message in the source ULP address **117** and the data length **118** and data **119**.

The host sends the send message onto the network with a TLP header addressing the datagram to the GMS that is the selected target of the message. The GMS receives the message and the GMS control function **136** determines that it is a send message datagram and looks up the implicit destination address in its implicit ULP address list **138** and the unicast host ULP auxiliary address in the host address map **137**. If either of addresses does not exist, an error message is returned to the sending host with a ULP receive message datagram. If the addresses are valid, the GMS control function removes the TLP header from the datagram and sends the ULP portion to the ULP server process corresponding to the destination implicit ULP address. Assume for discussion that this is the ULP server process **140**. The ULP server process extracts the auxiliary ULP address from the message and determines from the address that it is a unicast host ULP address. The server process then checks to see if this address is a member of the message group defined by the host address list **142**. If it is not, no further action is taken and the payload item in the message is not placed in any of the message queues **143**. If the host address is in the message group, the payload item in the message is placed in the single message queue corresponding to that host. The net effect is that the ULP server process has performed a set intersection operation on the members of the message group selected by the implicit ULP destination address and defined by the group membership list **142** with the members of the set of hosts defined by the auxiliary address. The payload item is them sent only to the hosts that are members of this set intersection.

Auxiliary Logical Destination

In this case in addition to an implicit destination **125**, there is also a single auxiliary address **127** in the datagram. The auxiliary address count **126** is one and the auxiliary destination addresses **127** is a logical ULP address. The payload consists of a message count **116** of one, the ULP of the host sending the message in the source ULP address **117** and the data length **118** and data **119**.

The host sends the send message onto the network with a TLP header addressing the datagram to the GMS that is the selected target of the message. The GMS receives the message and the GMS control function **136** determines that it is a send message datagram and looks up the implicit destination address in its implicit ULP address list **138** and the logical ULP auxiliary address in list of logical ULP addresses **145**. If either of addresses does not exist, an error message is returned to the sending host with a ULP receive message datagram. If the addresses are valid, the GMS control function removes the TLP header from the datagram and sends the ULP portion to the ULP server process corresponding to the destination implicit ULP address. Assume for discussion that this is the ULP server process **140**. The ULP server process extracts the auxiliary ULP address from the message and determines from the address that it is a logical ULP address. Assume for this example that this logical ULP address is the logical address **144**. The server process fetches the group membership list **147** corresponding to the logical address and performs a set intersection operation with the group membership list **142** of the server process. If there are no members of this set intersection, no further action is taken and the payload item in the message is not placed in any of the message queues **143**. If there are members of the set intersection operation, the payload item in the message is placed in the queues corresponding to the hosts that are members of the set intersection.

Multiple Auxiliary Addresses With Logical Operations

In its most sophisticated form, a send message can perform set operations between the implicit message group of the ULP server process and multiple logical and unicast ULP addresses. This is done by placing multiple auxiliary destination ULP addresses in the message with logical operators imbedded in the address list. The address count **126** holds a count of the total auxiliary addresses in the address list **127** and **128**. The auxiliary addresses are a mix of logical ULP addresses and unicast host ULP addresses. Two logical ULP addresses in the ULP address space are assigned the role of specifying set operations to be performed between the logical message groups and unicast host addresses in the message list. They are specially assigned addresses for the functions set intersection, set union. A third logical address is used to indicate set complement. The payload consists of a message count **116** of one, the ULP of the host sending the message in the source ULP address **117** and the data length **118** and data **119**.

The host sends the send message onto the network with a TLP header addressing the datagram to the GMS that is the selected target of the message. The GMS receives the message and the GMS control function **136** determines that it is a send message datagram and looks up the implicit ULP message in the implicit ULP address list **138** and all of the addresses in the address list either in the host ULP address map **137** or in the logical ULP address list **145** as appropriate. If any of addresses does not exist, an error message is returned to the sending host with a ULP receive message datagram. If the addresses are valid, the GMS control function removes the TLP header from the datagram and sends the ULP portion to the ULP server process corresponding to the destination implicit ULP address. Assume for discussion that this is the ULP server process **140**. The ULP server process extracts the auxiliary ULP address list from the message and scans it from beginning to end. The scanning and processing of the set operators is done in post-fix fashion. This means that arguments are read followed by an operator that is then applied to the arguments. The result of the operator becomes the first argument of the next operation. Therefore at the start of scanning two addresses are read from the address list. The next address will be an operator that is applied to the arguments and the result of this operator is the first argument to be used by the next operator. From then on a single address is read from the address list followed by a logical ULP address which is operator on the two arguments consisting of the new argument and the results of the last operator. The logical address used to indicate set complement is not a set operator, by an argument qualifier since it can precede any address in the address list. The meaning of the set complement argument qualifier is relative to the group membership of implicit group address in the send message. If the set complement qualifier precedes a unicast host address which is not a member of the message group selected by the implicit ULP address in the send message, the effective argument is the set of all hosts that are members of the implicit message group. If the set complement qualifier precedes a unicast host address which is a member of the message group selected by the implicit ULP address in the send message, the effective argument is the set of all hosts that are members of the implicit message group except for the original unicast host address qualified by the complement function. If the set complement qualifier precedes a logical ULP address the effective argument is the set of all hosts that are members of the implicit message group specified by the send message except hosts that are members of the logical message group preceded by the set complement modifier. Once the entire address list has been processed to a single result set of hosts, a set intersection operation is performed on this set and the set of members of the implicit message group **142** defined by the implicit address in the send message. If there are no members of this set intersection, no further action is taken and the payload item in the message is not placed in any of the message queues **143**. If there are members of the set intersection operation, the payload item in the message is placed in the queues corresponding to the hosts that are members of the set intersection.

Message Delivery and Aggregation

Once messages are entered into the message queues in the ULP server processes, there are a variety of ways that they can ultimately be delivered to the targeted hosts. In the invention, the delivery method is set on a per-ULP server process basis by attributes that are provided at the time that an implicit ULP message group and server process are created. It is important during the description of these methods to keep in mind that the invention is intended to provide an efficient means for a group of hosts to send messages to each other at a rapid rate during the implementation of a networked interactive application. Also assumed in the following description is that the GMS performs echo suppression when a host sends a message to a group that it belongs to. This means that the host will not receive a copy of its own message to the group either as a single un-aggregated message or as a payload item in an aggregated message. This is controlled by a ULP server process attribute that can be changed to stop echo suppression, but echo suppression is the default.

Immediate Delivery

The most simple delivery method is to immediately deliver the payload items to their targeted hosts as soon as they are placed in the message queues. Each payload item in a message queue will contain a ULP source address, a data length and the data to be sent. To implement immediate delivery, the ULP server process will remove a payload item from a message queue for a particular host **143**. The host address for this host will be obtained from the group membership list **142**. The payload item and the destination host address will be sent to the GMS control function **136** where it will be used to create a ULP receive message sent to the destination host. The GMS control function **136** will use the destination ULP host address to look up the TlP address of the host from the host address map **137**. This will be used to create a TLP header for the message **123**. The ULP message type **124** will be ULP receive, the destination ULP address **125** will be the destination host, the address count will be 0 and there will be no auxiliary addresses. The payload in this case will have a message count **116** of 1 and the payload item comprised of fields **117**, **118**, and **119** will be the payload element taken from the message queue.

Immediate delivery is useful when the message rate between a group of hosts is low. Consider four hosts that are members of an implicit message group where each member of the group sends a message to every other member of the group at a fixed rate. With immediate delivery, each host will send three messages to the other members of the group and receive three messages from the other members of the group at the fixed rate. This is acceptable is the size of the group is small and the message rate is low. However, it is obvious that total message rate is the product of the underlying message rate and the total number of members of the group minus one. Clearly this will result in unacceptably high message rates for large groups and highly interactive message rates. A group of 20 members that had an underlying message rate of 10 messages per second would yield a total message rate at each host of 190 messages sent and 190 messages received every second. This message rate will be unsupportable over a conventional dial-up connection to a conventional wide area network such as the Internet.

Aggregation

A key concept in the present invention is the aggregation of multiple messages in a message queue into a single ULP receive message to a host that contains multiple payload items in the payload. The ULP server process **140** removes payload items from a message queue **143** for a host and accumulates them in an aggregation buffer **149**. The aggregation buffer has buffer areas for each host for which there is a message queue. These individual host areas within the aggregation buffer are called host aggregation buffers. The start and end of this aggregation period can be controlled in a number of ways that will be described in the next sections. At the end of the aggregation period, the each host aggregation buffer may hold multiple payload items. The host aggregation buffer will hold a message count of the payload items followed by the multiple payload items. The contents of a host aggregation buffer along with the ULP host address of the corresponding host are sent to the GMS control function **136** where it will be used to create a ULP receive message sent to the destination host. The GMS control function **136** will use the destination ULP host address to look up the TLP address of the host from the host address map **137**. This will be used to create a TLP header for the message **123**. The ULP message type **124** will be ULP receive, the destination ULP address **125** will be the destination host, the address count will be 0 and there will be no auxiliary addresses. The payload in this case will have a message count **116** set by the message count value from the host aggregation buffer. The payload will contain all of the payload items from the host aggregation buffer.

The effect of aggregation will be to greatly reduce the total message rate received by the hosts. A single message to a host will be able to carry multiple payload items received from the other hosts during the aggregation period. This fits very well the interactive applications of this invention where groups of hosts will be sending messages to all the other hosts in the group at a periodic rate. Aggregation will be very effective in collecting together all of the messages from all of the other hosts into a single message for each member of the group. The reduces processing at each receiving host since a single message will be received rather than many separate messages. Aggregation will also reduce the total data rate to the hosts since aggregation eliminates the need for separate message headers for each payload item. The savings will be significant for small payload items since there will be only one message header comprising fields **123**, **124** and **125** for multiple payload items. In cases where a group of hosts are sending messages to the group at a periodic rate, it is often the case in many interactive applications that the data being sent by each host to the group is very similar to the messages sent by the other hosts. This affords the opportunity within an aggregated payload of multiple payload items to apply a data compression method across the multiple data elements of the payload elements. A wide variety of known data compression methods will lend themselves to this application. The first data element in the first payload item can be sent in uncompressed form with each subsequent data element being compressed using some form of difference coding method. A variety of known data compression methods use the concept of a predictor with differences from the predicted value being encoded. The first data element in an aggregated payload can be used as this predictor with the subsequent data elements coded using such a data compression method. These conventional data compression methods do not assume any knowledge of the internal structure or function of portions of a data element to compress. It is also possible to make use of application specific coding techniques that take advantage of such knowledge to potentially achieve much higher coding efficiency.

Server Isochronous

One method by which the aggregation time period can be defined is called Server Isochronous or SI. In this method, A ULP Server Process defines a uniform time base for defining the aggregation time period. This time base is defined by three parameters: the time period, the aggregation offset and the transmit offset. These parameters are set by the attributes provided in the create implicit group control function at the time the implicit group and the ULP server process are created. The time period is a fixed time interval during which the ULP server process will accumulate messages in the message queues, aggregate the messages in the queues and send the aggregated messages to the targeted hosts. The aggregation offset defines the point after the start of the time period after which arriving messages will be stored in the message queues for delivery in the next time period.

Therefore, at the aggregation offset after the start of the time period, a snapshot will be taken of all of the messages in each message queue. New messages will continue to arrive and be entered into the queues after the aggregation offset. Only those messages in the queues before the aggregation offset point will be aggregated into outbound messages. The resulting aggregated messages will then be sent to their targeted hosts at the point in time which is the transmit offset after the start of the time period. The result is that messages arrive continuously and are stored in the message queues. Once per time period the are aggregated into single messages to each host which is the target of messages and once per time period these aggregated messages are sent to the hosts.

Another embodiment of the SI method is to allow the ULP server process to dynamically vary the time period based on some criteria such as the received message rates, and/or received data rate. The ULP server could use a function to define the aggregation period based on the number of messages received per second or the total number of payload bytes received per second. One reasonable function would be to shorten the aggregation period as the rate or received messages or data rate of the received payloads increased. This would tend to keep the size of the outbound messages from growing too much as received messages and/or received data rate grew. Other possible functions could be used that varied the aggregation period based on received message rates, received payload data rates or other parameters available to the ULP server process.

Host Synchronous

The host synchronous or HS method of defining the aggregation time period allows the definition of a flexible time period that is controlled by the hosts. It is based on the concept of a turn which is a host sending a message to one or more members of the implicit message group which is operating is HS mode. Once every host in the message group has taken a turn, the aggregation period ends. A snapshot of the contents of the message queues is taken, the contents of each of the queues is aggregated and the aggregated messages are sent to the hosts targeted by each message queue. A refinement to this technique qualifies which of the three ULP send message types to the group constitute a host turn: a send only to the implicit address of the group, a send to a unicast host address within the group or a send to a logical ULP address which shares members with the group. The attributes of the group not only will define HS aggregation, but one or more ULP send message types that will be considered a host turn. A further refinement sets the total number of turns that a host can take in a single aggregation time period. The default will be one turn, but multiple turns can be allowed. If a host attempts to take more turns than allowed, the messages are ignored.

This aggregation technique has the additional benefit of causing the hosts which are member of an HS implicit message group to have their processing functions synchronized when they are executing the same interactive application. Many networked interactive applications are based on a simple overall three step operational model: wait for messages from other hosts, process the messages and the local users inputs to update the local application, send messages to the other hosts. This basic application loop is repeated at a rate fast enough to provide an interactive experience such as 5 to 30 times per second. It is desirable to keep such applications synchronized so that the states of the applications is consistent on the different host machines. When such applications communicate using the HS model of the present invention their operations will become naturally synchronized. The HS ULP server process will wait until all of the members of the message group has completed their turns and sent a message to the group before sending the aggregated messages to the members of the group. This will cause the applications on the hosts to wait until they have received the aggregated messages. They will all then start processing these messages along with the local user inputs. Even if they perform their processing at different speeds and send their next messages to the group at different times, the HS ULP server will wait until all have completed their processing and reported in with a message to the group. This will keep all of the host applications synchronized in that every host will be at the same application loop iteration as all of the others. This will keep the application state consistent on all of the hosts. Only network propagation delays from the GMS to the hosts and different processing speeds of the hosts will cause the start and completion of their processing to begin at different times. It is not a requirement in networked applications to keep all of the hosts precisely synchronized, only that that application state is consistent. The HS method provides a natural way to do this in the context of the present invention.

Preferred Embodiment

The detailed description of the invention has described a datagram implementation of the invention as the best way to explain the invention. The preferred embodiment of the invention is as follows.

In the preferred embodiment, the wide area network is the Internet and the TLP protocol is TCP/IP. The GMS is a general purpose computer system connected to the Internet and the hosts are personal computers connected to the Internet.

TCP/IP provides an number of advantages that provide for a more efficient applications interface on the hosts **151**. TCP/IP supports the concept of source and destination port numbers in its header. The ULP can make use of the port numbers to identify source and destination ULP connections. Most ULP send messages will be from hosts to a implicit ULP group addresses and most ULP receive messages will be from the implicit ULP addresses to the ULP host addresses. All of these and the ULP message type field can represented by source and destination port addresses within the TCP/IP header. This means that for most ULP messages, the ULP message encapsulated within the TCP/IP message need only contain the payload. There is the slight complication of the aggregated ULP receive messages sent from a ULP server process to a hosts. Here the destination port will be the host the source port will be for the implicit ULP group address and the payload will still contain the source host ULP addresses in each the payload items.

TCP/IP also supports header compression for low speed dial-up lines which is also important in this application. See RFC 1144. TCP/IP is a connection oriented protocol which provides reliable end-to-end transport. It handles re-transmission on errors and fragmentation and reassembly of data transparently to upper level protocols. Header compression allows much of the TCP/IP header to be omitted with each packet to be replaced by a small connection identifier. This connection ID will uniquely define a connection consisting of a source and destination IP address and source and destination TCP/IP port numbers.

At the interface to the application on the hosts, the preferred embodiment of the ULP is as a session layer protocol. In the preferred embodiment the application on a host opens a session with a ULP server process. This session is identified with a unique session ID on the host. The host application then sends data to the ULP host interface **151** tagged with this session ID. The session ID defines a host and implicit ULP pair including the TCP/IP TLP address of the GMS server that is running the particular ULP server process for the implicit ULP address. By binding the transport address of the GMS of a ULP server process to the session ID, we can transparently to the application support multiple group messaging servers on the network and a single host can have multiple active sessions with different physical group messaging servers. This avoids any address space collision problems that could arise from the fact that the ULP address space is unique to each GMS.

Alternate Embodiments

One possible extension to the invention is to extend the ULP to support a common synchronized time base on the GMS and the hosts that are connected to it. This would be most interesting in context of the SI message aggregation mode. The SI time base on the GMS could be replicated on all of the hosts and all of the hosts and the GMS could lock these time bases together. There are known methods to synchronize time bases on multiple computer systems. One such method is called Network Time Protocol (NTP).

Another extension to the invention is to define ULP server processes that perform specific application specific processing on the contents of the messages that are received. A variety of different application specific processing functions can be defined and implemented. A particular function would be selected by attributes provided in the create implicit group function. These functions could process the data in the message payloads and replace the data elements in the payloads with processed results. Separately, or in combination with processing the message payloads, the processing could store either raw message payload data in the application specific state storage area or could store processed results.

Clearly, the host system need not be personal computers, but could also be dedicated game consoles or television set top boxes or any other device with a programmable controller capable of implementing the ULP protocol.

The wide area network used to transport the ULP protocol need not be the Internet or based on IP. Other networks with some means for wide area packet or datagram transport are possible including ATM networks or a digital cable television network.

The invention now being fully described, it will be apparent to one of ordinary skill in the art that any changes and modifications can be made thereto without departing from the spirit or scope of the invention as set forth herein Accordingly, the present invention is to be limited solely by the scope of the appended claims.

What is claimed is:

1. A method for facilitating communications among a plurality of host computers over a network to implement a shared, interactive application, comprising the steps of:

(1) receiving a create message from one of the plurality of host computers, wherein said create message specifies a message group to be created;

(2) receiving join messages from a first subset of the plurality of host computers, wherein each of said join messages specifies said message group;

(3) receiving host messages from a second subset of said first subset of the plurality of host computers belonging to said message group, wherein each of said messages contains a payload portion and a portion that is used to identify said message group;

(4) aggregating said payload portions of said host messages received from said second subset of the plurality of host computers to create an aggregated payload;

(5) forming an aggregated message using said aggregated payload; and

(6) transmitting said aggregated message to said first subset of the plurality of host computers belonging to said message group;

wherein said aggregated message keeps the shared, interactive application operating consistently on each of said first subset of the plurality of host computers.

2. The method of claim 1, wherein the network is at least a portion of the Internet.

3. A method for facilitating communications among a plurality of host computers over a network to implement a shared, interactive application, comprising the steps of:

(1) receiving a create message from one of the plurality of host computers, wherein said create message specifies a message group to be created;

(2) receiving join messages from a first subset of the plurality of host computers, wherein each of said join messages specifies said message group;

(3) receiving host messages from a second subset of said first subset of the plurality of host computers belonging to said message group, wherein each of said messages contains a payload portion and a portion that is used to identify said message group;

(4) aggregating said payload portions of said host messages received from said second subset of the plurality of host computers to create an aggregated message;

(5) transmitting said aggregated message to said first subset of the plurality of host computers belonging to said message group;

wherein said aggregated message keeps the shared, interactive application operating consistently on each of said first subset of the plurality of host computers.

4. The method of claim 3, wherein the network is at least a portion of the Internet.

5. A method for facilitating communications among a plurality of host computers over a network to implement a shared, interactive application, comprising the steps of:

(1) receiving a host message from one of the plurality of host computers belonging to a message group, wherein said host message contains a payload portion and a portion that is used to identify said message group;

(2) forming a server message using said payload portion of said host message;

(3) transmitting said server message to each of the plurality of host computers belonging to said message group; and

(4) suppressing said server message such that said one of the plurality of host computers which originated said host message does not receive said server message;

wherein said server message keeps the shared, interactive application operating consistently on each of the plurality of host computers belonging to said message group.

6. The method of claim 5, wherein the network is at least a portion of the Internet.

7. A method for facilitating communications among a plurality of host computers over a network to implement a shared, interactive application, comprising the steps of:

(1) receiving messages from a subset of the plurality of host computers belonging to a message group, wherein each of said messages contains a payload portion and a portion that is used to identify said message group;

(2) aggregating said payload portions of said messages to create an aggregated payload; and

(3) transmitting said aggregated message to each of the plurality of host computers belonging to said message group;

wherein said aggregated message keeps the shared, interactive application operating consistently on each of the plurality of host computers belonging to said message group.

8. The method of claim **7**, wherein the network is at least a portion of the Internet.

9. The method of claim **7**, wherein step (3) is performed after pausing for a pre-determined time interval.

10. The method of claim **9**, wherein said pre-determined time interval is equivalent to the amount of time for the group messaging server to receive at least one message from each of the plurality host computers belonging to said first message group.

11. The method of claim **9**, wherein said pre-determined time interval is a function of the rate that said messages are received from said subset of the plurality of host computers belonging to said first message group.

12. A method for providing group messages to a plurality of host computers connected to a group messaging server over a unicast wide area communication network, comprising the steps of:

(1) communicating with the plurality of host computers using the unicast network and maintaining a list of message groups, each message group containing at least one host computer;

(2) receiving messages from a subset of the plurality of host computers, each host computer in said subset belonging to a first message group, wherein each of said messages contains a payload portion and a portion that is used to identify said first message group;

(3) aggregating said payload portions of said messages received from said subset of the plurality of host computers to create an aggregated payload;

(4) forming an aggregated message using said aggregated payload; and

(5) transmitting said aggregated message to a recipient host computer belonging to said first message group.

13. The method of claim **12**, wherein the unicast wide area communication network is at least a portion of the Internet.

14. The method of claim **12**, wherein the unicast wide area communication network is at least a portion of the Internet, and said group messaging server communicates with said plurality of host computers using a session layer protocol.

15. The method of claim **12**, wherein step (3) is performed after pausing for a pre-determined time interval.

16. The method of claim **15**, wherein said pre-determined time interval is equivalent to the amount of time for the group messaging server to receive at least one message from each of the plurality host computers belonging to said first message group.

17. The method of claim **15**, wherein said pre-determined time interval is a function of the rate that said messages are received from said subset of the plurality of host computers belonging to said first message group.

18. A method for facilitating communications among a plurality of host computers over a network to implement a shared, interactive application, comprising the steps of:

(1) receiving a host message from one of the plurality of host computers belonging to a message group, wherein said host message contains a payload portion and a portion that is used to identify said message group;

(2) forming a server message by using said payload portion of said host message; and aggregating said payload portion with the payload portion of a second host message received from another of the plurality of host computers belonging to said message group

(3) transmitting said server message to each of the plurality of host computers belonging to said message group;

whereby said server message keeps the shared, interactive application operating consistently on each of the plurality of host computers belonging to said message group.

19. The method of claim **18**, wherein the network is at least a portion of the Internet.

* * * * *

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(12) EX PARTE REEXAMINATION CERTIFICATE (9065th)

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Rothschild et al. (45) **Certificate Issued: Jun. 12, 2012**

(54) **SERVER-GROUP MESSAGING SYSTEM FOR INTERACTIVE APPLICATIONS**

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G06F 15/16 (2006.01)

(52) **U.S. Cl.** **709/245**; 709/218
(58) **Field of Classification Search** .... None
See application file for complete search history.

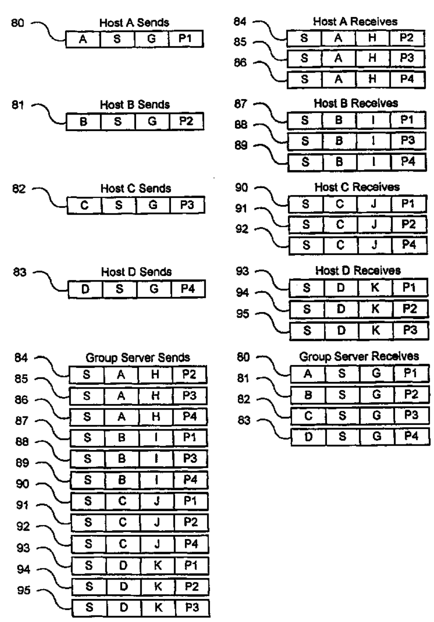
(56) **References Cited**

To view the complete listing of prior art documents cited during the proceeding for Reexamination Control Number 90/011,036, please refer to the USPTO's public Patent Application Information Retrieval (PAIR) system under the Display References tab.

Primary Examiner—Andrew L Nalven

(57) **ABSTRACT**

A method for deploying interactive applications over a network containing host computers and group messaging servers is disclosed. The method operates in a conventional unicast network architecture comprised of conventional network links and unicast gateways and routers. The hosts send messages containing destination group addresses by unicast to the group messaging servers. The group addresses select message groups maintained by the group messaging servers. For each message group, the group messaging servers also maintain a list of all of the hosts that are members of the particular group. In its most simple implementation, the method consists of the group server receiving a message from a host containing a destination group address. Using the group address, the group messaging server then selects a message group which lists all of the host members of the group which are the targets of messages to the group. The group messaging server then forwards the message to each of the target hosts. In an interactive application, many messages will be arriving at the group server close to one another in time. Rather than simply forward each message to its targeted hosts, the group messaging server aggregates the contents of each of messages received during a specified time period and then sends an aggregated message to the targeted hosts. The time period can be defined in a number of ways. This method reduces the message traffic between hosts in a networked interactive application and contributes to reducing the latency in the communications between the hosts.



EX PARTE REEXAMINATION CERTIFICATE ISSUED UNDER 35 U.S.C. 307

THE PATENT IS HEREBY AMENDED AS INDICATED BELOW.

Matter enclosed in heavy brackets [ ] appeared in the patent, but has been deleted and is no longer a part of the patent; matter printed in italics indicates additions made to the patent.

AS A RESULT OF REEXAMINATION, IT HAS BEEN DETERMINED THAT:

The patentability of claims **1-4** and **7-19** is confirmed.

Claims **5** and **6** are cancelled.

New claims **20-70** are added and determined to be patentable.

20. The method of claim 1, wherein a server implements a group messaging protocol layered on top of a transport protocol of said network, wherein said group messaging protocol uses an address space that is separate from an address space of said transport protocol.

21. The method of claim 20, wherein said group messaging protocol is performed at a session layer.

22. The method of claim 1, further comprising the step of performing, by said server, echo suppression.

23. The method of claim 1, wherein said plurality of host computers belonging to said message group correspond to players that are in close proximity to one another within a three-dimensional space of a computer game.

24. The method of claim 1, further comprising the step of changing membership of said message group based on activities of players within a computer game.

25. The method of claim 1, further comprising the step of changing membership of said message group based on changes in player position within a three-dimensional space of a computer game.

26. The method of claim 1, wherein membership of said message group changes dynamically over time.

27. The method of claim 1, wherein said application is a game.

28. The method of claim 1, wherein said transmitting is performed by an upper-level protocol implemented above a transport layer protocol of said network, wherein said transport layer protocol is TCP/IP.

29. The method of claim 1, wherein said transmitting are performed by an upper-level protocol implemented above a transport layer protocol of said network, wherein said plurality of host computers are unable to send upper-level protocol messages to one another except through said group messaging server.

30. The method of claim 1, further comprising the steps of:

a server receiving a control message to close said message group; and

removing said message group in response to receiving said request.

31. The method of claim 1, further comprising the steps of:

a server receiving, from a first host computer of said plurality of host computers, a control message to query message groups of said server; and

providing said list of message groups to said first host computer in response to said receiving said control message.

32. The method of claim 1, further comprising the steps of:

a server receiving, from a first host computer of said plurality of host computers, a control message to query members of said message group; and

providing a list of members of said message group to said first host computer in response to receiving said control message.

33. The method of claim 1, further comprising the steps of:

a server receiving, from a first host computer of said plurality of host computers, a control message to query attributes of said message group; and

providing attributes of said message group to said first host computer in response to receiving control message.

34. The method of claim 1, further comprising the steps of:

a server receiving, from a first host computer of said plurality of host computers, a control message to connect to said group messaging server; and

storing information regarding said first host computer in response to receiving said control message.

35. The method of claim 1, further comprising the steps of:

a server receiving, from a first host computer of said plurality of host computers, a control message to disconnect from said group messaging server; and

removing information regarding said first host computer in response to receiving said control message.

36. The method of claim 1, further comprising the step of forming said aggregated message by compressing said aggregated payload.

37. The method of claim 5, wherein said host message comprises application specific state information.

38. The method of claim 5, wherein said host message comprises information that other host computers in said message group use to maintain a consistent application state.

39. The method of claim 12, wherein a server implements a group messaging protocol layered on top of a transport protocol of said network, wherein said group messaging protocol uses an address space that is separate from an address space of said transport protocol.

40. The method of claim 39, wherein said first group messaging protocol is performed at a session layer.

41. The method of claim 12, further comprising the step of performing, by said server, echo suppression.

42. The method of claim 12, wherein said plurality of host computers belonging to said first message group correspond to players that are in close proximity to one another within a three-dimensional space of a computer game.

43. The method of claim 12, further comprising the step of changing membership of said first message group based on activities of players within a computer game.

44. The method of claim 12, further comprising the step of changing membership of said first message group based on changes in player position within a three-dimensional space of a computer game.

45. The method of claim 12, wherein membership of said first message group changes dynamically over time.

46. The method of claim 12, wherein said application is a game.

47. The method of claim 12, wherein said transmitting are performed by an upper-level protocol implemented above a transport layer protocol of said unicast network, wherein said transport layer protocol is TCP/IP.

48. The method of claim 12, wherein said transmitting are performed by an upper-level protocol implemented above a transport layer protocol of said unicast network, wherein said plurality of host computers are unable to send upper-level protocol messages to one another except through said group messaging server.

49. The method of claim 12, further comprising the steps of:

a server receiving a control message to close said first message group; and

removing said first message group in response to receiving said request.

50. The method of claim 12, further comprising the steps of:

a server receiving, from a first host computer of said plurality of host computers, a control message to query message groups of said server; and

providing said list of message groups to said first host computer in response to said receiving said control message.

51. The method of claim 12, further comprising the steps of:

a server receiving, from a first host computer of said plurality of host computers, a control message to query members of said first message group; and

providing a list of members of said first message group to said first host computer in response to receiving said control message.

52. The method of claim 12, further comprising the steps of:

a server receiving, from a first host computer of said plurality of host computers, a control message to query attributes of said first message group; and

providing attributes of said first message group to said first host computer in response to receiving control message.

53. The method of claim 12, further comprising the steps of:

a server receiving, from a first host computer of said plurality of host computers, a control message to connect to said first group messaging server; and

storing information regarding said first host computer in response to receiving said control message.

54. The method of claim 12, further comprising the steps of:

a server receiving, from a first host computer of said plurality of host computers, a control message to disconnect from said first group messaging server; and

removing information regarding said first host computer in response to receiving said control message.

55. The method of claim 12, further comprising the step of forming said aggregated message by compressing said aggregated payload.

56. The method of claim 18, wherein a server implements a group messaging protocol layered on top of a transport protocol of said network, wherein said group messaging protocol uses an address space that is separate from an address space of said transport protocol.

57. The method of claim 56, wherein said group messaging protocol is performed at a session layer.

58. The method of claim 18, further comprising the step of performing, by said server, echo suppression.

59. The method of claim 18, wherein said plurality of host computers belonging to said message group correspond to players that are in close proximity to one another within a three-dimensional space of a computer game.

60. The method of claim 18, further comprising the step of changing membership of said message group based on activities of players within a computer game.

61. The method of claim 18, further comprising the step of changing membership of said message group based on changes in player position within a three-dimensional space of a computer game.

62. The method of claim 18, wherein membership of said message group changes dynamically over time.

63. The method of claim 18, wherein said application is a game.

64. The method of claim 18, wherein said transmitting is performed by an upper-level protocol implemented above a transport layer protocol of said network, wherein said transport layer protocol is TCP/IP.

65. The method of claim 18, wherein said transmitting are performed by an upper-level protocol implemented above a transport layer protocol of said network, wherein said plurality of host computers are unable to send upper-level protocol messages to one another except through said group messaging server.

66. The method of claim 18, further comprising the steps of:

a server receiving a control message to close said message group; and

removing said message group in response to receiving said request.

67. The method of claim 18, further comprising the steps of:

a server receiving, from a first host computer of said plurality of host computers, a control message to query message groups of said server; and

providing said list of message groups to said first host computer in response to said receiving said control message.

68. The method of claim 18, further comprising the steps of:

a server receiving, from a first host computer of said plurality of host computers, a control message to query members of said message group; and

providing a list of members of said message group to said first host computer in response to receiving said control message.

69. The method of claim 18, further comprising the steps of:

a server receiving, from a first host computer of said plurality of host computers, a control message to query attributes of said message group; and

providing attributes of said message group to said first host computer in response to receiving control message.

70. The method of claim 18, further comprising the steps of:

a server receiving, from a first host computer of said plurality of host computers, a control message to connect ot said group messaging server; and

storing information regarding said first host computer in response to receiving said control message.

* * * * *

Paltalk Holdings, Inc. v. Riot Games, Inc. (D. Del. 2016)

U.S. Pat. No. 5,822,523
SERVER-GROUP MESSAGING SYSTEM FOR INTERACTIVE APPLICATIONS

Exhibit C
League of Legends – Sample Claim Chart

PREBEG | FAUCETT | ABBOTT

INTELLECTUAL PROPERTY &
COMMERCIAL LITIGATION

U.S. Pat. No. 5,822,523 **Claim**	**Riot Games** **League of Legends ("LoL")**
1. A method for providing group messages to a plurality of host computers connected over a unicast wide area communication network, comprising the steps of: **A previously agreed construction for "group messages" is:** Messages that are sent to a collection of one or more host computers belonging to a common message group.	Riot Games is the developer and publisher of League of Legends ("LoL"), a multiplayer online battle arena video game. LoL has a player client program installed on a user's computer (**a "host computer"**) that communicates directly with Riot Game's LoL severs over the Internet (**the Internet is a "wide area communication network"**). Several million people simultaneously play LoL during peak hours. Riot Games provides servers to host various things in League of Legends, such as: logins, games, chat, the RP Store, the shop, etc. **Regions** To help solve the problems of high-latency because of distance, Riot Games hosts multiple servers around the world.

Server Countries	Server Name	Abbreviation	Release Date	Language(s)	Location
	Brazil	BR	September 13th 2012[1]	Portugese	São Paulo, Brazil
	Europe Nordic & East	EUNE	July 13th 2010	English, Greek, Romanian, Polish,	Amsterdam, Netherlands

U.S. Pat. No. 5,822,523 Claim	Riot Games League of Legends (“LoL”)

			Hungarian, Czech	
Europe West	EUW	July 13th 2010	English, German, Spanish, French, Italian	Amsterdam, Netherlands
Latin America North	LAN	June 5th 2013[2]	Spanish	Miami, FL, United States[citation needed]
Latin America South	LAS	June 5th 2013[3]	Spanish	Santiago, Chile[citation needed]

<table>
<tr><th>U.S. Pat. No. 5,822,523
Claim</th><th>Riot Games
League of Legends (“LoL”)</th></tr>
<tr><td></td><td>
<table>
<tr><td>North America</td><td>NA</td><td>October 27th 2009[4]</td><td>English</td><td>Chicago, Illinois, United States</td></tr>
<tr><td>Public Beta Environment</td><td>PBE</td><td></td><td>English</td><td>Los Angeles, CA, United States</td></tr>
</table>

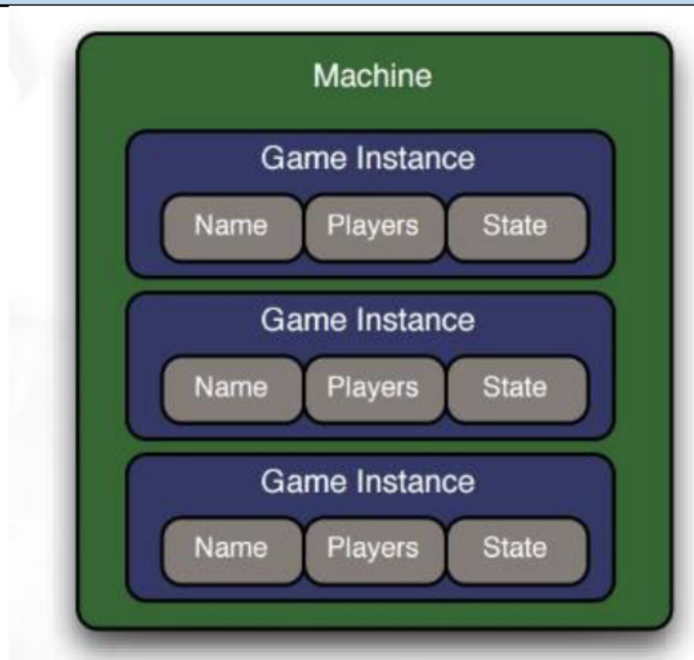
On information and belief, based on publicly available reverse engineering and developer/programmer presentations and published material, League of Legends utilizes the “ENet” protocol “Reliable UDP networking library” to communicate between the server and client over the Internet (and is thus “unicast”).

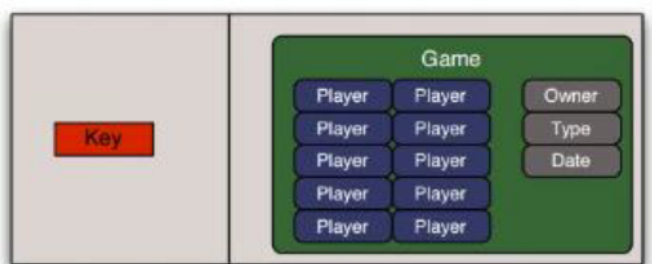
The combined Riot Games game server and League of Legends client software provide “a method for providing group messages to a plurality of host computers connected over a unicast wide area communication network”.</td></tr>
<tr><td>1.a providing a <u>group messaging server</u> coupled to said network, said server communicating with said plurality of host computers using said unicast network and maintaining a list of <u>message groups</u>, each message group</td><td>The Riot Game servers/clusters (collectively a “group messaging server”) maintain an expansive series of game sessions. Public information indicates up to 150,000 new game sessions an hour in some regions. Each game session may include 3 to 10 players. As “Riot runs multiple games per server”, the matchmaking servers and game servers reference game sessions (“message groups”) by a “key”/”identifier”. The matchmaking servers and game servers must store a list of game sessions in order to maintain state.

As existing games may be “observed” by the general public with a few minute delay, they can be referenced by “gameId”, indicating a hash exists of this Id to the actual game session. Riot Games presentations to various conferences provide slides which confirm this.</td></tr>
</table>

U.S. Pat. No. 5,822,523 Claim	Riot Games League of Legends ("LoL")
containing at least one host computer; **A previously agreed construction for "group messaging server" is:** A server or computer system with a network interface that maintains a set of message groups used by the host computers to communicate information between themselves. The group messaging server must be capable of receiving messages from the host computers addressed to a message group and sending messages to the host computers that have joined the message group. A group messaging server can process messages with or without aggregated payloads, and can allow for group membership to change very rapidly.	• Riot runs multiple games per server • A root object represents the server • As games are allocated child objects are added to this object

<table>
<tr><th>U.S. Pat. No. 5,822,523
Claim</th><th>Riot Games
League of Legends (“LoL”)</th></tr>
<tr><td>A previously agreed construction for “message group” is:

A collection of one or more host computers that (1) have joined a particular group and (2) receive group messages addressed to that particular group.</td><td>



The combined messaging system is provided by Riot Games for access by the League of Legends client.</td></tr>
</table>

U.S. Pat. No. 5,822,523 Claim	**Riot Games League of Legends ("LoL")**
	This Riot Games game server and matchmaking system are "a group messaging server coupled to said network, said server communicating with said plurality of host computers using said unicast network and maintaining a list of message groups, each message group containing at least one host computer".
1.b sending, by a plurality of host computers belonging to a first message group, messages to said server via said unicast network, said messages containing a **payload portion** and a **portion for identifying said first message group**; **A previously agreed construction for "payload portion" is:** The part of a message that contains data item(s) conveying information. **A previously agreed construction for "portion for identifying said first message group" is:** Any part of a message, sent by a host computer to a group messaging server, that identifies	Based on the traffic analysis included, and the gameplay interaction witnessed, League of Legends clients continually track the position of remote players/champions. This information is never transmitted to other players directly, but is funneled through the Riot Games game server. Each game "tick", the client sends the server a message including position updates and other actions such as skill or item usage (which are parts of a message that contains data item(s) conveying information). These messages are received by a Riot Games controlled server. On information and belief, each message contains a player/champion identifier, and data indicating the position to move to, and data such as skill or item usage. On information and belief, the messages also include an index to the game session and the team the player/champion is on. Both of these identify the message group. Thus the League of Legends clients consistently perform the process of "sending, by a plurality of host computers belonging to a first message group, messages to said server via said unicast network, said messages containing a payload portion and a portion for identifying said first message group".

U.S. Pat. No. 5,822,523 **Claim**	**Riot Games** **League of Legends ("LoL")**
the message group of a receiving host computer.	
1.c aggregating, by said server in a time interval determined in accordance with a predefined criterion, said payload portions of said messages to create an aggregated payload; **A previously entered construction for this clause is:** The group messaging server forms an aggregated payload by aggregating at least one data item from the payloads of all the claimed messages it receives from the claimed plurality of host computers within a certain time period. The data items may be aggregated in any order and the time period is certain in that it must arise from criteria specified prior to the beginning of the time interval. **A previously entered construction for "aggregating" is:**	The Riot Games servers clearly update the other players on the local player's movement and vice versa. As shown in the trace graph above, the amount of information traveling from the server to the local player greatly exceeds the amount of information from client to server, while the number of packets is virtually identical. Furthermore, during normal gameplay operation, the ratio of server to client versus client to server bytes per second (ignoring the packet headers) is linearly dependent upon the number of visible players. Given the absence of an increased packet count from the server and the appearance of a scaled increase of information, as well as the obvious perceived impact of the gameplay interaction thus created, the server must aggregate the incoming data from each player into an aggregated payload. Once past the initial transfer of map and information all tested game sessions, regardless of the number of players involved, resulted in a consistent, fixed packet rate. Based on traffic analysis, the client and server both operate with a fixed game "tick". Thus the Riot Games game server performs the process of "aggregating, by said server in a time interval determined in accordance with a predefined criterion, said payload portions of said messages to create an aggregated payload".

U.S. Pat. No. 5,822,523 Claim	**Riot Games League of Legends ("LoL")**
to collect two or more data items together as a unit, however, where each data item retains its identity and may be extracted from the unit	
1.d forming an aggregated message using said aggregated payload; and **A previously entered construction for this clause is:** creating one or more aggregated messages that contain data items from an aggregated payload **A previously entered construction for "aggregated message" is:** one or more messages containing destination data and data items from an aggregated payload	Each packet sent from the Riot Server to the local client is an "aggregated message". This packet includes a normal UDP header and the claimed aggregated payload. Each item in this payload retains its identity to allow the client to modify the appropriate object (e.g., player champion). Thus the Riot Games game server "forms an aggregated message using said aggregated payload".
1.e transmitting, by said server via said unicast network, said aggregated message to a	As described above, based on the packet trace information and developer dialogue, the Riot Server sends an aggregated payload to each player.

U.S. Pat. No. 5,822,523 Claim	**Riot Games League of Legends ("LoL")**
recipient host computer belonging to said first message group.	Thus the Riot Games game server "transmits, by said server via said unicast network, said aggregated message to a recipient host computer belonging to said first message group".
2. The method of claim 1 wherein said time interval is a fixed period of time.	The client and server both operate with a fixed game "tick." This is the "time interval".
6. The method of claim 1 wherein said network is Internet and said server communicates with said plurality of host computers using a session layer protocol. **A previously agreed construction for "session layer protocol" is:** A protocol for a layer in the OSI reference model on top of the transport layer protocol.	The League of Legends client and Riot Games server communicate through a managed UDP socket, which by nature includes a session layer protocol incorporating the UDP transfer level communication. Once an initial handshaking process is completed, the server and client operate in consistent communication, without the need for new exchange of credentials. In a game environment where cheating is a paramount problem, this could not be accomplished without a reliable session and transfer of information between the server and client, as it would be unable to determine if an incoming message was authentic. Thus, the communication must include a session layer. Normal definitions of this layer include: "Layer 5 deals with establishing and maintaining a context for a sequence of messages delivered by layer 4", and "This layer establishes, manages and terminates connections between applications. The session layer sets up, coordinates, and terminates conversations, exchanges, and dialogues between the applications at each end. It deals with session and connection coordination." UDP exists on layer 4, the "transport" layer. As League of Legends manages the connections and authentication of this UDP transmission, it by definition operates at the session layer. Thus the Riot Games server "communicates with said plurality of host computers using a session layer protocol".

EXHIBIT D

Terms of Use

TERMS OF USE AGREEMENT (TOU) LEAGUE OF LEGENDS®

Last Modified: October 23, 2012

League of Legends® (the "**Game**") is a free-to-play, session-based, multiplayer online battle-arena computer game developed and operated by Riot Games, Inc., a Delaware Corporation ("**Riot Games**"). For purposes of this Agreement (defined below), "**you**" and "**your**" mean the user of the computer on which the Game will be or has been installed.

PLEASE READ THIS TERMS OF USE AGREEMENT (THIS "**TERMS OF USE**" OR "**AGREEMENT**") CAREFULLY. BY CLICKING THE "ACCEPT" BUTTON BELOW, OR BY PARTICIPATING IN THE GAME, OR BY USING THE HTTP://NA.LEAGUEOFLEGENDS.COM WEBSITE AND RELATED WEBPAGES (THE "**SITE**"), YOU AGREE THAT THIS AGREEMENT IS ENFORCEABLE LIKE ANY WRITTEN CONTRACT SIGNED BY YOU. IF YOU DO NOT AGREE TO ALL OF THE TERMS OF THE AGREEMENT, CLICK ON THE BUTTON THAT INDICATES THAT YOU DO NOT AGREE TO ACCEPT THE TERMS OF THIS AGREEMENT (IF APPLICABLE) AND DO NOT PARTICIPATE IN THE GAME OR USE THE SITE.

Please note that in using the Site and/or the Game, you may be required to provide Riot Games with certain personally identifiable information, retention and use of which are subject to the Riot Games Privacy Policy (the "**Privacy Policy**") (http://na.leagueoflegends.com/legal/privacy), incorporated herein by reference. Your use of the Site and/or the Game signifies that you have read, understand and agree with the terms of the Privacy Policy.

I. LIMITED USE LICENSE

The Site and the Game are available for use only by authorized end users in accordance with the terms and conditions set forth in this Agreement. Your rights to use the Game software (the "**Software**") are defined in and subject to the terms and conditions of the Game End User License Agreement (the "**EULA**") (http://na.leagueoflegends.com/legal/eula), which is incorporated herein by reference, in addition to this Agreement. The Site, the Game, the Software and "fan kits," if any are made available (collectively, the "**Properties**") are provided for your individual, non-commercial, entertainment purposes only. Except as may be expressly permitted by Riot Games, you may not sell, copy, exchange, transfer, publish, assign or otherwise distribute anything you copy or derive from the Properties.

II. REQUIREMENTS

In using the Site, and/or by clicking "accept" when you install the Software, you acknowledge that you have read, understand and agree with the terms of this Agreement. In order to participate in the Game, you must also: (i) read, understand and agree to the EULA; (ii) install a valid copy of the Software; (iii) register for an account in the Game (an "**Account**"); and (iv) meet the hardware and connection requirements published on the Site. These requirements may change as the Game evolves. You are wholly responsible for the cost of all internet connection fees, along with all equipment, servicing, or repair costs necessary to allow you access to the Game.

III. ACCOUNT INFORMATION

A. General. While some elements of the Site may be generally accessed by the public, certain aspects of the Site (e.g. posting in the Forums, as defined below) as well as participation in the Game requires you to create an Account by providing Riot Games with certain personal information, specifically, your email address and date of birth. You agree that you will supply accurate and complete information to Riot Games, and that you will update that information promptly after it changes. All of the information you provide to Riot Games will be governed by the terms and conditions of this Agreement and the Privacy Policy. The information will be used by Riot Games for a variety of internal purposes, including without limitation, to maintain the Account, to ensure that your Account is unique, to deal with security, debugging and technical support issues, and for possible payment-related issues. You acknowledge that, if any information provided by you is untrue, inaccurate, not current or incomplete, Riot Games reserves the right to terminate this Agreement, your Account, and/or your use of the Game. Please note that in utilizing certain areas of the Site (e.g. purchasing merchandise) or the Game (e.g. purchasing Riot Points (defined below)), you will be requested to provide additional information in order to complete a purchase, such as your name, full address, credit card information or other payment information as appropriate to the selected payment method.

B. Eligibility. Only "natural persons," as opposed to any kinds of legal entities (e.g., corporations, limited liability companies, and/or partnerships), shall have the privilege of establishing an Account. By entering into this Agreement and creating an Account, you represent that you are an adult and have the legal capacity to enter into a contract in the jurisdiction where you reside. You agree to comply with this Agreement on behalf of yourself and, at your discretion, any minor children for whom you are the parent or legal guardian and whom you have authorized to play the Game using your Account. You further agree that you are entirely liable for all activities conducted through your Account, and are responsible for ensuring that you and/or your child is aware of, understands, and complies with the terms of this Agreement and any and all other Riot Games rules, policies, notices and/or agreements.

THE SITE AND THE GAME ARE NOT DIRECTED AT CHILDREN UNDER 13 YEARS OF AGE, NOR DOES RIOT GAMES KNOWINGLY COLLECT INFORMATION FROM CHILDREN UNDER 13. IF YOU ARE UNDER 13, PLEASE DO NOT SUBMIT ANY PERSONALLY IDENTIFIABLE INFORMATION TO RIOT GAMES.

C. Login Credentials. In creating an Account, you will be required to select a unique username and password (collectively, "**Login Credentials**"), which you will use each time you access the Game. You may not share your Account with anyone other than as expressly set forth herein, and you are entirely responsible for maintaining the confidentiality of your Login Credentials and for any and all activities (including purchases and charges, as applicable) that are conducted through your Account. Please notify Riot Games immediately if you become aware of any breach of security, including any loss, theft or unauthorized disclosure of your Login Credentials.

D. Account Sales. The Account supplied to you is personal to you, and Riot Games does not recognize and expressly forbids the transfer of user Accounts. You shall not purchase, sell, gift or trade any Account, or make any such offer, and any attempt shall be null and void. Any distribution by you of your Account and/or your Login Credentials (except as expressly provided herein or otherwise explicitly approved of by Riot Games) may result in suspension or termination of your Account.

E. Suspension/Termination.

1. By Riot Games. RIOT GAMES RESERVES THE RIGHT TO SUSPEND, TERMINATE, MODIFY OR DELETE YOUR ACCOUNT AT ANY TIME

FOR ANY REASON OR NO REASON, WITH OR WITHOUT NOTICE TO YOU, AND WITH NO LIABILITY OF ANY KIND TO YOU. Additionally, Riot Games may stop offering and/or supporting the Game at any time. For purposes of explanation and not limitation, most Account suspensions, terminations and/or deletions are the result of violation of this Agreement, the EULA, the Privacy Policy, or the Summoner's Code (defined below). Accounts terminated by Riot Games shall not be reinstated under any conditions whatsoever.

2. By You. You may terminate your Account at any time, for any reason or no reason, by contacting Riot Games at support@riotgames.com.
3. By the Community via Crowd Sourcing. Riot Games has empowered its community of users (the "**Community**") to police the compliance of other users with the "**Summoner's Code**" (http://na.leagueoflegends.com/articles/The_Summoners_Code), which outlines the principles of ideal game play behavior, as well as with other Riot Games policies. Consistent with the guidelines found at http://na.leagueoflegends.com/legal/tribunal, Community members, including you as a user, are allowed to submit descriptions of activity and actions of certain users within the Game, and collectively determine if that particular user was in compliance with the Riot Games policies relating to user conduct, including, but not limited to, the Summoner's Code and the Code of Conduct (defined below). This system of allowing the Community to review user behavior in the Game is called **The Tribunal®**. Should The Tribunal determine that you have acted in contravention of any one of the Riot Games policies, Riot Games may, in its sole and absolute discretion, ban your use of the Game and suspend, terminate and/or delete your Account.

IV. OWNERSHIP

A. Intellectual Property. All rights and title in and to the Properties, and all content included therein (including, without limitation, user Accounts, computer code, titles, objects, artifacts, characters, character names, locations, location names, stories, story lines, dialog, catch phrases, artwork, graphics, structural or landscape designs, animations, sounds, musical compositions and recordings, Riot Points (defined below), audio-visual effects, character likenesses, and methods of operation) are owned by Riot Games or its licensors. The Properties, and all content therein are protected by United States and other international intellectual property laws. Riot Games and its licensors reserve all rights in connection with the Properties, including, without limitation, the exclusive right to create derivative works therefrom. You agree that you will not create any work of authorship based on the Properties except as expressly permitted by Riot Games. Additionally, except as otherwise set forth in this Section IV.A, Riot Games does not authorize you to make any use whatsoever of any Riot Games trademarks, service marks, trade names, logos, domain names, taglines, and/or trade dress (collectively, the "**Riot Games Marks**") under any circumstances without a written license agreement. Any reproduction, redistribution, or modification of the Properties, or use of the Properties not in accordance with the EULA or this Agreement, is expressly prohibited by law and may result in severe civil and criminal penalties.

Notwithstanding the above, Riot Games may make a "fan kit" available to you (which may be located on the Site) that includes a limited license to use certain Riot Games Marks and other proprietary material. Except for the license expressly granted with the "fan kit," Riot Games reserves all rights, title, and interest in Riot Games Marks and all other intellectual property, and does not authorize you to display or use such in any manner, including but not limited to use on websites, on blogs, in forums, in signatures, on products, or in printed or electronic publications.

B. Game Assets, Riot Points and Virtual Items. When using the Game, you may accumulate in-Game assets associated with your Account, including, without limitation, objects, artifacts, currency, items, equipment, and/or other value or status indicators ("**Game Assets**") that reside on servers operated by Riot Games as data. You acknowledge and agree that such Game Assets are accumulated as part of your Account and therefore you shall have no ownership or other property interest in any of those Game Assets. You further acknowledge and agree that Riot Games has the right, but not the obligation, to delete, alter, move, remove, or transfer any and all Game Assets, in whole or in part, at any time and for any reason, with or without notice to you, and with no liability of any kind to you. Riot Games does not provide or guarantee, and expressly disclaims any value, cash or otherwise, attributed to any data residing on servers operated by Riot Games, including without limitation the Game Assets associated with your Account.

If you have a valid, active Account, you may participate in our Riot Points service offering, which is a redeemable point system that operates like virtual currency ("**Riot Points**") used to license certain Game Assets that can be used while playing the Game, including, without limitation, special champions, champion "skins," and boosts ("**Virtual Items**"). Riot Points can be purchased online through the in-Game store or at retail in the form of a prepaid Riot Games Game Card. Please note that you must register your Riot Games Game Card in the in-Game store in order to access the Riot Points the card contains. Riot Points might also be provided to you by Riot Games as part of a promotion, or through other means, such as completing certain quests or achievements in the Game, or through Riot Games-sponsored contests or sweepstakes. You agree that you will be solely responsible for paying any applicable taxes related to the acquisition of, use of or access to Riot Points. Riot Points are sold or issued in bundles and the price may vary depending on the amount you purchase and where you are purchasing. As Riot Games feels necessary, in its sole and absolute discretion, Riot Games may limit the total amount of Riot Points that may be purchased at any one time, and/or limit the total Riot Points that may be held in your Account in the aggregate. Riot Games will notify you in the event that you near any such limit. Additionally, price and availability of Riot Points and/or Virtual Items are subject to change without notice.

You are solely responsible for verifying that the proper amount of Riot Points has been added to or deducted from your Account during any given transaction, so please notify Riot Games immediately should you believe that a mistake has been made with respect to your Riot Points balance. Riot Games will investigate your claim, and in doing so, may request some additional information and/or documentation to verify your claim. Riot Games will let you know the results of the investigation, however, you acknowledge and agree that Riot Games has sole and absolute discretion in determining whether or not your claim is valid, and if so, the appropriate remedy.

YOU FURTHER ACKNOWLEDGE AND AGREE THAT THE RIOT POINTS SYSTEM AND THE VIRTUAL ITEMS YOU ACQUIRE HAVE NO MONETARY VALUE AND CANNOT BE REDEEMED FOR CASH. NO REFUNDS WILL BE MADE FOR THE PURCHASE OF RIOT POINTS OR FOR VIRTUAL ITEMS OBTAINED USING RIOT POINTS. Some Virtual Items you obtain may have expiration dates while others do not, and each Virtual Item you obtain using Riot Points will be included in your Account until the earlier of that Virtual Item's expiration date, or your Account's expiration or termination date, or such date when Riot Games ceases to offer or support the Game.

The sale or transfer of Virtual Items or Riot Points between users may only be conducted via services approved of and provided by Riot Games, if any, and Riot Games may terminate any Account that acts in contravention of this prohibition.

NOTWITHSTANDING ANYTHING TO THE CONTRARY HEREIN, YOU ACKNOWLEDGE AND AGREE THAT YOU SHALL HAVE NO OWNERSHIP OR OTHER PROPERTY INTEREST IN YOUR ACCOUNT, AND YOU FURTHER ACKNOWLEDGE AND AGREE THAT ALL RIGHTS IN AND TO THE ACCOUNT ARE AND SHALL FOREVER BE OWNED BY AND INURE TO THE BENEFIT OF RIOT GAMES. YOU ACKNOWLEDGE AND AGREE THAT YOU HAVE NO CLAIM, RIGHT, TITLE, OWNERSHIP OR OTHER PROPRIETARY INTEREST IN THE GAME ASSETS, VIRTUAL ITEMS OR RIOT POINTS THAT YOU ACQUIRE, REGARDLESS OF THE CONSIDERATION OFFERED OR PAID IN EXCHANGE FOR RIOT POINTS OR VIRTUAL ITEMS. FURTHERMORE, RIOT GAMES SHALL NOT BE LIABLE IN ANY MANNER FOR THE DESTRUCTION, DELETION, MODIFICATION, IMPAIRMENT, "HACKING," OR ANY OTHER DAMAGE OR LOSS OF ANY KIND CAUSED TO THE GAME ASSETS, VIRTUAL ITEMS OR RIOT POINTS, INCLUDING BUT NOT LIMITED TO THE DELETION OF GAME ASSETS, VIRTUAL ITEMS OR RIOT POINTS UPON THE TERMINATION OR EXPIRATION OF YOUR ACCOUNT.

C. Unsolicited Idea Submissions. Riot Games values your feedback on its services and products, but please do not submit any creative ideas, suggestions or materials. Neither Riot Games nor any of its employees and/or contractors accept or consider unsolicited ideas, original creative artwork or other works, including, without limitation, ideas or suggestions for new or improved games or technologies, game or product enhancements, marketing plans or names for new games (collectively "**Unsolicited Ideas**"). Please do not send your Unsolicited Ideas to Riot Games or its employees and/or contractors. This policy is aimed at avoiding potential misunderstandings or disputes when Riot Games' products or services might seem similar to Unsolicited Ideas that are submitted. If you do submit your Unsolicited Ideas to Riot Games or to any of its employees and/or contractors despite this policy, then you hereby acknowledge and agree that, from the time of transmission or dispatch, you grant Riot Games and its designees a worldwide, perpetual, irrevocable, sublicenseable, transferable, assignable, non-exclusive and royalty-free right and license to use, reproduce, distribute, adapt, modify, translate, create derivative works of, publicly perform, publicly display, digitally perform, make, have made, sell, offer for sale and import your Unsolicited Ideas, including, without limitation, all copyrights, trademarks, trade secrets, patents, industrial rights and all other intellectual and proprietary rights related thereto, in any media now known or hereafter developed, for any purpose whatsoever, commercial or otherwise, including, without limitation, giving the Unsolicited Ideas to others, without any compensation to you. To the extent necessary, you agree that you undertake to execute and deliver any and all documents and perform any and all actions necessary or desirable to ensure that the rights to use the Unsolicited Ideas granted to Riot Games as specified above are valid, effective and enforceable. You also give up any claim that any use by Riot Games and/or its licensees of your Unsolicited Ideas violates any of your rights, including but not limited to moral rights, privacy rights, rights to publicity, proprietary or other rights, and/or rights to credit for the material or ideas set for therein.

V. CODE OF CONDUCT

While using any of the Properties, you agree to comply with all applicable laws, rules and regulations. You also agree to comply with certain additional rules that govern your use of the Properties (the "**Code of Conduct**"). The Code of Conduct is not meant to be exhaustive, and Riot Games reserves the right to modify this Code of Conduct at any time, as well as take appropriate disciplinary measures including Account termination and deletion to protect the integrity and spirit of the Properties, regardless of whether a specific behavior is listed here as prohibited. In addition to this Code of Conduct, please see the Summoner's Code for additional guidance on exemplary game-play behavior. The following are examples of behavior that warrant disciplinary measures:

A. Impersonating any person, business, or entity, including an employee of Riot Games, or communicating in any way that makes it appear that the communication originates from Riot Games;

B. Posting identifying information about yourself, or any other user, to the Site or within the Game;

C. Harassing, stalking, or threatening any other users in the Game;

D. Removing, altering or concealing any copyright, trademark, patent or other proprietary rights notices of Riot Games contained in the Site, the Game and/or the Software. You also may not transmit content that violates or infringes the rights of others, including without limitation, patent, trademark, trade secret, copyright, publicity, personal rights or other proprietary or non-proprietary rights;

E. Transmitting or communicating any content which, in the sole and exclusive discretion of Riot Games, is deemed offensive, including, but not limited to, language that is unlawful, harmful, threatening, abusive, harassing, defamatory, vulgar, obscene, sexually explicit, or racially, ethnically, or otherwise objectionable;

F. Transmitting or facilitating the transmission of any content that contains a virus, corrupted data, trojan horse, bot keystroke logger, worm, time bomb, cancelbot or other computer programming routines that are intended to and/or actually damage, detrimentally interfere with, surreptitiously intercept or mine, scrape or expropriate any system, data or personal information;

G. Spamming chat, whether for personal or commercial purposes, by disrupting the flow of conversation with repeated postings of a similar nature;

H. Participating in any action which, in the sole and exclusive judgment of Riot Games, "exploits" an undocumented aspect of the Game in order to secure an unfair advantage over other users;

I. Participating in any action which, in the sole and exclusive judgment of Riot Games, defrauds any other user of the Game, including, but not limited to, by "scamming" or "social engineering;"

J. Using any unauthorized third party programs, including but not limited to "mods," "hacks," "cheats," "scripts," "bots," "trainers," and automation programs, that interact with the Software in any way, for any purpose, including, without limitation, any unauthorized third party programs that intercept, emulate, or redirect any communication between the Software and Riot Games and any unauthorized third party programs that collect information about the Game by reading areas of memory used by the Software to store information;

K. Accessing or attempting to access areas of the Game or Game servers that have not been made available to the public;

L. Selecting a Summoner name that is falsely indicative of an association with Riot Games, contains personally identifying information, infringes on the proprietary or non-proprietary rights of third parties, or that is offensive, defamatory, vulgar, obscene, sexually explicit, racially, ethnically, or otherwise objectionable. You may not use a misspelling or an alternative spelling to circumvent this restriction on Summoner name choices. Riot Games may modify any name which, in the sole and exclusive judgment of Riot Games, violates this provision without further notification to you, and may take further disciplinary measures, including Account termination, for repeated violations; or

M. Logging out or exiting the Game during live game-play. Riot Games' automated **Leaverbuster®** system tracks this data overtime and issues a temporary ban when a user is determined to have left mid-game too many times. The length of the temporary ban will increase over time if a particular Account continues to leave live game play.

VI. USER CONTENT

A. Ownership. "**Content**" means any communications, images, sounds, and all the material and information that you upload or transmit through the Site or the Game, or that other users upload or transmit, including, without limitation, any Forum (defined below) postings and/or the in-Game real-time interactive chat text ("**Chat**").

You hereby acknowledge and agree that you remain fully responsible for and are the owner of any and all Content. However, you grant Riot Games from the time of uploading or transmission of the Content, non-exclusively, all now known or hereafter existing copyrights and all other intellectual property rights to all Content of every kind and nature, in perpetuity (or for the maximum duration of protection afforded by applicable law), throughout the universe and you hereby grant Riot Games as a present non-exclusive license of future rights all such intellectual property rights to the extent owned by you. In the event that any of the Content is not licensable, you hereby grant to Riot Games and its licensors, including, without limitation, its respective successors and assigns, a perpetual, irrevocable, sublicensable, transferable, worldwide, paid-up right to reproduce, fix, adapt, modify, translate, reformat, transmit, or provide access to electronically, broadcast, communicate to the public by telecommunication, display, perform, enter into computer memory, and use and practice such Content as well as all modified and derivative works thereof, without compensation to you. To the extent necessary, you agree that you will undertake to execute and deliver any and all documents and perform any and all actions necessary or desirable to ensure that the rights to use the Content granted to Riot Games as specified above are valid, effective and enforceable. You also hereby waive any moral rights you may have in such Content under the laws of any jurisdiction to the maximum extent permitted by the laws of your jurisdiction. You represent, warrant and agree that none of the Content will be subject to any obligation, whether of confidentiality, attribution or otherwise, on the part of Riot Games and Riot Games will not be liable for any use or disclosure of any Content. You further acknowledge and agree that you shall not upload or otherwise transmit on or through the Site or the Game any Content that is subject to any third-party rights.

B. Consent to Monitoring. Riot Games does not, and cannot, pre-screen or monitor all Content. However, its representatives may monitor and/or record your communications (including, without limitation, Forum postings and/or Chat) when you are playing the Game or using the Site, and you hereby provide your irrevocable consent to such monitoring and recording. You acknowledge and agree that you have no expectation of privacy concerning the submission of any Content, and you further acknowledge and agree that your Chat may be used as part of The Tribunal proceedings as more specifically set forth in Section VI.C below. Riot Games does not assume any responsibility or liability for Content that is generated by users of the Site and/or Game. Riot Games has the right but not the obligation, in its sole discretion, to edit, refuse to post, or remove any Content. Furthermore, Riot Games also reserves the right, at all times and in its sole discretion, to disclose any Content for any reason, including, without limitation (i) to satisfy any applicable law, regulation, legal process or governmental request; (ii) to enforce the terms of this Agreement or any other agreement; (iii) to protect the legal rights and remedies of Riot Games; (iv) where someone's health or safety may be threatened; (v) to report a crime or other offensive behavior; or (vi) as part of The Tribunal proceedings. Please take care to not provide any personally identifiable information in the Chat or the Forums and to abide by the Code of Conduct, understanding that you do not have an expectation of privacy in the Content you provide in the Chat or Forums, and that members of Riot Games and the Community, outside of those you play directly with or against in the Game, might have access to the information in the Chat or the Forums at any time.

C. The Tribunal. All Chat will be recorded by Riot Games and stored for a period determined by Riot Games in its sole discretion, which period Riot Games may change from time to time in accordance with the terms of The Tribunal policy. Should your in-Game actions or conduct be reported by another user as being in contravention of the Summoner's Code, in violation of this Agreement or outside the scope of any one of Riot Games' policies, and should your case come before The Tribunal, the entire Chat log from that particular reported Game session will be included in The Tribunal report and available for viewing by randomly selected members of the Community who are eligible and opt to participate in The Tribunal.

D. Forums. If you have a valid and active Account, you may post communications and other content to the "forums" section of the Site (the "**Forums**"). You agree to abide by the Code of Conduct, as well as the policy concerning Links (found below) while participating in the Forums. You understand that much of the information included in the Forums is from other players who are not employed by or under the control of Riot Games. You further acknowledge that a large volume of information is available in the Forums and that people participating in such Forums may occasionally post messages or make statements, whether intentionally or unintentionally, that are inaccurate, misleading, deceptive, abusive or even unlawful. Riot Games neither endorses nor is responsible for such messages or statements, or for any opinion, advice, information or other utterance made or displayed in the Forums by you or the other users. The opinions expressed in the Forums reflect solely the opinions of you and/or the other users and may not reflect the opinions of Riot Games. Riot Games is not responsible for any errors or omissions in postings, for hyperlinks embedded in messages or for any results obtained from the use of the information contained in the Forums. Under no circumstances will Riot Games be liable for any loss or damage caused by your reliance on the information in the Forums or your use of the Forums. You should be aware that, when you disclose information about yourself in a Forum, the information is being made publicly available and may be collected and used by other users. When you disclose any information in a Forum, you do so at your own risk. Riot Games reserves the right to, but has no obligation to, monitor the Forums, or any postings or other materials that you or other players transmit or post on the Forums, to alter or remove any such materials, and to disclose such materials and the circumstances surrounding their transmission to any third party in order to operate the Site properly or to comply with legal obligations or governmental requests.

VII. UPDATES AND MODIFICATIONS

A. Agreement. Riot Games reserves the right, in its sole and absolute discretion, to revise, update, change, modify, add to, supplement, or delete certain terms of this Agreement as the Properties evolve; provided, however, that material changes to this Agreement will not be applied retroactively. Such changes will be effective with or without prior notice to you. You can review the most current version of this Agreement by clicking on the "Terms of Use" link located at the bottom of the Site. You are responsible for checking this Agreement periodically for changes. If any future changes to this Agreement are unacceptable to you or cause you to no longer be in agreement or compliance with this Agreement, you must terminate this Agreement and immediately stop using the Properties. Your continued use of any of the Properties following any revision to this Agreement constitutes your complete and irrevocable acceptance of any and all such changes. Please note that Riot Games may also revise other policies, including the EULA and Privacy Policy, at any time, and the new versions will be available on the Site. If at any time you do not agree with any portion of the then-current version of a particular Riot Games policy, including but not limited to this Agreement, you must immediately stop using the Properties.

B. The Properties. In an effort to improve the Properties, you agree that Riot Games may change, modify, update, suspend, "nerf," or restrict your access to any features or parts of the Properties, and may require that you download and install updates to the Software, at any time without notice or liability to you. You also understand and agree that any such changes or updates to the Properties might change the system specifications necessary to play the Game, and in such a case, you, and not Riot Games, are responsible for purchasing any necessary additional software and/or hardware in order to access and play the Game.

VIII. LINKS

The Site may contain links to websites operated by other parties. Riot Games provides these links to you as a convenience, or other users might be posting these links as user-provided Content. Use of these links and the external websites are at your own risk. The linked sites are not under the control of Riot Games, and Riot Games is not responsible for the content available on the other sites. Such links do not imply endorsement by Riot Games of information or material on any other site, and Riot Games disclaims all liability with regard to your access to and use of such linked websites.

Should you choose to provide a link on the Site or within the Game (e.g., on the Forums or via Chat) to an external website, unless otherwise set forth in a written agreement between you and Riot Games, you acknowledge and agree to the following: (i) the appearance, position and other aspects of the link may not be such as to damage or dilute the goodwill associated with Riot Games' and/or its licensors' names and trademarks; (ii) the appearance, position and other attributes of the link may not create the false appearance that your organization or entity is sponsored by, affiliated with, or associated with Riot Games; (iii) when selected by a user, the link must display the external website on full-screen and not within a "frame" on the linking Site; and (iv) Riot Games reserves the right to revoke its consent to the link at any time and in its sole discretion.

IX. FEES

Some aspects of the Game may require you to pay a fee, and you agree that you will provide accurate and complete payment information to the third-party payment provider used by Riot Games. You further agree to pay all fees and applicable taxes incurred by you or anyone using an Account registered to you. Riot Games may revise the pricing for the Game or any item associated therewith at any time. All fees and charges are payable in accordance with payment terms in effect at the time the fee or the charge becomes due and payable. Riot Games may, from time to time, modify, amend, or supplement its fees and fee-billing methods, and such changes shall be effective immediately upon posting in this Agreement or elsewhere on the Site or in the Game. If there is a dispute regarding payment of fees to Riot Games, your Account may be closed without warning or notice at the sole discretion of Riot Games.

YOU ACKNOWLEDGE AND AGREE THAT ANY APPLICABLE FEES AND OTHER CHARGES FOR FEE-BASED SERVICES (INCLUDING WITHOUT LIMITATION RIOT POINTS) ARE PAYABLE IN ADVANCE AND NOT REFUNDABLE IN WHOLE OR IN PART. YOU ARE FULLY LIABLE FOR ALL CHARGES TO YOUR ACCOUNT, INCLUDING ANY UNAUTHORIZED CHARGES.

X. NOTICE AND PROCEDURE FOR CLAIMS OF COPYRIGHT INFRINGMENT (DMCA)

If you are a copyright owner or agent thereof and believe that content posted on the Site by a Riot Games user infringes upon your copyright, please submit notice pursuant to the Digital Millennium Copyright Act (17 U.S.C. § 512(c)) to the Riot Games Copyright Agent with the following information:

A. An electronic or physical signature of the person authorized to act on behalf of the owner of the copyright;

B. A description of the copyrighted work that you claim has been infringed;

C. The URL of the location on the Riot Games Site containing the material that you claim is infringing;

D. Your address, telephone number, and email address;

E. A statement by you that you have a good faith belief that the disputed use is not authorized by the copyright owner, its agent, or the law; and

F. A statement by you, made under penalty of perjury, that the above information in your notice is accurate and that you are the copyright owner or authorized to act on the copyright owner's behalf.

Riot Games' Copyright Agent can be reached by mail at: Riot Games, Inc., 10736 Jefferson Blvd., #622, Culver City, CA 90230 ATTN: Copyright Agent; or by email at: copyright@riotgames.com. This email address is intended solely for the receipt of said notices and not for general inquiries or requests of Riot Games. Attachments cannot be accepted at the email address for security reasons. Accordingly, any notification of infringement submitted electronically with an attachment will not be received or processed. Please note that these notifications are legal notices, and that Riot Games may provide copies of such notices to the participants in the dispute or to third parties, at its discretion or as required by law. The Privacy Policy does not protect information provided in these notices.

XI. WARRANTY DISCLAIMER

THE PROPERTIES ARE PROVIDED TO YOU ON AN “AS IS” AND “AS AVAILABLE” BASIS WITHOUT WARRANTIES OR REPRESENTATIONS OF ANY KIND, EXPRESS OR IMPLIED. TO THE FULLEST EXTENT PERMITTED BY APPLICABLE LAW, RIOT GAMES DISCLAIMS ALL WARRANTIES, EXPRESS OR IMPLIED, WHICH MIGHT APPLY TO THE PROPERTIES, INCLUDING WITHOUT LIMITATION, IMPLIED WARRANTIES OF TITLE, NON-INFRINGEMENT, MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, ANY WARRANTIES THAT MAY ARISE FROM COURSE OF DEALING, COURSE OF PERFORMANCE OR USAGE OF TRADE, AND ANY WARRANTIES AS TO THE ACCURACY, RELIABILITY OR QUALITY OF ANY CONTENT OR INFORMATION CONTAINED WITHIN THE PROPERTIES. RIOT GAMES DOES NOT WARRANT THAT THE PROPERTIES WILL BE UNINTERRUPTED OR ERROR-FREE, THAT DEFECTS WILL BE CORRECTED, OR THAT THE PROPERTIES ARE FREE OF VIRUSES OR OTHER HARMFUL COMPONENTS. YOU ASSUME ALL RESPONSIBILITY FOR SELECTING THE PROPERTIES TO ACHIEVE YOUR INTENDED RESULTS, AND FOR THE INSTALLATION OF, USE OF, AND RESULTS OBTAINED FROM THE PROPERTIES.

Because some states or jurisdictions do not allow the disclaimer of implied warranties, the forgoing disclaimer may, in whole or in part, not apply to you.

XII. INDEMNIFICATION

YOU HEREBY AGREE TO INDEMNIFY, DEFEND AND HOLD HARMLESS RIOT GAMES FROM AND AGAINST ANY AND ALL CLAIMS, LAWSUITS, DAMAGES, LOSSES, LIABILITIES AND COSTS (INCLUDING ATTORNEYS' FEES) THAT DIRECTLY OR INDIRECTLY ARISE OR RESULT FROM YOUR USE OR MISUSE OF THE PROPERTIES, OR ANY VIOLATION BY YOU OF ANY OF THE PROVISIONS OF THIS AGREEMENT, THE EULA OR THE PRIVACY POLICY. Riot Games reserves the right, at its own expense and in its sole and absolute discretion, to assume the exclusive defense and control of any matter otherwise subject to indemnification by you, in which event you will cooperate with Riot Games in asserting any available defenses.

XIII. LIMITATION OF LIABILITY

UNDER NO CIRCUMSTANCES, AND UNDER NO LEGAL THEORY, WHETHER IN CONTRACT, TORT (INCLUDING NEGLIGENCE), STRICT LIABILITY OR OTHERWISE, SHALL RIOT GAMES BE LIABLE TO YOU OR ANY OTHER PERSON FOR ANY INDIRECT, INCIDENTAL, CONSEQUENTIAL, SPECIAL, EXEMPLARY, OR PUNITIVE DAMAGES OF ANY KIND (INCLUDING, WITHOUT LIMITATION, DAMAGES FOR LOSS OF BUSINESS, LOSS OF DATA, LOSS OF GOOD WILL, OR LOST PROFITS), OR ANY DAMAGES FOR GROSS NEGLIGENCE OF ANY KIND (INCLUDING, WITHOUT LIMITATION, DAMAGES FOR WORK STOPPAGE, COMPUTER FAILURE OR MALFUNCTION, OR ANY OTHER

COMMERCIAL DAMAGES OR LOSSES) ARISING FROM YOUR USE OR MISUSE OF THE PROPERTIES, EVEN IF RIOT GAMES KNEW OR SHOULD HAVE KNOWN OF THE POSSIBILITY OF SUCH DAMAGES. IN NO EVENT SHALL RIOT GAMES BE LIABLE FOR ANY DAMAGES IN EXCESS OF ANY AMOUNT YOU HAVE PAID TO RIOT GAMES FOR GAME-RELATED TRANSACTIONS, IF ANY, DURING THE SIX (6) MONTHS IMMEDIATELY PRIOR TO THE TIME YOUR CAUSE OF ACTION AROSE.

Because some states or jurisdictions do not allow the exclusion or the limitation of liability for consequential or incidental damages, in such states or jurisdictions, the liability of Riot Games shall be limited to the fullest extent permitted by applicable law.

XIV. EQUITABLE REMEDIES

You hereby acknowledge and agree that Riot Games would suffer irreparable harm if this Agreement were not specifically enforced. Consequently, in addition to such monetary and other relief as may be recoverable at law, you agree that Riot Games shall be entitled to specific performance or other injunctive relief, without bond, other security, or proof of damages, as remedy for any breach or threatened breach of this Agreement. Additionally, in the event any legal or administrative action or proceeding is brought by either party in connection with this Agreement and consistent with Section XV below, the prevailing party in such action or proceeding shall be entitled to recover from the other party all the costs, attorneys' fees and other expenses incurred by such prevailing party as the result of the action or proceeding.

XV. NEGOTIATIONS, BINDING ARBITRATION AND GOVERNING LAW

A. Negotiations. Disputes can be expensive and time consuming for both parties. In an effort to accelerate resolution and reduce the cost of any dispute or claim related to this Agreement ("**Claim**"), you and Riot Games agree to first attempt to informally negotiate any Claim for at least thirty (30) days (except those Claims expressly excluded in Section XV.F below). Riot Games will send its notice to the address it has on file to the extent that you have provided additional contact information to Riot Games (e.g. by participating in a promotion or survey, or contacting a customer services representative). Otherwise, Riot Games will send its notice to the email address associated with your Account. You will send your notice to Riot Games, Inc., 10736 Jefferson Blvd., #622, Culver City, CA 90230, Attn: Legal Department. Please note that this informal resolution procedure does not suspend any statutory limitation periods applicable to the bringing of a Claim.

B. Binding Arbitration. If the parties fail to resolve a Claim through negotiations, within such thirty (30)-day period, either you or Riot Games may elect to have the Claim (except as otherwise provided in Section XV.F) finally and exclusively resolved by binding arbitration by sending a written notice requesting arbitration to the other party. Any election to arbitrate by one party shall be final and binding on the other. The arbitration will be conducted under the Commercial Arbitration Rules of the American Arbitration Association ("AAA Rules") and, where appropriate, the AAA's Supplementary Procedures for Consumer Related Disputes ("AAA Consumer Rules") that are in effect at the time the arbitration is initiated and under the terms set forth in this Agreement. Both the AAA Rules and the AAA Consumer Rules can be found at the AAA website, www.adr.org. In the event of a conflict between the terms set forth in this Section XV.B and either the AAA Rules or the AAA Consumer Rules, the terms in this Section XV.B will control and prevail.

Except as otherwise set forth in Section XV.F, you may seek any remedies available to you under federal, state or local laws in an arbitration action. As part of the arbitration, both you and Riot Games will have the opportunity for discovery of non-privileged information that is relevant to the Claim. The arbitrator will provide a written statement of the arbitrator's decision regarding the Claim, the award given and the arbitrator's findings and conclusions on which the arbitrator's decision is based. The determination of whether a Claim is subject to arbitration shall be governed by the Federal Arbitration Act and determined by a court rather than an arbitrator. Except as otherwise provided in this Agreement, (i) you and Riot Games may litigate in court to compel arbitration, stay proceedings pending arbitration, or confirm, modify, vacate or enter judgment on the award entered by the arbitrator; and (ii) the arbitrator's decision is final, binding on all parties and enforceable in any court that has jurisdiction, provided that any award may be challenged if the arbitrator fails to follow applicable law.

BY AGREEING TO THIS ARBITRATION PROVISION, YOU UNDERSTAND THAT YOU AND RIOT GAMES ARE WAIVING THE RIGHT TO SUE IN COURT AND HAVE A JURY TRIAL.

C. Arbitration Fees. If we are initiating arbitration for a Claim, we will pay all costs charged by the AAA Rules for initiating the arbitration. Your share of all other fees and costs of the arbitration, including your share of arbitrator compensation, will be charged pursuant to the AAA Rules, and where appropriate, limited by the AAA Consumer Rules. Where your share of the costs is deemed to be excessive by the arbitrator, Riot Games will pay all arbitration fees and expenses.

D. Location. The arbitration will take place in your hometown area if you so notify Riot Games in your notice of arbitration or within ten (10) days following receipt of Riot Games' arbitration notice. In the absence of a notice to conduct the arbitration in your hometown area, the arbitration will be conducted in Los Angeles, California, unless the parties agree to video, phone and/or internet connection appearances. Any Claim not subject to arbitration (other than claims proceeding in any small claims court), or where no election to arbitrate has been made, shall be decided exclusively by a court of competent jurisdiction in Los Angeles, California, United States of America, and you and Riot Games agree to submit to the personal jurisdiction of that court.

E. Limitations. You and Riot Games agree that any arbitration shall be limited to the Claim between Riot Games and you individually. YOU AND RIOT GAMES AGREE THAT (A) THERE IS NO RIGHT OR AUTHORITY FOR ANY DISPUTE TO BE ARBITRATED ON A CLASS-ACTION BASIS OR TO UTILIZE CLASS ACTION PROCEDURES; (B) THERE IS NO RIGHT OR AUTHORITY FOR ANY DISPUTE TO BE BROUGHT IN A PURPORTED REPRESENTATIVE CAPACITY OR AS A PRIVATE ATTORNEY GENERAL; AND (C) NO ARBITRATION SHALL BE JOINED WITH ANY OTHER.

F. Exceptions to Negotiations and Arbitration. You and Riot Games agree that the following Claims are not subject to the above provisions concerning negotiations and binding arbitration: (i) any Claims seeking to enforce or protect, or concerning the validity of, any of your or Riot Games' intellectual property rights; (ii) any Claim related to, or arising from, allegations of theft, piracy, invasion of privacy or unauthorized use; and (iii) any claim for equitable relief. In addition to the foregoing, either party may assert an individual action in small claims court for Claims that are within the scope of such courts' jurisdiction in lieu of arbitration.

G. Governing Law. Except as otherwise provided in this Agreement, this Agreement shall be governed by, and will be construed under, the laws of the United States of America and the law of the State of California, without regard to conflict of law principles. The application of the United Nations Convention on Contracts for the International Sale of Goods is expressly excluded. Other laws may apply if you choose to access the Game from outside of the United States. In such an event, those local laws shall affect this Agreement only to the extent necessary in that jurisdiction, and this Agreement shall be interpreted to give maximum effect to the terms and conditions in this Agreement. You are responsible for compliance with all local laws if and to the extent local laws are applicable. The New Zealand Consumer Guarantees Act of 1993 (the "**Act**") may apply to the Game if you access the Game from, and are a resident of, New Zealand. Notwithstanding anything to the contrary in this Agreement, if the Act applies then you may have other rights or remedies as set out in the Act which may apply in addition to or instead of those set out in this Agreement.

H. Severability. You and Riot Games agree that if any portion this Section XV is found illegal or unenforceable (except any portion of Section XV.F), that portion shall be severed and the remainder of the Section shall be given full force and effect. If Section XV.F is found to be illegal or unenforceable then neither you nor Riot Games will elect to arbitrate any Claim falling within that portion of Section XV.F found to be illegal or unenforceable and such Claim shall be exclusively decided by a court of competent jurisdiction within Los Angeles, State of California, United States of America, and you and Riot Games agree to submit to the personal jurisdiction of that court.

XVI. TERMINATION

This Agreement (and all subsequent modifications, if any) shall remain effective until terminated. Both you and Riot Games may terminate this Agreement at any time for any reason or for no reason. Termination by Riot Games will be effective upon notice to you, termination or deletion of your Account, or its decision to permanently discontinue offering and/or supporting the Game, which it may do at any time in its sole discretion. You may terminate this Agreement at any time simply by not using the Site or the Game. If, however, you wish to terminate your Account, you must affirmatively do so by notifying Riot Games at support@riotgames.com as stated above. Upon termination of this Agreement, your right to use the Properties shall immediately cease.

XVII. MISCELLANEOUS

A. Assignment. Riot Games may assign this Agreement, in whole or in part, to any person or entity at any time with or without your consent. You may not assign the Agreement without Riot Games' prior written consent, and any unauthorized assignment by you shall be null and void.

B. Customer Contact. If you have any questions concerning these terms and conditions, or if you would like to contact Riot Games for any other reason, please contact Riot Games support at support@riotgames.com, or visit the "support" tab on the Site.

C. Entire Agreement. This Agreement represents the complete agreement between you and Riot Games concerning the Site, the Game, and the subject matter of the Agreement, and supersedes any prior or contemporaneous agreements between you and Riot Games; provided however that this Agreement shall coexist with, and shall not supersede, the EULA or the Privacy Policy.

D. Force Majeure. Riot Games shall not be liable for any delay or failure to perform resulting from causes outside the reasonable control of Riot Games, including, without limitation, any failure to perform hereunder due to unforeseen circumstances or cause beyond Riot Games' control such as acts of god, war, terrorism, riots, embargoes, acts of civil or military authorities, fire, floods, accidents, strikes, or shortages of transportation facilities, fuel, energy, labor or materials.

E. Location. The Site and the Game are operated by Riot Games in the United States. Those who choose to access the Site and/or the Game from locations outside the United States do so on their own initiative and are responsible for compliance with applicable local laws. The Software is subject to United States export controls as set forth in the EULA.

F. No Partnership. You agree that no joint venture, partnership, employment, or agency relationship exists between you and Riot Games as a result of this Agreement or your use of the Site or the Game.

G. No Waiver. Riot Games' failure to enforce any provision of this Agreement shall in no way be construed to be a present or future waiver of such provision, nor in any way affect the right of any party to enforce each and every such provision thereafter. The express waiver by Riot Games of any provision, condition or requirement of this Agreement shall not constitute a waiver of any future obligation to comply with such provision, condition or requirement.

H. Notices. Except as otherwise expressly provided herein, all notices given by you or required under this Agreement shall be in writing and addressed to: Riot Games, Inc., 10736 Jefferson Blvd., #622, Culver City, CA 90230.

I. Reform and Severability. If any provision of this Agreement is held to be invalid or unenforceable for any reason, such provision shall be reformed to the extent necessary to make it enforceable to the maximum extent permissible so as to affect the intent of the parties, and the remainder of this Agreement shall continue in full force and effect. If, however, it is determined that such provision cannot be reformed, then that provision shall be deemed severable from these terms and shall not affect the validity and enforceability of any remaining provisions.

J. Section Headings. The section headings used herein are for convenience only and shall not affect the interpretation of this Agreement or have any other legal effect.

K. Survival. The provisions of Sections IV, VI.A, IX, XI-XV, and XVII shall survive any termination of this Agreement.

YOU HEREBY ACKNOWLEDGE THAT YOU HAVE READ AND UNDERSTAND THE FOREGOING TERMS OF USE AGREEMENT AND AGREE THAT SELECTING THE "ACCEPT" BUTTON BELOW AND/OR YOUR USE OF ANY OF THE PROPERTIES IS AN ACKNOWLEDGMENT OF YOUR AGREEMENT TO BE BOUND BY THE TERMS AND CONDITIONS OF THIS AGREEMENT.

EULA

END USER LICENSE AGREEMENT (EULA)
LEAGUE OF LEGENDS®

Last Modified: October 23, 2012

League of Legends® (the "**Game**") is a free-to-play, session-based, multiplayer online battle-arena computer game developed and operated by Riot Games, Inc., a Delaware Corporation ("**Riot Games**"). For purposes of this License Agreement (defined below), "**you**" and "**your**" mean the user of the computer on which the Game will be or has been installed.

PLEASE READ THIS END USER LICENSE AGREEMENT (THIS "**EULA**" OR "**LICENSE AGREEMENT**") CAREFULLY. BY CLICKING THE "ACCEPT" BUTTON BELOW OR USING THE GAME OR INSTALLING THE GAME CLIENT SOFTWARE (THE "**SOFTWARE**"), YOU AGREE THAT THIS LICENSE AGREEMENT IS ENFORCEABLE LIKE ANY WRITTEN CONTRACT SIGNED BY YOU. IF YOU DO NOT AGREE TO ALL OF THE TERMS OF THIS LICENSE AGREEMENT, CLICK ON THE BUTTON THAT INDICATES THAT YOU DO NOT AGREE TO ACCEPT THE TERMS OF THIS LICENSE AGREEMENT, AND DO NOT COMPLETE INSTALLATION OF THE SOFTWARE. BY ENTERING INTO THIS LICENSE AGREEMENT, YOU REPRESENT THAT YOU ARE AN ADULT AND HAVE THE LEGAL CAPACITY TO ENTER INTO A CONTRACT IN THE JURISDICTION WHERE YOU RESIDE.

I. LIMITED USE LICENSE

Subject to the terms and conditions of this License Agreement and your agreement therewith, Riot Games hereby grants to you and you hereby accept a limited, non-exclusive, non-transferable license to internally install and execute solely as a component of the Game (i) the Software and related explanatory materials ("**Documentation**"); and (ii) any Software upgrades, patches, subsequent versions, and updates (collectively, "**Updates**") licensed to you by Riot Games. The Software and the Game are provided for your individual, non-commercial, entertainment purposes only. Except as may be expressly permitted by Riot Games, you may not sell, copy, exchange, transfer, publish, assign or otherwise distribute anything you copy or derive from the Software or the Game.

II. REQUIREMENTS

In installing and using the Software and playing the Game, you acknowledge that you have read, understand and agree with the terms of this License Agreement. You must also: (i) read, understand and agree to the Riot Games Terms of Use (http://na.leagueoflegends.com/legal/termsofuse) (the "**Terms of Use**"), incorporated herein by reference; (ii) register for an account in the Game (an "**Account**") (as further explained in the Terms of Use); and (iii) meet the hardware and connection requirements published at http://na.leagueoflegends.com (the "**Site**"). These requirements may change as the Game evolves. You are wholly responsible for the cost of all internet connection fees, along with all equipment, servicing, or repair costs necessary to allow you access to the Game.

III. ADDITIONAL LICENSE LIMITATIONS

The limited license granted to you in Section I is subject to the additional limitations set forth below in this Section III. Any use of the Software in violation of the license limitations set forth below is an unauthorized use of the Software outside of the license granted to you in Section I, and will be regarded as an infringement of the copyrights Riot Games holds in and to the Software and the Game. You agree that you will not, under any circumstances:

A. Sell, lease, rent, loan or otherwise transfer the Software, or grant a security interest in or transfer reproductions of the Software or the Game, to a third party;

B. Copy, photocopy, reproduce, translate, reverse engineer, decompile, derive source code from, or disassemble, in whole or in part, the Software or the Game, or create derivative works based on the Game, except that you are authorized to (i) make one (1) copy of the Software and the Documentation for personal archival purposes only; and (ii) use third party image and video capture software to capture the output of the Software as audio, video and/or still image files solely for personal, not for profit use pursuant to the Terms of Use and any applicable Riot Games policies pertaining to audio or video creation;

C. Modify or cause to be modified any files that are part of the Software in any way not expressly authorized by Riot Games;

D. Make use of, or cause any other person or entity to make use of, the Software or the Game for any commercial purpose, including but not limited to (i) participating in the Game in exchange for payment (e.g. "leveling" services); or (ii) selling in-Game items outside of the Game, or selling Game Accounts, except such transactions as may be authorized by Riot Games and conducted via services provided by Riot Games; or

E. Use any unauthorized third-party programs that interact with the Software in any way, including but not limited to, "mods," "hacks," "cheats," "scripts," "bots," "trainers," or automation programs, or any third-party programs that intercept, emulate or redirect any communication between the Software and Riot Games, or that collect information about the Game by reading areas of memory used by the Software to store information about the Game.

IV. OWNERSHIP

All rights and title in and to the Software and the Game, and all content included therein (including, without limitation, Accounts, computer code, titles, objects, artifacts, characters, character names, locations, location names, stories, story lines, dialog, catch phrases, artwork, graphics, structural or landscape designs, animations, sounds, musical compositions and recordings, Riot Points, audio-visual works, character likenesses, and methods of operation) are owned by Riot Games or its licensors. The Software and the Game and all content therein are protected by United States and other international intellectual property laws. Riot Games and its licensors reserve all rights in connection with the Software and the Game, including, without limitation, the exclusive right to create derivative works therefrom, and you agree that you will not create any work of authorship based on the Game except as expressly permitted by Riot Games. You acknowledge and agree that you have no interest, monetary or otherwise, in any feature or content contained in the Game. You further acknowledge and agree that you shall have no ownership or other property interest in your Account, and you acknowledge and agree that all rights in and to the Account are and shall forever be owned by and inure to the benefit of Riot Games. Please see the Terms of Use for a complete espousal of all of Riot Games ownership rights.

V. CODE OF CONDUCT

While using the Software and playing the Game, you agree to comply with all applicable laws, rules and regulations. You also agree to comply with certain additional rules that govern your use of the Game (the "**Code of Conduct**"). The Code of Conduct is not meant to be exhaustive, and Riot Games reserves the right to modify this Code of Conduct at any time, as well as take any appropriate disciplinary measures including Account termination and deletion to protect the integrity and spirit of the Game, regardless of whether a specific behavior is listed here as prohibited. In addition to this Code of Conduct, please see the Summoner's Code for additional guidance on exemplary game-play behavior. The following are examples of behavior that warrant disciplinary measures:

A. Impersonating any person, business, or entity, including an employee of Riot Games, or communicating in any way that makes it appear that the communication originates from Riot Games;

B. Posting identifying information about yourself, or any other user, in the Game;

C. Harassing, stalking, or threatening any other users in the Game;

D. Removing, altering or concealing any copyright, trademark, patent or other proprietary rights notices of Riot Games contained in the Game and/or the Software. You also may not transmit content that violates or infringes the rights of others, including without limitation, patent, trademark, trade secret, copyright, publicity, personal rights or other proprietary or non-proprietary rights;

E. Transmitting or communicating any content which, in the sole and exclusive discretion of Riot Games, is deemed offensive, including, but not limited to, language that is unlawful, harmful, threatening, abusive, harassing, defamatory, vulgar, obscene, sexually explicit, or racially, ethnically, or otherwise objectionable;

F. Transmitting or facilitating the transmission of any content that contains a virus, corrupted data, trojan horse, bot keystroke logger, worm, time bomb, cancelbot or other computer programming routines that are intended to and/or actually damage, detrimentally interfere with, surreptitiously intercept or mine, scrape or expropriate any system, data or personal information;

G. Spamming chat, whether for personal or commercial purposes, by disrupting the flow of conversation with repeated postings of a similar nature;

H. Participating in any action which, in the sole and exclusive judgment of Riot Games, "exploits" an undocumented aspect of the Game in order to secure an unfair advantage over other users;

I. Participating in any action which, in the sole and exclusive judgment of Riot Games, defrauds any other user of the Game, including, but not limited to, by "scamming" or "social engineering;"

J. Accessing or attempting to access areas of the Game or Game servers that have not been made available to the public;

K. Logging out, disconnecting or exiting the Game during live game-play. Riot Games' automated **Leaverbuster**® system tracks this data and may issue temporary bans to users who frequently leave during live game-play. The length of the temporary ban will increase over time if a particular Account continues to leave during live game-play; or

L. Selecting a Summoner name that is falsely indicative of an association with Riot Games, contains personally identifying information, infringes on the proprietary or non-proprietary rights of third parties, or that is offensive, defamatory, vulgar, obscene, sexually explicit, racially, ethnically, or otherwise objectionable. You may not use a misspelling or an alternative spelling to circumvent this restriction on Summoner name choices. Riot Games may modify any name which, in the sole and exclusive judgment of Riot Games, violates this provision without further notification to you, and may take further disciplinary measures, including Account termination, for repeated violations.

VI. CONSENT TO MONITORING

When you are using the Software, the Software may monitor your computer's random access memory (RAM) for unauthorized third party programs prohibited by Section III.E that interact with the Software and/or the Game. In the event that the Software detects such an unauthorized third party program, information may be communicated back to Riot Games, including the name of your Account, your internet protocol (IP) address, details about the unauthorized third party program detected, and the time and date that the unauthorized third party program was detected, along with the hardware specs and performance characteristics of your computer, with or without additional notice to you. No other information about you or your computer will be communicated to Riot Games with the Software. If the Software detects the use of an unauthorized third party program, your access to the Game may be terminated with or without additional notice to you.

VII. UPDATES AND MODIFICATIONS

A. The Software and the Game. Riot Games may provide Updates to the Software that must be installed for you to continue to play the Game. Each time you launch the Software to play the Game, you hereby give your consent to Riot Games to remotely install any Updates to the Software that resides on your computer, with or without additional notification to you.

B. License Agreement. Riot Games reserves the right, in its sole and absolute discretion, to revise, update, change, modify, add to, supplement, or delete certain terms of this License Agreement as the Game and the law evolve; provided, however, that material changes to this License Agreement will not be applied retroactively. Such changes will be effective with or without prior notice to you. You can review the most current version of this License Agreement by clicking on the "EULA" link located at the bottom of the Site. You are responsible for checking this License Agreement periodically for changes. If the Software requires an Update at the time you launch the Software to access the Game, you will also have the opportunity to review and to accept or reject the current version of this License Agreement. If any future changes to this License Agreement are unacceptable to you or cause you to no longer be in agreement or compliance with this License Agreement, you may terminate this License Agreement in accordance with Section IX and must immediately stop playing the Game and uninstall the Software. Your continued use of the Game following any revision to this License Agreement constitutes your complete and irrevocable acceptance of any and all such changes.

VIII. TERMINATION OF AGREEMENT

This License Agreement is effective until terminated. You may terminate this License Agreement at any time by notifying Riot Games of your intention to terminate. Riot Games may terminate this License Agreement at any time, for any reason or no reason. Upon termination, whether by you or Riot Games, the license granted to you in Section I shall immediately terminate, and you must immediately and permanently remove the Software from your computer's permanent memory and destroy any and all copies of the Software that may be in your possession.

IX. TERMINATION OF GAME SERVICE

The Game is an "on-line" game that must be played over the internet through a service provided by or on behalf of Riot Games. You acknowledge and agree that Riot Games, in its sole and absolute discretion, may stop providing support for or access to the Game at any time, for any reason or no reason. You also agree that Riot Games may change, modify, suspend, "nerf," discontinue, or restrict your access to any features or parts of the Game at any time without notice or liability to you. You acknowledge that you have no interest, monetary or otherwise, in any feature of or content in the Software or the Game.

X. EXPORT CONTROLS

The Software is subject to all applicable export restrictions. You must comply with all export and import laws and restrictions and regulations of any United States or foreign agency or authority relating to the Software and its use. The Software may not be re-exported, downloaded or otherwise exported to, or downloaded or installed by a national or resident of, any country to which the United States has embargoed goods, or to anyone on the U.S. Treasury Department's list of Specially Designated Nationals or the U.S. Commerce Department's Table of Denial Orders. You represent and warrant that you are not located in, under the control of, or a national or resident of any such country or on any such list.

XI. WARRANTY DISCLAIMER

THE GAME (INCLUDING WITHOUT LIMITATION THE SOFTWARE AND THE DOCUMENTATION) IS PROVIDED TO YOU ON AN “AS IS” AND “AS AVAILABLE” BASIS WITHOUT WARRANTIES OR REPRESENTATIONS OF ANY KIND, EXPRESS OR IMPLIED. TO THE FULLEST EXTENT PERMITTED BY APPLICABLE LAW, RIOT GAMES DISCLAIMS ALL WARRANTIES, EXPRESS OR IMPLIED, WHICH MIGHT APPLY TO THE GAME OR THE SOFTWARE, INCLUDING WITHOUT LIMITATION, IMPLIED WARRANTIES OF TITLE, NON-INFRINGEMENT, MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, ANY WARRANTIES THAT MAY ARISE FROM COURSE OF DEALING, COURSE OF PERFORMANCE OR USAGE OF TRADE, AND ANY WARRANTIES AS TO THE ACCURACY, RELIABILITY OR QUALITY OF ANY CONTENT OR INFORMATION CONTAINED WITHIN THE GAME AND/OR THE SOFTWARE. RIOT GAMES DOES NOT WARRANT THAT THE GAME AND/OR THE SOFTWARE WILL BE UNINTERRUPTED OR ERROR-FREE, THAT DEFECTS WILL BE CORRECTED, OR THAT THE SOFTWARE IS FREE OF VIRUSES OR OTHER HARMFUL COMPONENTS. YOU ASSUME ALL RESPONSIBILITY FOR SELECTING THE GAME AND/OR THE SOFTWARE TO ACHIEVE YOUR INTENDED RESULTS, AND FOR THE INSTALLATION OF, USE OF, AND RESULTS OBTAINED FROM THE GAME AND THE SOFTWARE.

Because some states or jurisdictions do not allow the disclaimer of implied warranties, the forgoing disclaimer may, in whole or in part, not apply to you.

XII. INDEMNIFICATION

YOU HEREBY AGREE TO INDEMNIFY, DEFEND AND HOLD HARMLESS RIOT GAMES FROM AND AGAINST ANY AND ALL CLAIMS, LAWSUITS, DAMAGES, LOSSES, LIABILITIES AND COSTS (INCLUDING ATTORNEYS’ FEES) THAT DIRECTLY OR INDIRECTLY ARISE OR RESULT FROM YOUR USE OR MISUSE OF THE GAME AND/OR THE SOFTWARE, OR ANY VIOLATION BY YOU OF ANY OF THE PROVISIONS OF THIS LICENSE AGREEMENT. Riot Games reserves the right, at its own expense and in its sole and absolute discretion, to assume the exclusive defense and control of any matter otherwise subject to indemnification by you, in which event you will cooperate with Riot Games in asserting any available defenses.

XIII. LIMITATION OF LIABILITY

UNDER NO CIRCUMSTANCES, AND UNDER NO LEGAL THEORY, WHETHER IN CONTRACT, TORT (INCLUDING NEGLIGENCE), STRICT LIABILITY OR OTHERWISE, SHALL RIOT GAMES BE LIABLE TO YOU OR ANY OTHER PERSON FOR ANY INDIRECT, INCIDENTAL, CONSEQUENTIAL, SPECIAL, EXEMPLARY, OR PUNITIVE DAMAGES OF ANY KIND (INCLUDING, WITHOUT LIMITATION, DAMAGES FOR LOSS OF BUSINESS, LOSS OF DATA, LOSS OF GOOD WILL, OR LOST PROFITS), OR ANY DAMAGES FOR GROSS NEGLIGENCE OF ANY KIND (INCLUDING, WITHOUT LIMITATION, DAMAGES FOR WORK STOPPAGE, COMPUTER FAILURE OR MALFUNCTION, OR ANY OTHER COMMERCIAL DAMAGES OR LOSSES) ARISING FROM YOUR USE OR MISUSE OF THE SOFTWARE AND/OR THE GAME, EVEN IF RIOT GAMES KNEW OR SHOULD HAVE KNOWN OF THE POSSIBILITY OF SUCH DAMAGES. FURTHER, RIOT GAMES SHALL NOT BE LIABLE IN ANY WAY FOR ANY LOSS OR DAMAGE TO PLAYER CHARACTERS, VIRTUAL GOODS (E.G., WEAPONS, SPELLS, ARMOR, SKINS, ETC.) OR VIRTUAL CURRENCY, RIOT POINTS, ACCOUNTS, STATISTICS, OR USER STANDINGS, RANKS, OR PROFILE INFORMATION STORED BY THE GAME. RIOT GAMES SHALL NOT BE RESPONSIBLE FOR ANY INTERRUPTIONS OF SERVICE, INCLUDING WITHOUT LIMITATION ISP DISRUPTIONS, SOFTWARE OR HARDWARE FAILURES, OR ANY OTHER EVENT WHICH MAY RESULT IN A LOSS OF DATA OR DISRUPTION OF SERVICE. IN NO EVENT SHALL RIOT GAMES BE LIABLE FOR ANY DAMAGES IN EXCESS OF ANY AMOUNT YOU HAVE PAID TO RIOT GAMES FOR GAME-RELATED TRANSACTIONS, IF ANY, DURING THE SIX (6) MONTHS IMMEDIATELY PRIOR TO THE TIME YOUR CAUSE OF ACTION AROSE.

Because some states or jurisdictions do not allow the exclusion or the limitation of liability for consequential or incidental damages, in such states or jurisdictions, the liability of Riot Games shall be limited to the fullest extent permitted by applicable law.

XIV. EQUITABLE REMEDIES

You hereby acknowledge and agree that Riot Games would suffer irreparable harm if this License Agreement were not specifically enforced. Consequently, in addition to such monetary and other relief as may be recoverable at law, you agree that Riot Games shall be entitled to specific performance or other injunctive relief, without bond, other security, or proof of damages, as remedy for any breach or threatened breach of this License Agreement. Additionally, in the event any legal or administrative action or proceeding is brought by either party in connection with this License Agreement and consistent with Section XV below, the prevailing party in such action or proceeding shall be entitled to recover from the other party all the costs, attorneys' fees and other expenses incurred by such prevailing party as the result of the action or proceeding.

XV. NEGOTIATIONS, BINDING ARBITRATION AND GOVERNING LAW

A. Negotiations. Disputes can be expensive and time consuming for both parties. In an effort to accelerate resolution and reduce the cost of any dispute or claim related to this License Agreement ("**Claim**"), you and Riot Games agree to first attempt to informally negotiate any Claim for at least thirty (30) days (except those Claims expressly excluded in Section XV.F below). Riot Games will send its notice to the address it has on file to the extent that you have provided additional contact information to Riot Games (e.g. by participating in a promotion or survey, or contacting a customer services representative). Otherwise, Riot Games will send its notice to the email address associated with your Account. You will send your notice to Riot Games, Inc., 10736 Jefferson Blvd., #622, Culver City, CA 90230, Attn: Legal Department. Please note that this informal resolution procedure does not suspend any statutory limitation periods applicable to the bringing of a Claim.

B. Binding Arbitration. If the parties fail to resolve a Claim through negotiations, within such thirty (30)-day period, either you or Riot Games may elect to have the Claim (except as otherwise provided in Section XV.F) finally and exclusively resolved by binding arbitration by sending a written notice requesting arbitration to the other party. Any election to arbitrate by one party shall be final and binding on the other. The arbitration will be conducted under the Commercial Arbitration Rules of the American Arbitration Association ("AAA Rules") and, where appropriate, the AAA's Supplementary Procedures for Consumer Related Disputes ("AAA Consumer Rules") that are in effect at the time the arbitration is initiated and under the terms set forth in this License Agreement. Both the AAA Rules and the AAA Consumer Rules can be found at the AAA website, www.adr.org. In the event of a conflict between the terms set forth in this Section XV.B and either the AAA Rules or the AAA Consumer Rules, the terms in this Section XV.B will control and prevail.

Except as otherwise set forth in Section XV.F, you may seek any remedies available to you under federal, state or local laws in an arbitration action. As part of the arbitration, both you and Riot Games will have the opportunity for discovery of non-privileged information that is relevant to the Claim. The arbitrator will provide a written statement of the arbitrator's decision regarding the Claim, the award given and the arbitrator's findings and conclusions on which the arbitrator's decision is based. The determination of whether a Claim is subject to arbitration shall be governed by the Federal Arbitration Act and determined by a court rather than an arbitrator. Except as otherwise provided in this License Agreement, (i) you and Riot Games may litigate in court to compel arbitration, stay proceedings pending arbitration, or confirm, modify, vacate or enter judgment on the award entered by the arbitrator; and (ii) the arbitrator's decision is final, binding on all parties and enforceable in any court that has jurisdiction, provided that any award may be challenged if the arbitrator fails to follow applicable law.

BY AGREEING TO THIS ARBITRATION PROVISION, YOU UNDERSTAND THAT YOU AND RIOT GAMES ARE WAIVING THE RIGHT TO SUE IN COURT AND HAVE A JURY TRIAL.

C. Arbitration Fees. If we are initiating arbitration for a Claim, we will pay all costs charged by the AAA Rules for initiating the arbitration. Your share of all other fees and costs of the arbitration, including your share of arbitrator compensation, will be charged pursuant to the AAA Rules, and where appropriate, limited by the AAA Consumer Rules. Where your share of the costs is deemed to be excessive by the arbitrator, Riot Games will pay all arbitration fees and expenses.

D. Location. The arbitration will take place in your hometown area if you so notify Riot Games in your notice of arbitration or within ten (10) days following receipt of Riot Games' arbitration notice. In the absence of a notice to conduct the arbitration in your hometown area, the arbitration will be conducted in Los Angeles, California, unless the parties agree to video, phone and/or internet connection appearances. Any Claim not subject to arbitration (other than claims proceeding in any small claims court), or where no election to arbitrate has been made, shall be decided exclusively by a court of competent jurisdiction in Los Angeles, California, United States of America, and you and Riot Games agree to submit to the personal jurisdiction of that court.

E. Limitations. You and Riot Games agree that any arbitration shall be limited to the Claim between Riot Games and you individually. YOU AND RIOT GAMES AGREE THAT (A) THERE IS NO RIGHT OR AUTHORITY FOR ANY DISPUTE TO BE ARBITRATED ON A CLASS-ACTION BASIS OR TO UTILIZE CLASS ACTION PROCEDURES; (B) THERE IS NO RIGHT OR AUTHORITY FOR ANY DISPUTE TO BE BROUGHT IN A PURPORTED REPRESENTATIVE CAPACITY OR AS A PRIVATE ATTORNEY GENERAL; AND (C) NO ARBITRATION SHALL BE JOINED WITH ANY OTHER.

F. Exceptions to Negotiations and Arbitration. You and Riot Games agree that the following Claims are not subject to the above provisions concerning negotiations and binding arbitration: (i) any Claims seeking to enforce or protect, or concerning the validity of, any of your or Riot Games' intellectual property rights; (ii) any Claim related to, or arising from, allegations of theft, piracy, invasion of privacy or unauthorized use; and (iii) any claim for equitable relief. In addition to the foregoing, either party may assert an individual action in small claims court for Claims that are within the scope of such courts' jurisdiction in lieu of arbitration.

G. Governing Law. Except as otherwise provided in this License Agreement, this License Agreement shall be governed by, and will be construed under, the laws of the United States of America and the laws of the State of California, without regard to conflict of law principles. The application of the United Nations Convention on Contracts for the International Sale of Goods is expressly excluded. Other laws may apply if you choose to access the Game from outside of the United States. In such an event, those local laws shall affect this License Agreement only to the extent necessary in that jurisdiction, and this License Agreement shall be interpreted to give maximum effect to the terms and conditions in this License Agreement. You are responsible for compliance with all local laws if and to the extent local laws are applicable. The New Zealand Consumer Guarantees Act of 1993 (the "**Act**") may apply to the Game if you access the Game from, and are a resident of, New Zealand. Notwithstanding anything to the contrary in this License Agreement, if the Act applies then you may have other rights or remedies as set out in the Act which may apply in addition to or instead of those set out in this License Agreement.

H. Severability. You and Riot Games agree that if any portion this Section XV is found illegal or unenforceable (except any portion of Section XV.F), that portion shall be severed and the remainder of the Section shall be given full force and effect. If Section XV.F is found to be illegal or unenforceable then neither you nor Riot Games will elect to arbitrate any Claim falling within that portion of Section XV.F found to be illegal or unenforceable and such Claim shall be exclusively decided by a court of competent jurisdiction within Los Angeles, State of California, United States of America, and you and Riot Games agree to submit to the personal jurisdiction of that court.

XVI. MISCELLANEOUS

This License Agreement represents the complete agreement between you and Riot Games with respect to the subject matter hereof, and supersedes any prior or contemporaneous agreements between you and Riot Games; provided however that this License Agreement shall coexist with, and shall not supersede, the Terms of Use or the Privacy Policy. To the extent that the provisions of this License Agreement conflict with the Terms of Use, the conflicting provisions in the Terms of Use shall govern. The Game is operated by Riot Games in the United States. Those who choose to access the Game from locations outside the United States do so on their own initiative and are responsible for compliance with applicable local laws. Riot Games' failure to enforce any provision of this License Agreement shall in no way be construed to be a present or future waiver of such provision, nor in any way affect the right of any party to enforce each and every such provision thereafter. The express waiver by Riot Games of any provision, condition or requirement of this License Agreement shall not constitute a waiver of any future obligation to comply with such provision, condition or requirement. If any provision of this License Agreement is held to be invalid or unenforceable for any reason, such provision shall be reformed to the extent necessary to make it enforceable to the maximum extent permissible so as to affect the intent of the parties, and the remainder of this License Agreement shall continue in full force and effect. If, however, it is determined that such provision cannot be reformed, then that provision shall be deemed severable from these terms and shall not affect the validity and enforceability of any remaining provisions. The provisions of Sections IV, and X through XVI shall survive any termination of this License Agreement. If you have any questions concerning these terms and conditions, or if you would like to contact Riot Games for any other reason, please contact Riot Games support at support@riotgames.com.

YOU HEREBY ACKNOWLEDGE THAT YOU HAVE READ AND UNDERSTAND THE FOREGOING END USER LICENSE AGREEMENT AND AGREE THAT BY CLICKING "ACCEPT" AND/OR INSTALLING THE SOFTWARE AND PLAYING THE GAME, YOU ARE ACKNOWLEDGING YOUR AGREEMENT TO BE BOUND BY THE TERMS AND CONDITIONS OF THIS LICENSE AGREEMENT.

ABOUT LEAGUE OF LEGENDS | PREPAID CARDS | HELP US IMPROVE | SERVICE STATUS | TRIBUNAL | SUPPORT | ESPORTS PRO SITE

PLAY NOW

SIGNUP | SUPPORT

EULA | UPDATED PRIVACY POLICY | TERMS OF USE | TRIBUNAL POLICY

Paltalk Holdings, Inc. v. Riot Games (D. Del. 2016)

U.S. Pat. No. 6,226,686
SERVER-GROUP MESSAGING SYSTEM FOR INTERACTIVE APPLICATIONS

Exhibit E
League of Legends – Sample Claim Chart

PFA

PREBEG | FAUCETT | ABBOTT

INTELLECTUAL PROPERTY &
COMMERCIAL LITIGATION

<table>
<tr><th>U.S. Pat. No. 6,226,686
Claim</th><th>Riot Games
League of Legends (“LoL”)</th></tr>
<tr><td>7. A method for facilitating communications among a plurality of host computers over a network to implement a shared, interactive application, comprising the steps of:

A previously agreed construction for “shared, interactive application” is:

Software operating on multiple host computers that provides for sufficient interaction to allow users of the hosts to share an application or experience.</td><td>Riot Games is the developer and publisher of League of Legends (“LoL”), a multiplayer online battle arena video game (a “shared, interactive application”). LoL has a player client program installed on a user’s computer (a “host computer”) that communicates directly with Riot Game’s LoL severs over the Internet (a “network”). Several million people simultaneously play LoL during peak hours.

Riot Games provides servers to host various things in League of Legends, such as: logins, games, chat, the RP Store, the shop, etc.

Regions
To help solve the problems of high-latency because of distance, Riot Games hosts multiple servers around the world.

<table>
<tr><th>Server Countries</th><th>Server Name</th><th>Abbreviation</th><th>Release Date</th><th>Language(s)</th><th>Location</th></tr>
<tr><td></td><td>Brazil</td><td>BR</td><td>September 13th 2012[1]</td><td>Portugese</td><td>São Paulo, Brazil</td></tr>
</table>
</td></tr>
</table>

U.S. Pat. No. 6,226,686 Claim	**Riot Games League of Legends (“LoL”)**					
		Europe Nordic & East	EUNE	July 13th 2010	English, Greek, Romanian, Polish, Hungarian, Czech	Amsterdam, Netherlands
		Europe West	EUW	July 13th 2010	English, German, Spanish, French, Italian	Amsterdam, Netherlands
		Latin America North	LAN	June 5th 2013[2]	Spanish	Miami, FL, United States[*citation needed*]

U.S. Pat. No. 6,226,686 **Claim**	**Riot Games** **League of Legends ("LoL")**
	Latin America South | LAS | June 5th 2013[3] | Spanish | Santiago, Chile[*citation needed*] North America | NA | October 27th 2009[4] | English | Chicago, Illinois, United States On information and belief, based on publicly available reverse engineering and developer/programmer presentations and published material, League of Legends utilizes the "ENet" protocol "Reliable UDP networking library" to communicate between the server and client. Packet traces confirm UDP is used. League of Legends is a multiplayer online battle arena, real-time strategy video game developed and published by Riot Games. It provides a rich game environment for multiple players to interact in and wage multifaceted warfare in a shared game session.
(1) receiving messages from a subset of the plurality of host computers belonging to a message group, wherein each of said messages contains a	Based on a traffic analysis and the gameplay interaction witnessed, League of Legends clients continually track the position of remote players/champions. This information is never transmitted to other players directly, but is funneled through the Riot Games game server. Each game "tick", one or more clients in a game (one example of a message group) send the server a message including position updates and other actions such as skill or item usage (a payload portion).

U.S. Pat. No. 6,226,686 Claim	**Riot Games League of Legends ("LoL")**
payload portion and a portion that is used to identify said message group; **A previously agreed construction for the term "portion that is used to identify said message group" is:** Any part of a message, sent by a host computer to a group messaging server, that identifies the message group of a receiving host computer	These messages are received by a Riot Games controlled server. On information and belief, each message contains a player/champion identifier, and data indicating the position to move to, and data such as skill or item usage. On information and belief, the messages also include an index to the game session and the team the player/champion is on. On information and belief, these messages include the player's actions (payload portion), as well an identifier for the first message group such as a player id, index, and/or IP/port combination (portion used to identify the message group).
(2) aggregating said payload portions of said messages to create an aggregated payload; and **A previously entered construction for "aggregating said payload portions" is:** Aggregating at least one data item from the payloads of all the claimed messages from the claimed plurality of host	The Riot Games server clearly updates the other players on the local player's movement and actions and vice versa. The amount of information traveling from the server to the local player greatly exceeds the amount of information from client to server. Furthermore, during normal gameplay operation, the ratio of server to client versus client to server bytes per second (ignoring the packet headers) is linearly dependent upon the number of visible players. Given the absence of an increased packet count from the server and the appearance of a scaled increase of information by number of players in the game, as well as the immediate perceptible impact of the gameplay interaction thus created, the server must aggregate the incoming data from each player into an aggregated payload. Each item in this payload retains its identity to allow the game client to modify the appropriate object (e.g., player champion). Each packet sent from the Riot Server to the local client is an "aggregated message". This packet includes a normal UDP header and the claimed aggregated payload.

U.S. Pat. No. 6,226,686 Claim	**Riot Games League of Legends ("LoL")**
computers. The data items may be aggregated in any order. **A previously entered construction for "aggregating said payload portions … to create an aggregated payload" is:** Aggregating said payload portions of said host messages...to create one or more aggregated payloads.	
(3) transmitting said aggregated message to each of the plurality of host computers belonging to said message group;	As described above, based on the packet trace information and developer dialogue, the Riot Server sends an aggregated payload to each player.
wherein said aggregated message keeps the shared, interactive application operating consistently on each of the plurality of host computers belonging to said message group.	Among other things, messages relay movement, skill activation, item acquisition, and chat. Based on observed behavior, when disconnected from the server's update stream the client will cease to maintain the game state and request reconnection. Without this information from the server's update stream, the client is unable to see the actions of other players and would eventually "time out" and disconnect from the game. With the server's update stream, the game operates consistently for each player.

JS 44 (Rev 11/15)

CIVIL COVER SHEET

The JS 44 civil cover sheet and the information contained herein neither replace nor supplement the filing and service of pleadings or other papers as required by law, except as provided by local rules of court. This form, approved by the Judicial Conference of the United States in September 1974, is required for the use of the Clerk of Court for the purpose of initiating the civil docket sheet. *(SEE INSTRUCTIONS ON NEXT PAGE OF THIS FORM.)*

I. (a) PLAINTIFFS

PalTalk Holdings, Inc.

(b) County of Residence of First Listed Plaintiff
(EXCEPT IN U.S. PLAINTIFF CASES)

(c) Attorneys *(Firm Name, Address, and Telephone Number)*

DEFENDANTS

Riot Games, Inc.

County of Residence of First Listed Defendant Los Angeles County, CA
(IN U.S. PLAINTIFF CASES ONLY)

NOTE: IN LAND CONDEMNATION CASES, USE THE LOCATION OF THE TRACT OF LAND INVOLVED

Attorneys *(If Known)*

II. BASIS OF JURISDICTION *(Place an "X" in One Box Only)*

- ❒ 1 U S Government Plaintiff
- ☒ 3 Federal Question *(U.S. Government Not a Party)*
- ❒ 2 U S Government Defendant
- ❒ 4 Diversity *(Indicate Citizenship of Parties in Item III)*

III. CITIZENSHIP OF PRINCIPAL PARTIES *(Place an "X" in One Box for Plaintiff and One Box for Defendant)*

(For Diversity Cases Only)

	PTF	DEF		PTF	DEF
Citizen of This State	❒ 1	❒ 1	Incorporated *or* Principal Place of Business In This State	❒ 4	❒ 4
Citizen of Another State	❒ 2	❒ 2	Incorporated *and* Principal Place of Business In Another State	❒ 5	❒ 5
Citizen or Subject of a Foreign Country	❒ 3	❒ 3	Foreign Nation	❒ 6	❒ 6

IV. NATURE OF SUIT *(Place an "X" in One Box Only)*

CONTRACT
- ❒ 110 Insurance
- ❒ 120 Marine
- ❒ 130 Miller Act
- ❒ 140 Negotiable Instrument
- ❒ 150 Recovery of Overpayment & Enforcement of Judgment
- ❒ 151 Medicare Act
- ❒ 152 Recovery of Defaulted Student Loans (Excludes Veterans)
- ❒ 153 Recovery of Overpayment of Veteran's Benefits
- ❒ 160 Stockholders' Suits
- ❒ 190 Other Contract
- ❒ 195 Contract Product Liability
- ❒ 196 Franchise

REAL PROPERTY
- ❒ 210 Land Condemnation
- ❒ 220 Foreclosure
- ❒ 230 Rent Lease & Ejectment
- ❒ 240 Torts to Land
- ❒ 245 Tort Product Liability
- ❒ 290 All Other Real Property

TORTS

PERSONAL INJURY
- ❒ 310 Airplane
- ❒ 315 Airplane Product Liability
- ❒ 320 Assault, Libel & Slander
- ❒ 330 Federal Employers' Liability
- ❒ 340 Marine
- ❒ 345 Marine Product Liability
- ❒ 350 Motor Vehicle
- ❒ 355 Motor Vehicle Product Liability
- ❒ 360 Other Personal Injury
- ❒ 362 Personal Injury - Medical Malpractice

PERSONAL INJURY
- ❒ 365 Personal Injury - Product Liability
- ❒ 367 Health Care/ Pharmaceutical Personal Injury Product Liability
- ❒ 368 Asbestos Personal Injury Product Liability

PERSONAL PROPERTY
- ❒ 370 Other Fraud
- ❒ 371 Truth in Lending
- ❒ 380 Other Personal Property Damage
- ❒ 385 Property Damage Product Liability

CIVIL RIGHTS
- ❒ 440 Other Civil Rights
- ❒ 441 Voting
- ❒ 442 Employment
- ❒ 443 Housing/ Accommodations
- ❒ 445 Amer w/Disabilities - Employment
- ❒ 446 Amer w/Disabilities - Other
- ❒ 448 Education

PRISONER PETITIONS

Habeas Corpus:
- ❒ 463 Alien Detainee
- ❒ 510 Motions to Vacate Sentence
- ❒ 530 General
- ❒ 535 Death Penalty

Other:
- ❒ 540 Mandamus & Other
- ❒ 550 Civil Rights
- ❒ 555 Prison Condition
- ❒ 560 Civil Detainee - Conditions of Confinement

FORFEITURE/PENALTY
- ❒ 625 Drug Related Seizure of Property 21 USC 881
- ❒ 690 Other

LABOR
- ❒ 710 Fair Labor Standards Act
- ❒ 720 Labor/Management Relations
- ❒ 740 Railway Labor Act
- ❒ 751 Family and Medical Leave Act
- ❒ 790 Other Labor Litigation
- ❒ 791 Employee Retirement Income Security Act

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- ❒ 462 Naturalization Application
- ❒ 465 Other Immigration Actions

BANKRUPTCY
- ❒ 422 Appeal 28 USC 158
- ❒ 423 Withdrawal 28 USC 157

PROPERTY RIGHTS
- ❒ 820 Copyrights
- ☒ 830 Patent
- ❒ 840 Trademark

SOCIAL SECURITY
- ❒ 861 HIA (1395ff)
- ❒ 862 Black Lung (923)
- ❒ 863 DIWC/DIWW (405(g))
- ❒ 864 SSID Title XVI
- ❒ 865 RSI (405(g))

FEDERAL TAX SUITS
- ❒ 870 Taxes (U S Plaintiff or Defendant)
- ❒ 871 IRS—Third Party 26 USC 7609

OTHER STATUTES
- ❒ 375 False Claims Act
- ❒ 376 Qui Tam (31 USC 3729(a))
- ❒ 400 State Reapportionment
- ❒ 410 Antitrust
- ❒ 430 Banks and Banking
- ❒ 450 Commerce
- ❒ 460 Deportation
- ❒ 470 Racketeer Influenced and Corrupt Organizations
- ❒ 480 Consumer Credit
- ❒ 490 Cable/Sat TV
- ❒ 850 Securities/Commodities/ Exchange
- ❒ 890 Other Statutory Actions
- ❒ 891 Agricultural Acts
- ❒ 893 Environmental Matters
- ❒ 895 Freedom of Information Act
- ❒ 896 Arbitration
- ❒ 899 Administrative Procedure Act/Review or Appeal of Agency Decision
- ❒ 950 Constitutionality of State Statutes

V. ORIGIN *(Place an "X" in One Box Only)*

- ☒ 1 Original Proceeding
- ❒ 2 Removed from State Court
- ❒ 3 Remanded from Appellate Court
- ❒ 4 Reinstated or Reopened
- ❒ 5 Transferred from Another District *(specify)*
- ❒ 6 Multidistrict Litigation

VI. CAUSE OF ACTION

Cite the U S. Civil Statute under which you are filing **(*Do not cite jurisdictional statutes unless diversity*)**:
35 U.S.C. § 271

Brief description of cause:
Patent Infringement

VII. REQUESTED IN COMPLAINT:

❒ CHECK IF THIS IS A **CLASS ACTION** UNDER RULE 23, F.R.Cv.P.

DEMAND $

CHECK YES only if demanded in complaint:
JURY DEMAND: ☒ Yes ❒ No

VIII. RELATED CASE(S) IF ANY

(See instructions): JUDGE DOCKET NUMBER

DATE
12/16/2016

SIGNATURE OF ATTORNEY OF RECORD
/s/ Andrew C. Mayo

FOR OFFICE USE ONLY

RECEIPT # AMOUNT APPLYING IFP JUDGE MAG JUDGE