Server Load Balancer

LB-8000

Administration Guide

Trademarks

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Revision

PLANET Server Load Balancer Administration Guide
For Model: LB-8000
Part No.: EMA-LB8000

Table of Content

1. Introduction

1.1. Getting Started

Before you start to install LB-8000 into your network environment, we suggest you browse the *Quick Installation Guide for LB-8000* first to prepare the basic necessary environment. When you are ready to install LB-8000, you can refer to the following documentation to make your installation is successful.

- **Quick Installation Guide for LB-8000**
  This guide provides the quick procedures to setup a simple cluster system of NAT model. It also includes the procedures to setup the redundancy of LB-8000 (The primary manager and backup manager).

- **User Guide for LB-8000**
  This guide provides the user operating instructions on each screen of web based management system and each command of CLI (command line interface) of LB-8000.

- **Administration Guide for LB-8000**
  This guide provides the administrative information on the technology of LB-8000. It also provides the setup procedures that are not introduced in *Quick Installation Guide for LB-8000*, such as different cluster models.

1.2. Terms used in this document

In this document, we use the following terms to identify the roles of machine:

- **LB-8000**: the cluster manager and a **director** for forwarding the requests to *realservers*.
- **Client**: the user applications that connects to the LB-8000.
- **Realservers**: the servers that provide the *services*. The *realservers* handle the requests from the clients.

We also use some short terms to identify the name of IPs:

Client IP	= CIP
Virtual IP	= VIP (the IP of virtual server)
Director IP	= DIP (the IP on the LB-8000 in the realserver's network)
Realserver IP	= RIP (and RIP1, RIP2...) (the IP on the realserver)

2. LB-8000 Overview

The LB-8000 is a load balancer for a cluster of servers that appears to be one server to an outside client. This apparent single server is called here a "**virtual server**". The realservers are under the control of the LB-8000, which runs a Linux kernel patched to include the Linux *ipvs* code.

When a client requests a new connection to a virtual server (e.g., a web cluster), the LB-8000 will choose a realserver for the client. Since then, all packets from the client will go through the LB-8000 to that particular realserver. The association between the client and the realserver will last for only the life span of the tcp connection (or udp exchange). For the next tcp connection, the LB-8000 will choose a new realserver (which may or may not be the same as the first realserver). (Please refer to Chapter 3 Configure the Cluster for detail information)

3. Configure the cluster

LB-8000 provides three types of cluster. They are NAT model, Direct Routing model and IP Tunneling model.

Here is a basic network configuration of LB-8000 as depicted in Fig. 1.

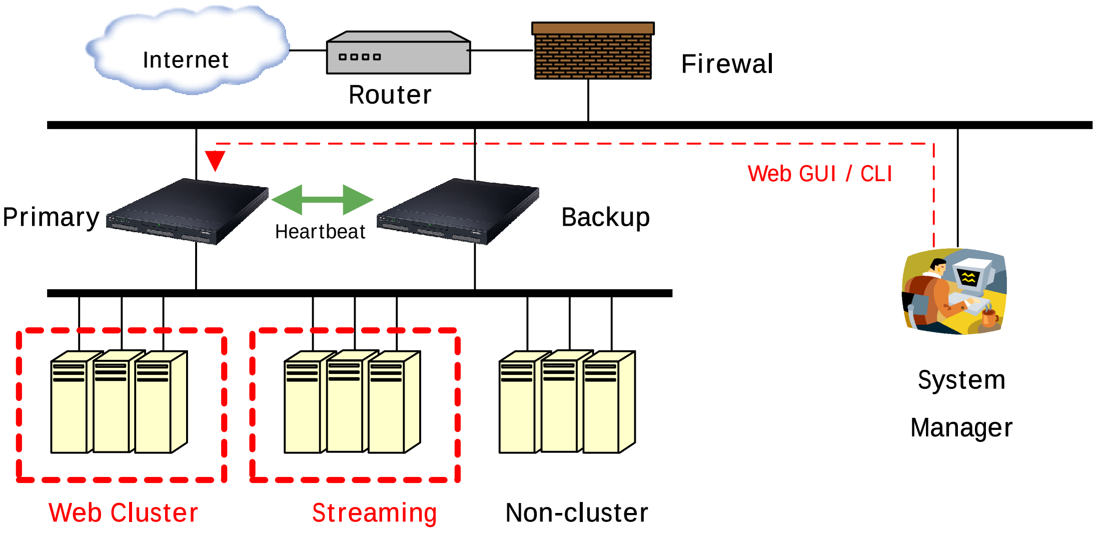


Fig. 1 LB-8000 network topology

3.1. NAT Model

In NAT model, the destination IP address of incoming packets are rewritten by the LB-8000 to be the IP address of one of the realservers and then forwarded to the realserver. Then, the replies from the realserver are sent to the LB-8000 and each source IP address is rewritten to be the original IP address of client.

Unlike the other two methods of forwarding used in LB-8000 (DR model and IP Tunneling model), the realserver only needs a functional TCP/IP stack. The realserver can have any kind of operating system and almost no modifications are required to the configuration of the realservers (except setting their default gateway).

3.1.1. Gateway for realservers

For NAT model to work

- ***All packets from the realservers to the client must go through the LB-8000.***

So, you must set the default gateway of realserver to LB-8000. Forgetting to set this up is the most common cause of failure when setting up a NAT model.

When you are configuring the IP address of network 2 (eth1) of LB-8000, the gateway of network 2 is the virtual gateway for realservers. So, you should set the default gateway of realserver to this gateway IP address.

In tradition, the default gateway of the realserver would be the router to the Internet and the packet (RIP **à** CIP) would be sent directly to the client. In a LB-8000 NAT model, the default gateway of the realservers must be the LB-8000. The LB-8000 masquerades the packet from the realserver (rewrites it to VIP **à** CIP) and the client receives a rewritten packet with the expected source IP of the VIP.

Note *The packet must be routed via the LB-8000; there must be no other path to the client. A packet arriving at the client directly from the realserver will not be seen as a reply to the client's request and the connection will hang.*

3.1.2. How does a virtual server via NAT work?

First consider the following figure (Fig.2).

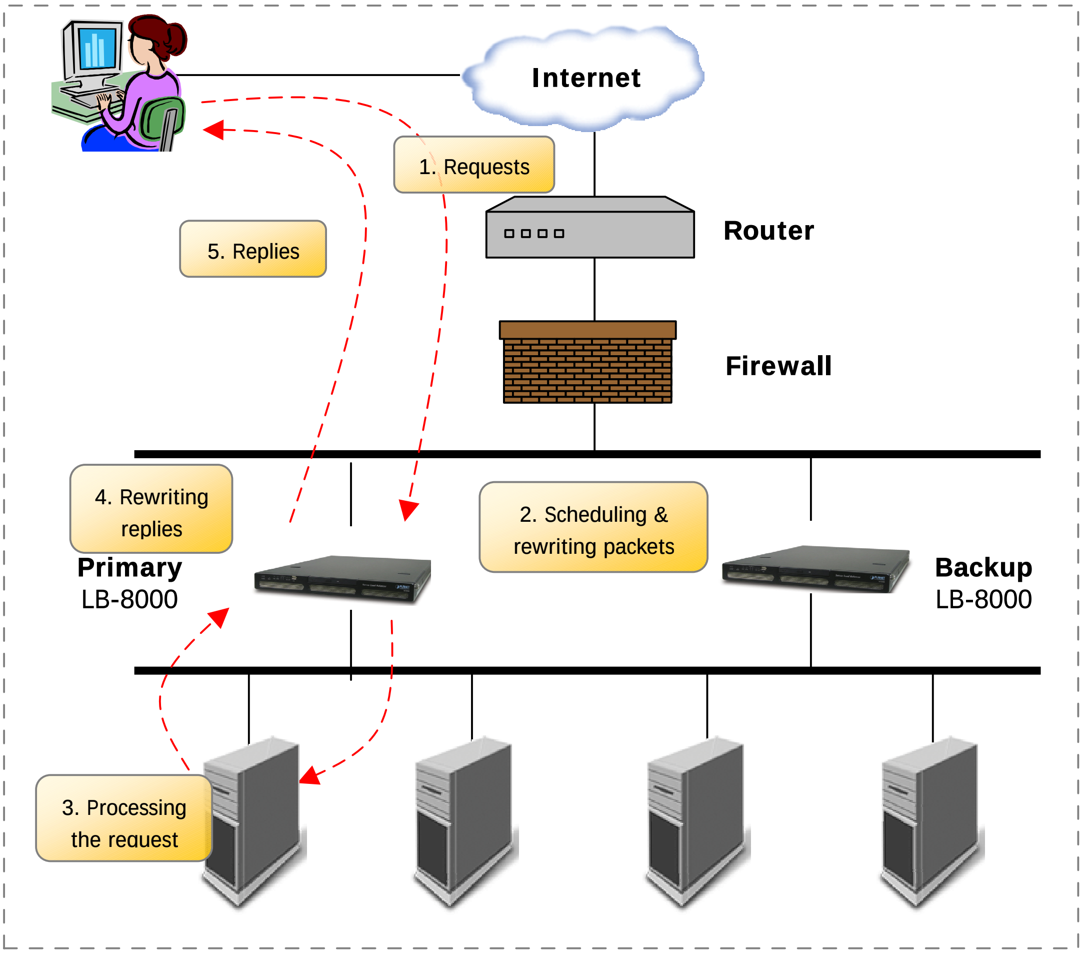


Fig. 2 NAT configuration

When a user requests the service provided by the server cluster, the request packet destined for virtual IP address (the external IP address for the load balancer) arrives at the LB-8000. The LB-8000 examines the packet's destination address and port number. If they are matched for a virtual server service according to the virtual server rule table, a real server is chosen from the cluster by a scheduling algorithm, and the connection is added into the hash table which records the established connection. Then, the destination address and the port of the packet are rewritten to those of the chosen server, and the packet is forwarded to the server. When the incoming packet belongs to this connection and the chosen server can be found in the hash table, the packet will be rewritten and forwarded to the chosen server. When the reply packets come back, the load balancer rewrites the source address and port of the packets to those of the virtual service. After the connection is terminated or timeout, the connection record will be removed from the hash table.

The following diagram shows the handshaking process of HTTP protocol:

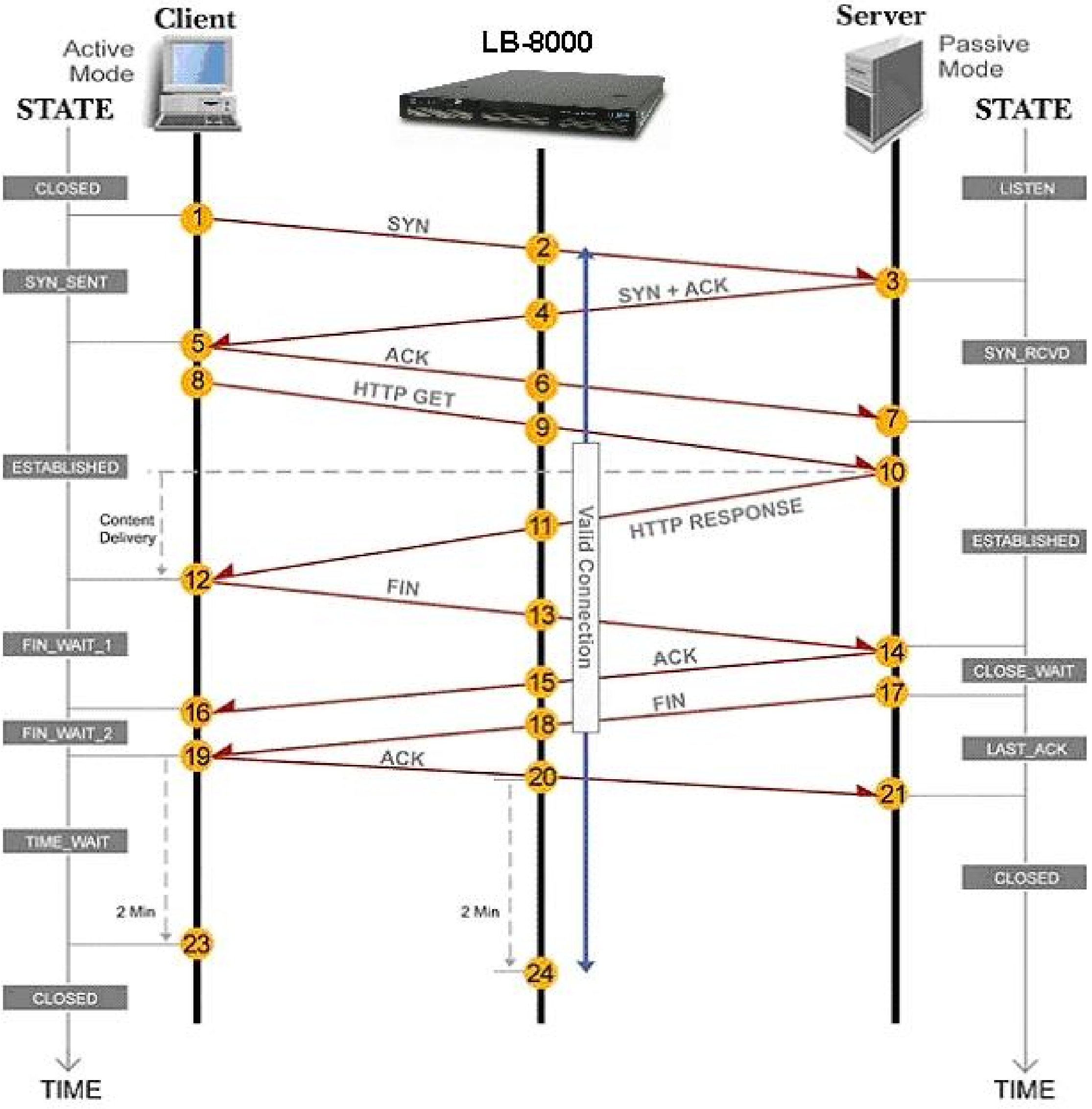


Fig. 3 HTTP handshaking protocol with LB-8000 NAT configuration

Here is an example to make it clear. In the example, computers are configured as follows. Please notes that the IP address of 172.16.0.1 is the virtual gateway IP of network 2 interface (eth1) of LB-8000 and realservers)

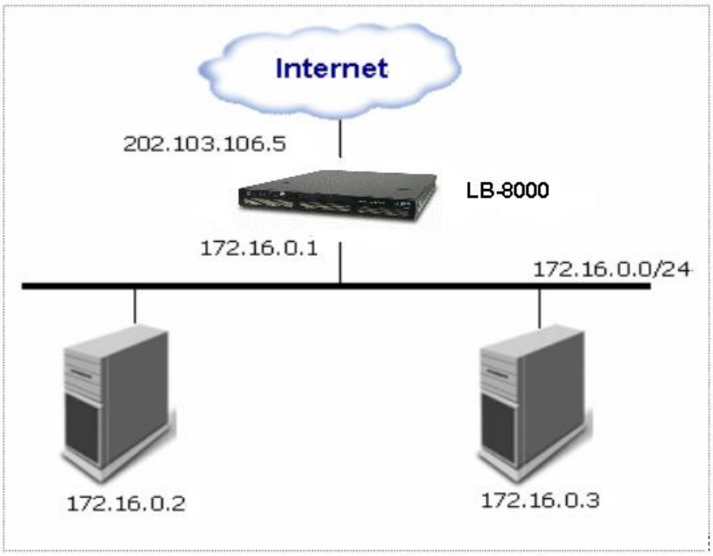


Fig. 4 LB-8000 and 2 Realservers configuration

Note *Realservers can run any OS that supports TCP/IP; the default gateway of real servers must be the LB-8000 (172.16.0.1 in this example).*

The following table illustrates the rules specified in the LB-8000 with virtual server support.

Protocol	Virtual IP Address	Port	Real IP Address	Port	Weight
HTTP	202.103.106.5	80	172.16.0.2	80	1
			172.16.0.3	8000	2
FTP	202.103.106.5	21	172.16.0.3	21	1

All traffic destined for IP address 202.103.106.5 Port 80 is load-balanced over real IP address 172.16.0.2 Port 80 and 172.16.0.3 Port 8000. Traffic destined for IP address 202.103.106.5 Port 21 is port-forwarded to real IP address 172.16.0.3 Port 21.

Packet rewriting works as follows.

(1) The incoming packet for web service would have source and destination addresses as:

Source	202.100.1.2:3456	DEST	202.103.106.5:80

(2) The LB-8000 will choose a real server, e.g. 172.16.0.3:8000. The packet would be rewritten and forwarded to the server as:

Source	202.100.1.2:3456	DEST	172.16.0.3:8000

(3) Replies get back to the load balancer as:

Source	172.16.0.3:8000	DEST	202.100.1.2:3456

(4) The packets would be written back to the virtual server address and returned to the client as:

Source	202.103.106.5:80	DEST	202.100.1.2:3456

3.2. Direct Routing Model

In Direct Routing model, real servers and the LB-8000 share the virtual IP address. The LB-8000 has a network interface configured with the virtual IP address too, which is used to accept request packets, and it directly route the packets to the chosen servers. All the real servers have their **non-arp alias** interface configured with the virtual IP address (e.g., a loopback interface), so that the real servers can process the packets locally. The LB-8000 and the real servers must have one of their network interfaces physically linked by a HUB/Switch.

3.2.1. How does a virtual server via Direct Routing work?

The architecture of virtual server via direct routing is illustrated as follows:

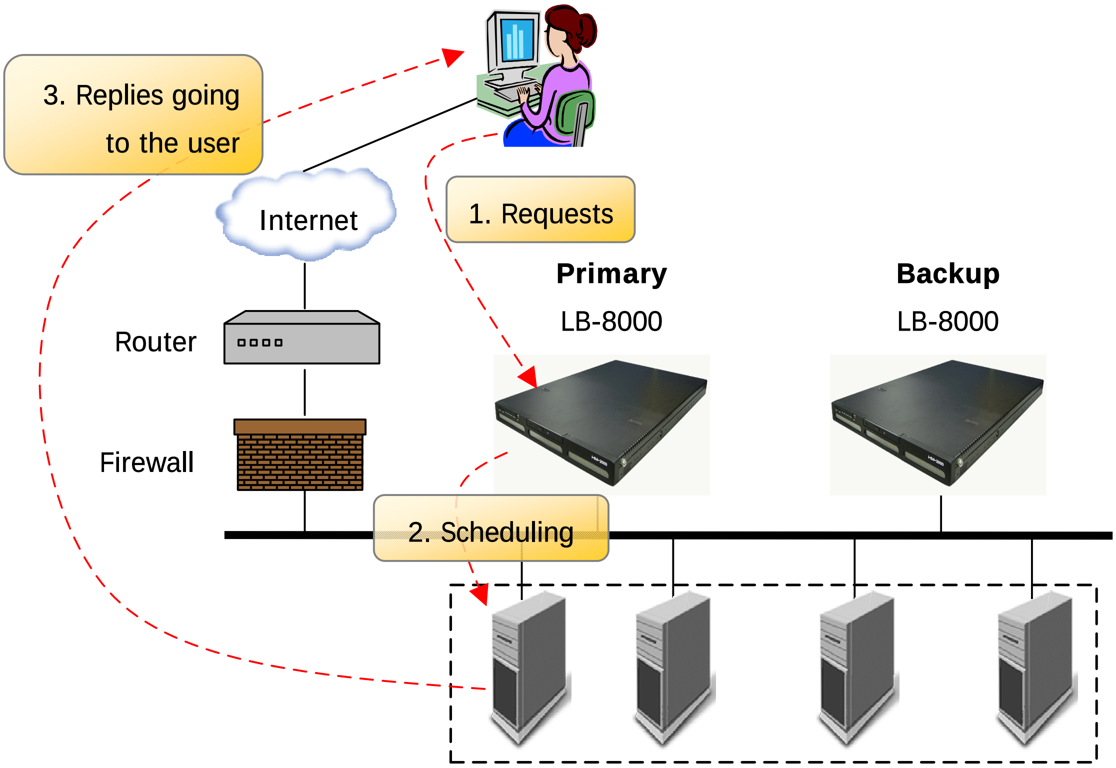


Fig. 5 Direct Routing configuration

When a user requests a virtual service provided by the LB-8000, the packet destined for virtual IP address (the IP address for the virtual server) was send to the LB-8000 from the user. The LB-8000 examines the packet's destination address and port. If they are matched for a virtual service, a real server is chosen from the cluster by a scheduling algorithm, and the connection is added into the hash table that records connections. Then, the LB-8000 forwards the packet to the chosen server. When the incoming packet belongs to this connection and the chosen server can be found in the hash table, the packet will be again routed to the server. When the server receives the forwarded packet, the server finds that the packet is for the address on its alias interface or for a local socket, so it processes the request and returns the result directly to the user finally. After a connection is terminated or timeout, the connection record will be removed from the hash table.

The direct routing workflow is illustrated in the following steps:

Protocol	Virtual IP Address	Port	Real IP Address	Port	Weight
HTTP	192.168.1.110	80	192.168.1.6	80	2
			192.168.1.7	80	1

(1) There is http request from client which IP address is 192.168.2.100

Source	Destination	Data
192.168.2.100:3456	192.168.1.110:80	******

(2) Then LB-8000 will choose a realserver from the schedule and create a link-layer packet. In this packet, the original IP address of source and destination will be the data.

Source MAC	Destination MAC	Data (IP datagram)
00:00:00:00:00:66	00:00:00:00:00:88	source=192.168.2.100:3456, dest=192.168.1.110:80, data=******

(3) When realserver receive this packet, and then recovers it to IP datagram.

Source	Destination	Data
192.168.2.100:3456	192.168.1.110:80	******

(4) Now, realserver looks up the routing table, find the VIP (192.168.1.110) is its local IP address. So the realserver processes this request locally and generates the replies.

Source	Destination	Data
192.168.1.110:80	192.168.2.100:3456	******

(5) Then this reply packet leaves realservers via its default gateway, not via LB-8000.

The LB-8000 simply changes the MAC address of the data frame to that of the chosen server and retransmits it on the LAN. This is the reason that the LB-8000 and each server must be directly connected to one another by a single uninterrupted segment of a LAN.

And the following picture shows the handshake process of HTTP protocol:

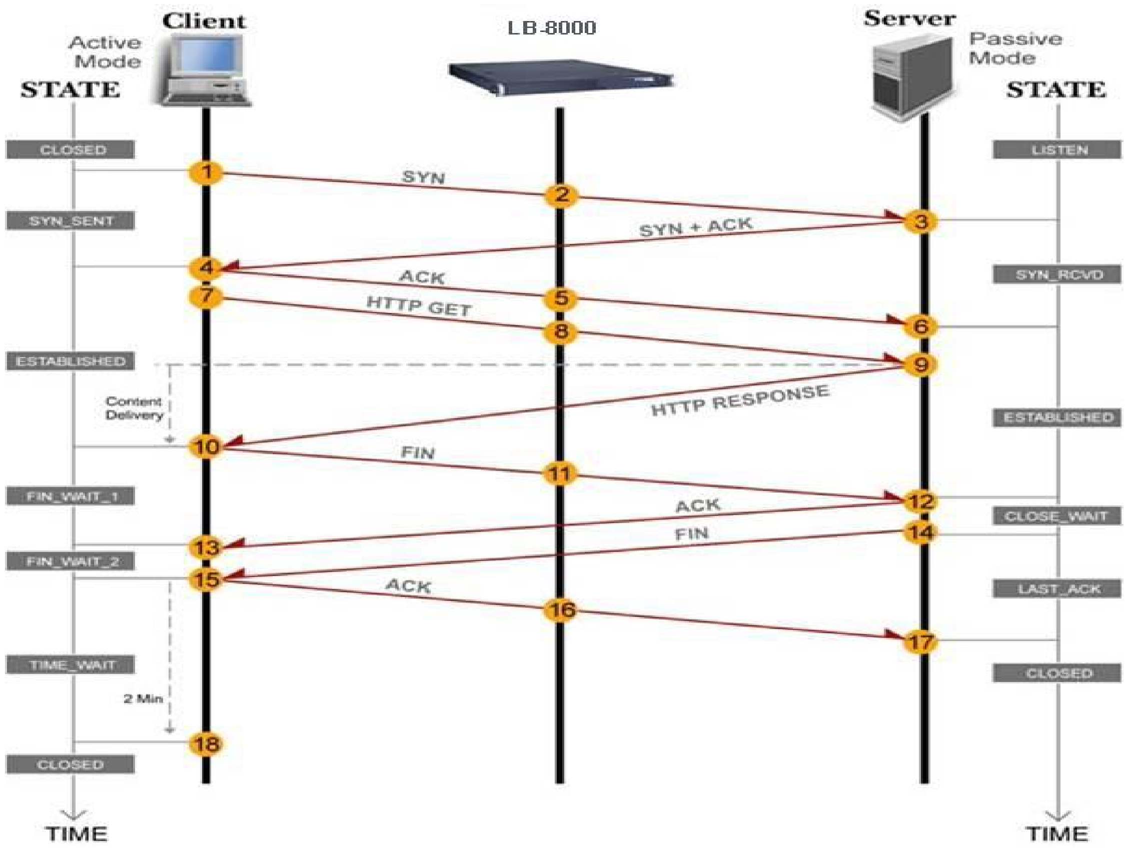


Fig. 6 HTTP handshaking protocol with LB-8000 Direct Routing configuration

3.2.2. The important concept on Direct Routing Model

The setup and testing of DR model are the same as IP Tunneling model except that all machines within the DR model (i.e., the LB-8000 and realservers) must be able to ARP each other. This means that they have to be on the same network without any forwarding devices between them. That is to say they are using the same piece of transport layer hardware ("wire"), e.g., RJ-45. There can be hub(s) or switch(es) in this mix. Communication within the LB-8000 is by link-layer, using MAC addresses rather than IP's. All machines in the cluster of LB-8000 have the VIP, only the VIP on the LB-8000 replies to ARP requests, the VIP on the realservers must be on a non-arp device (e.g., lo:0, dummy).

The restrictions for DR model are:

- The client must be able to connect to the VIP on the LB-8000.
- Realservers and the LB-8000 must be physically wired together (they must be able to ARP each other) as packets are sent by link-layer from the LB-8000 to the realservers.

- The route from the realservers to the client cannot go through the LB-8000, i.e. the LB-8000 cannot be the default gateway for the realservers. (Note: the client does not need to connect to the realservers for the LB-8000 to function. The realservers could be behind a firewall, but the realservers must be able to send packets to the client). The return packets, from the realservers to the client, go directly from the realservers to the client and do not go back through the LB-8000. For high throughput, each realserver can have its own router/connection to the client/Internet and return packets need not go through the router attached with the LB-8000.

Note *In order to provide the graceful service, the real servers should be configured to listen the VIP only.*

Normally for DR model, the client is on a different network to the LB-8000/server(s), and each realserver has its own route to the outside world. In the simple test case below, all machines are on the 192.168.1.0 network without routers, and the return packets would be sent directly to the client via the network device on 192.168.1.0 (presumably).

3.3. IP Tunneling Model

IP tunneling (IP encapsulation) is a technique to encapsulate IP datagram within IP datagrams, which allows datagrams destined for one IP address to be wrapped and redirected to another IP address. IP encapsulation is now commonly used in Extranet, Mobile-IP, IP-Multicast, tunneled host or network.

First, let's look at the figure of virtual server via IP tunneling. The most different thing of virtual server between IP tunneling model and NAT model is how LB-8000 sends the requests to real servers.

3.3.1. How does a virtual server via IP Tunneling work?

The architecture of virtual server via IP Tunneling is illustrated as follows:

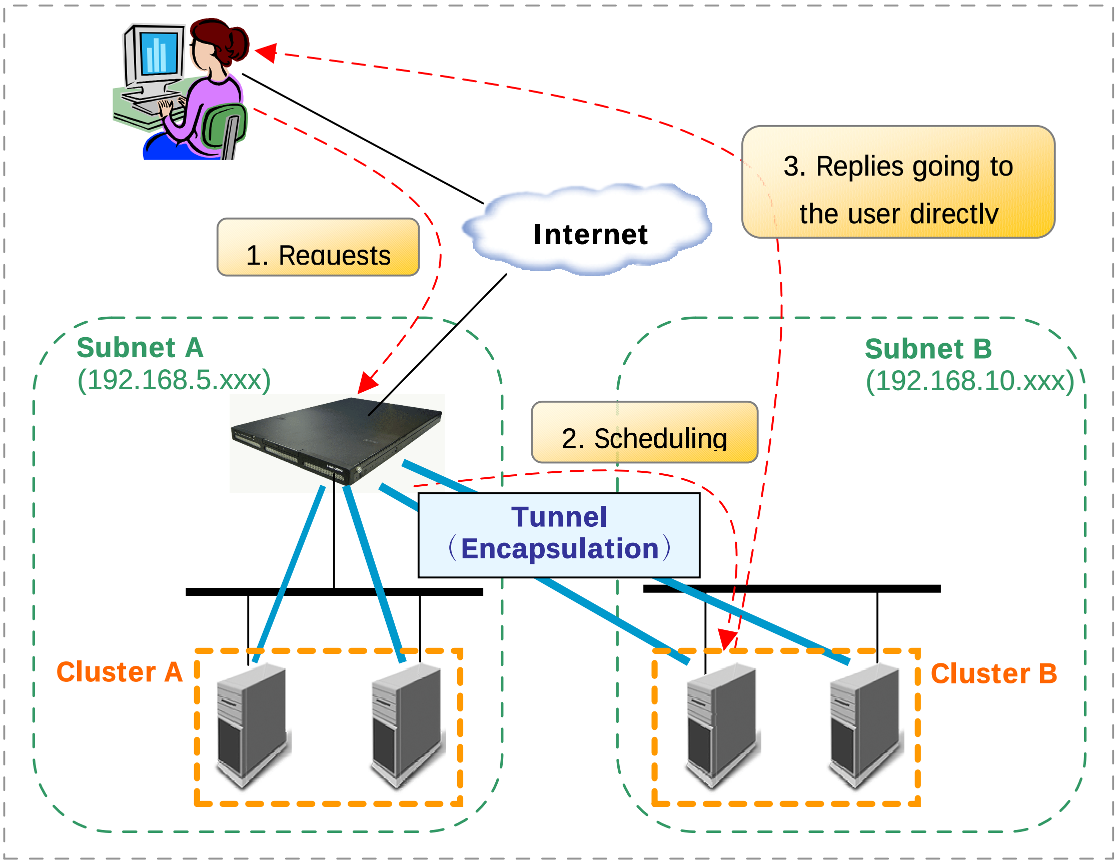


Fig. 7 LB-8000 IP Tunneling configuration

When a user requests a virtual service provided by the server cluster, a packet destined for virtual IP address (the IP address for the virtual server) is received by LB-8000. The LB-8000 examines the packet's destination address and port. If they are matched for the virtual service, a real server is chosen from the cluster according to a connection scheduling algorithm, and the connection is added into the hash table which records connections. Then, the LB-8000 encapsulates the packet within an IP datagram and forwards it to the chosen server. When an incoming packet belongs to this connection and the chosen server can be found in the hash table, the packet will be again encapsulated and forwarded to that server. When the server receives the encapsulated packet, it decapsulates the packet and processes the request, finally return the result directly to the user according to its own routing table. After a connection is terminated or timeout, the connection record will be removed from the hash table.

The workflow is illustrated in the following steps:

Protocol	Virtual IP Address	Port	Real IP Address	Port	Weight
HTTP	192.168.1.110	80	192.168.23.6	80	2
			192.168.23.7	80	1

The IP address of LB-8000 is 192.168.1.88.

(1) There is http request from client which IP address is 192.168.2.100

Source	Destination	Data
192.168.2.100:3456	192.168.1.110:80	******

(2) Then LB-8000 will choose a realserver from the schedule and encapsulate into IPIP packet. In this packet, the original IP address of source and destination will be the data.

Source	Destination	Data (IP datagram)
192.168.1.88	192.168.23.6	source=192.168.2.100:3456, dest=192.168.1.110:80, data=******

(3) When realserver receive this packet, and then recovers it to IP datagram.

Source	Destination	Data
192.168.2.100:3456	192.168.1.110:80	******

(4) Now, realserver looks up the routing table, find the VIP (192.168.1.110) is its local IP address. So the realserver processes this request locally and generates the replies.

Source	Destination	Data
192.168.1.110:80	192.168.2.100:3456	******

(5) Then this reply packet leaves realservers via its default gateway, not via LB-8000.

Note that real servers can have any real IP address in any network, and they can be geographically distributed, but they must support IP encapsulation protocol. Their tunnel devices are all configured up so that the systems can decapsulate the received encapsulation packets properly, and the <Virtual IP Address> must be configured on non-arp devices or any alias of non-arp devices, or the system can be configured to redirect packets for <Virtual IP Address> to a local socket.

Finally, when an encapsulated packet arrives, the real server decapsulates it and finds that the packet is destined for <Virtual IP Address>, it says, "Oh, it is for me, so I do it.", it processes the request and returns the result directly to the user.

3.3.2. The important concept on IP Tunneling Model

IP Tunneling model is based on DR model and has the same high scalability/throughput of DR model.

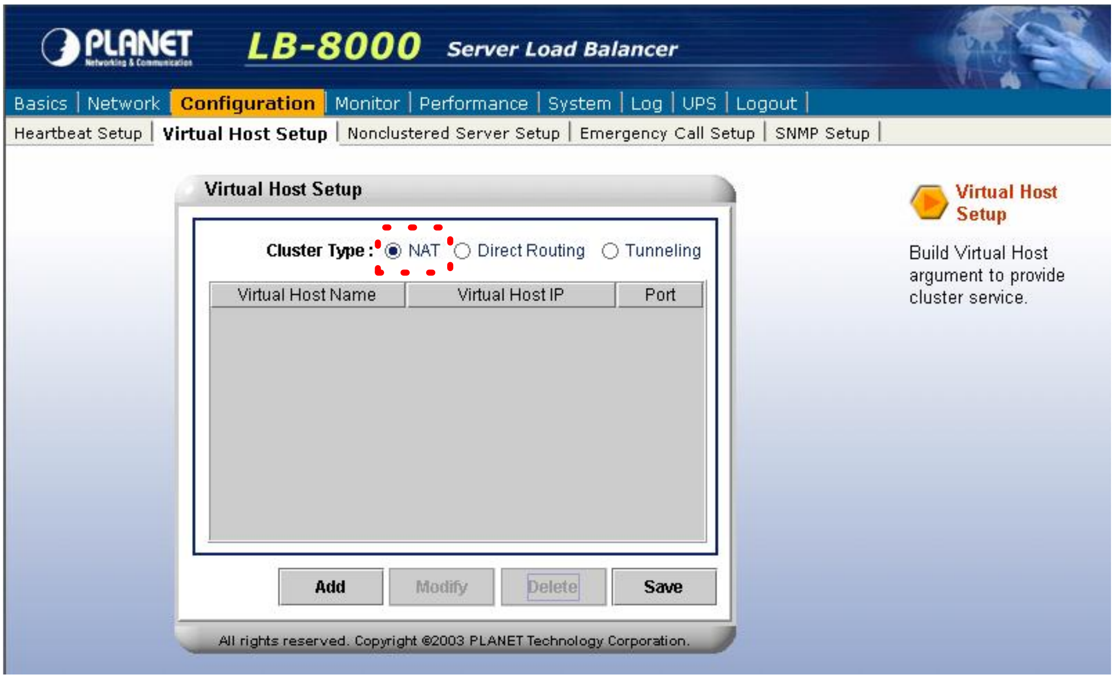
IP Tunneling model can be used with realservers that can tunnel (==IPIP encapsulation). The LB-8000 encapsulates the request packet inside an IPIP packet before sending it to the realserver. The realserver must be able to decapsulate the IPIP packet (currently Linux only). (With DR model, the realservers can have almost any OS.)

Unlike DR model, with IP Tunneling model, the realservers can be on a network different from the LB-8000, and can be on separate networks. Thus the realservers could be in different countries (e.g., a set of ftp mirror sites for a project). If this is the case the realservers will generate reply packets with VIP **à** CIP. And the routers for the realservers will have to be programmed to accept outgoing packets with source IP =VIP. Routers normally drop these packets as an anti-spoofing measure.

If the realservers are on the same network as the LB-8000, then DR model and IP Tunneling model are the same in performance and ease of setup.

3.4. How to configure a cluster?

You can configure a cluster by click **Configuration** in the main menu, and then click **Virtual Host Setup** in the sub-menu to add, modify or delete a cluster. When you configure the first cluster, you should select the cluster type you want.


PLANET Networking & Communication
LB-8000 Server Load Balancer
Basics | Network | Configuration | Monitor | Performance | System | Log | UPS | Logout |
Heartbeat Setup | Virtual Host Setup | Nonclustered Server Setup | Emergency Call Setup | SNMP Setup |
Add
Modify
Delete
Save

Virtual Host Setup

Cluster Type : ● NAT ○ Direct Routing ○ Tunneling

Virtual Host Name	Virtual Host IP	Port

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Virtual Host Setup

Build Virtual Host argument to provide cluster service.

Fig. 8 LB-8000 Network Configuration GUI

There are two concepts:

- All clusters should be the same model. For example, you cannot create a cluster as NAT model and another cluster as Direct Routing model.
- If you change any one of the cluster type in the existing clusters. Then all clusters will be changed to the same cluster type. For example, if you change the cluster type of one of the existing clusters from NAT model to Direct Routing model, all clusters will be changed to Direct Routing model.

You also can configure the cluster by issuing “cluster” and “rs” command from CLI. Please refer to *Chapter 4 CLI Configuration* on *User’s Manual of LB-8000* for detail description.

4. Select Load Distribution Schedule

When receiving a request from a client, the LB-8000 assigns a realserver to handle the request based on a "schedule". The available schedules are:

- Round robin (rr), weighted round robin (wrr) - new connections are assigned to each realserver in turn.
- Least connection (lc), weighted least connection (wlc) - new connections are assigned to the realserver with the least number of connections. The assigned real server might not be the least busy one but it’s the direction we try to approach. The following sections show the detail description on each schedule.

4.1. Round-Robin Schedule

The round-robin scheduling algorithm sends each incoming request to the next server on its list. In a cluster with three real servers (servers A, B and C), the first request would go to server A, the second request would go to server B, the third request would go to server C, and the forth request would go to server A again. It treats all real servers equally regardless of the number of incoming connections or response time for each server.

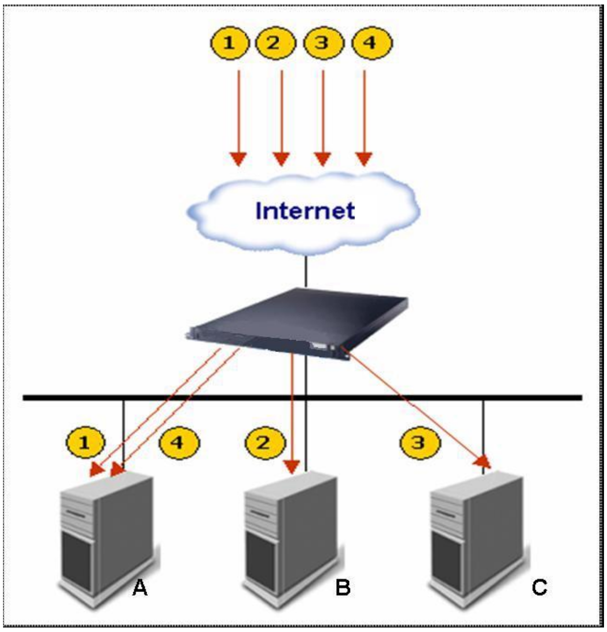


Fig. 9 LB-8000 Round Robin scheduling

4.2. Weighted Round-Robin Schedule

The weighted round-robin scheduling is designed to better handle servers with different processing capacities. Each server can be assigned a weight, an integer value that indicates the processing capacity. The default weight is 1 and can be set up to 99. For example, the real servers, A, B and C, have the weights, 4, 3, 2 respectively, a good scheduling sequence will be AABABCABC in a scheduling period. In the implementation of the weighted round-robin scheduling, a scheduling sequence will be generated according to the server weights after the rules of Virtual Server are modified. The network connections are directed to the different real servers based on the scheduling sequence in a round-robin manner.

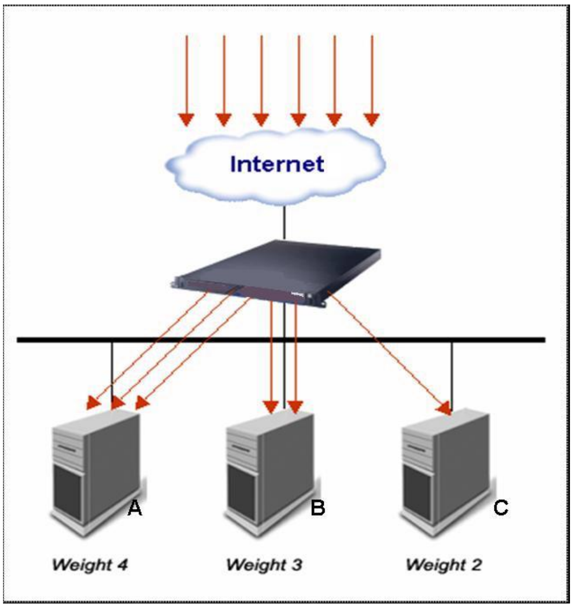


Fig. 10 Weighted RR scheduling

The weighted round-robin scheduling is better than the round-robin scheduling, when the processing capacity of real servers are different. However, it may lead to dynamic load imbalance among the real servers if the load of the requests is varying highly. In short, there is the possibility that a majority of requests requiring large responses may be directed to the same real server.

Actually, the round-robin scheduling is a special instance of the weighted round-robin scheduling, in which all the weights are equal.

4.3. Least-Connection Schedule

The least-connection scheduling algorithm directs network connections to the server with the least number of established connections. This is one of the dynamic scheduling algorithms; because it needs to count live connections for each server. For a Virtual Server that is managing a collection of servers with similar performance, least-connection scheduling is good to smooth distribution when the load of requests vary a lot. Virtual Server will direct requests to the real server with the fewest active connections.

At a first glance it might seem that least-connection scheduling can also perform well even when there are servers of various processing capacities, because the faster server will get more network connections. But there is a potential issue for this algorithm. That is TCP’s TIME_WAIT state. The TCP's TIME_WAIT is usually 2 minutes, during this 2 minutes a busy web site often receives thousands of connections, for example, the server A is twice as powerful as the server B, the server A is processing thousands of requests and keeping them in the TCP's TIME_WAIT state, but server B is crawling to get its thousands of connections finished. Before doing the configuration, the administrator needs to consider all network situations.

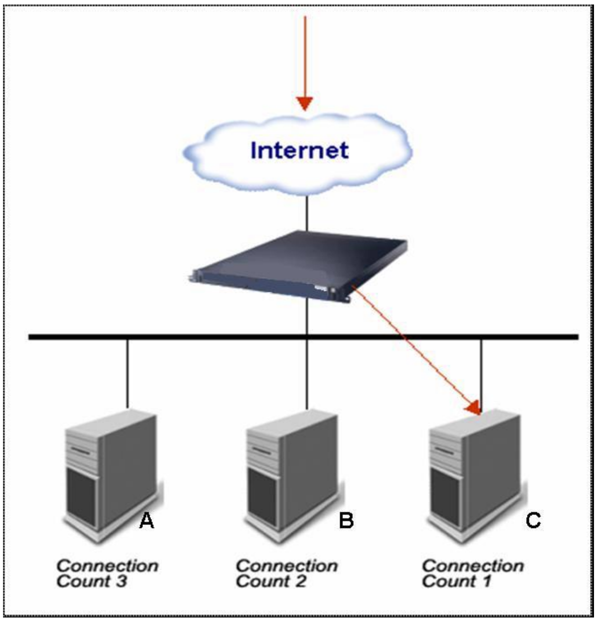


Fig. 11 Least-Connection scheduling

4.4. Weighted Least-Connection Schedule

The weighted least-connection scheduling is a superset of the least-connection scheduling, in which you can assign a performance weight to each real server. The servers with a higher weight value will receive a larger percentage of live connections at any time. The Virtual Server Administrator can assign a weight to each real server, and network connections are scheduled to each server in which the percentage of the current number of live connections for each server is a ratio to its weight. The default weight is one.

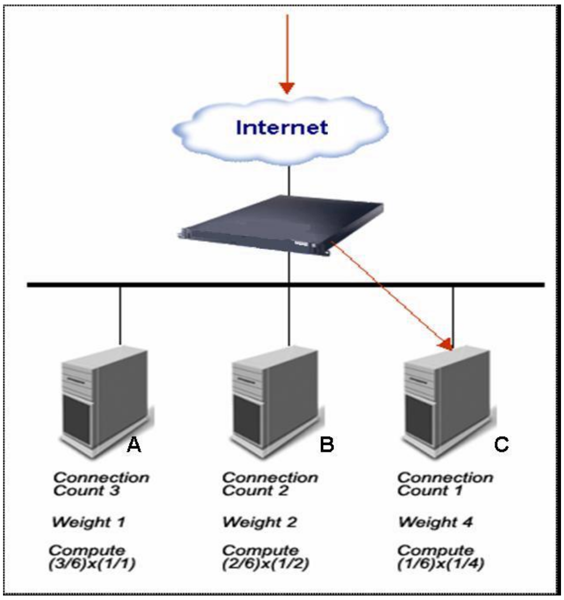


Fig. 12 Weighted LC scheduling

The weighted least-connections scheduling works as follows:

Supposing there is n real servers, each server i has weight W_i (i=1,..,n), and alive connections C_i (i=1,..,n), ALL_CONNECTIONS is the sum of C_i (i=1,..,n), the next network connection will be directed to the server j, in which

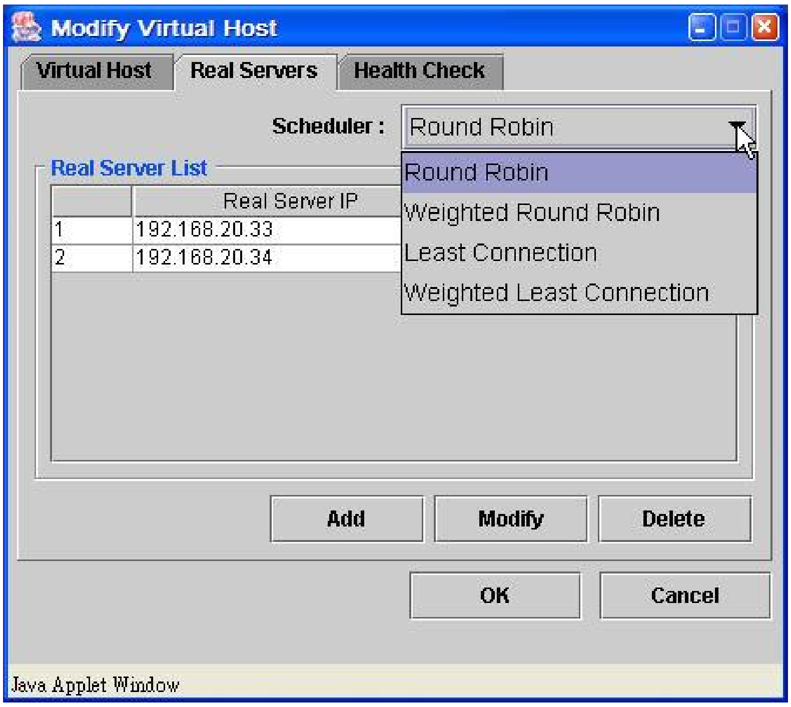
$(C_j/\text{ALL\_CONNECTIONS})/W_j = \min \{ (C_i/\text{ALL\_CONNECTIONS})/W_i \}$ (i=1,..,n)

Since the ALL_CONNECTIONS is a constant in this lookup, there is no need to divide C_i by ALL_CONNECTIONS, it can be optimized as

$C_j/W_j = \min \{ C_i/W_i \}$ (i=1,..,n)

4.5. How to configure the schedule of a cluster?

When you create a new cluster, you can configure the schedule of this cluster. And you also can change the schedule of an existing cluster at any time. Here is the screen where you can configure the schedule.



Scheduler : Round Robin

Round Robin
Weighted Round Robin
Least Connection
Weighted Least Connection

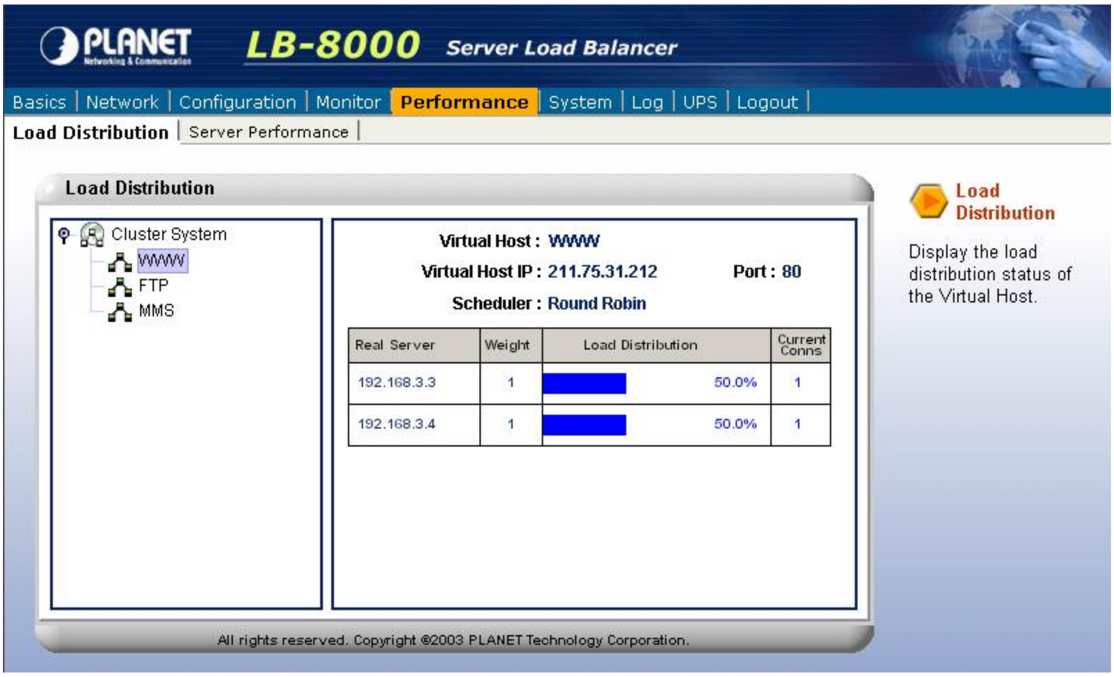
Real Server List

	Real Server IP
1	192.168.20.33
2	192.168.20.34

Fig. 13 Configuring the scheduling

4.6. Monitor the load distribution of LB-8000

You can monitor the load distribution from the web management system. As the following screen shows:


PLANET Networking & Communication
LB-8000 Server Load Balancer
Basics | Network | Configuration | Monitor | Performance | System | Log | UPS | Logout
Load Distribution | Server Performance
Load Distribution
Cluster System
WWW
FTP
MMS
Load Distribution
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Virtual Host : WWW

Virtual Host IP : 211.75.31.212 Port : 80

Scheduler : Round Robin

Real Server	Weight	Load Distribution	Current Conns
192.168.3.3	1	50.0%	1
192.168.3.4	1	50.0%	1

Display the load distribution status of the Virtual Host.

Fig. 14 LB-8000 Connections

Or you can monitor the load distribution by issuing “load” command from CLI. Here is the example:

```
LB8000> load
Load Distribution
Virtual Host: WWW1          IP Address: 211.75.31.212          Port: 80
Real Server        Port       Weight    Connections        Distribution
=====================================================================
192.168.3.3     www        1            50                          50.00%
192.168.3.4     www        1            50                          50.00%
LB8000>
```

The way that LB-8000 counts current connections:

Current connections # means how many connections are currently connected to a realserver and can be found from LB-8000 GUI at PERFORMANCE > LOAD DISTRIBUTION. The way LB-8000 counts connections is to start from point 2, when the SYN packet from the client arriving LB-8000, to point 24, when two-minute timeout passes after point 20. Please refer to Fig. 15.

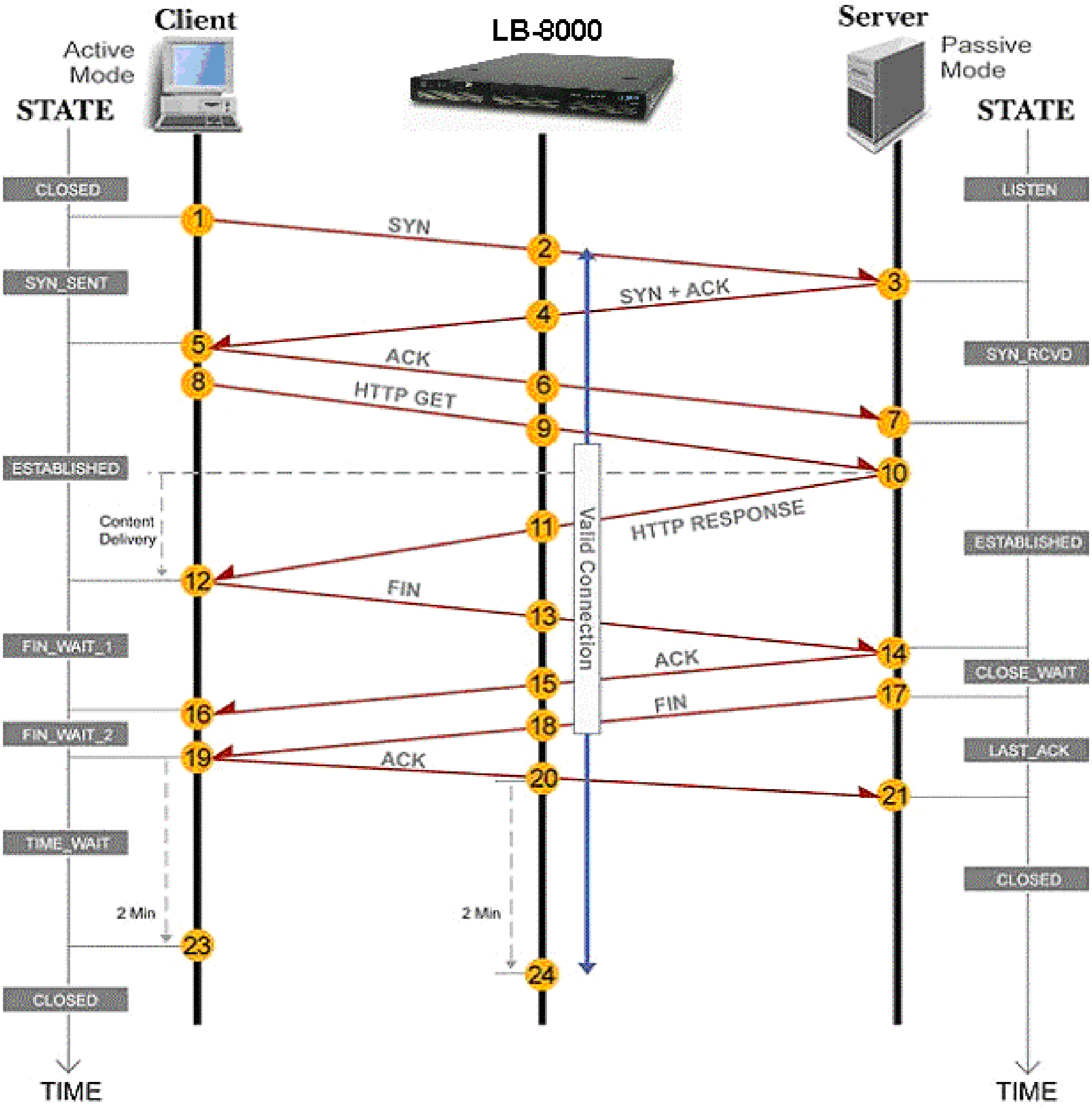


Fig. 15 Connections

And the bar of load distribution is shown by percentage. The percentage is computed by the current connection # divided by the total connection # of cluster. As the above screen, the total connection # of cluster is 1 + 1 = 2. So the percentages of each realserver are 50%, 50%.

Please note that this number depicts the connections # kept in the connection table of LB-8000 and may not be able to truly reflect the state of the real server. Namely, the count may still stay even after the TCP state of the realserver turns to CLOSED (point 21).

For example, system admin will not see the current connections # changed immediately after some clients finish downloading a file from one real server. This is not because of the error of the counter but because LB-8000 will not end the count until that connection really disappears from its connection table (point 24).

Here are the default timeout values of each state:

- CLOSE state: 10 seconds
- CLOSE_WAIT state: 60 seconds
- ESTABLISHED state: 900 seconds (adjustable)
- FIN_WAIT state: 120 seconds (adjustable)
- LAST_ACK state: 30 seconds
- SYN_ACK state: 120 seconds
- SYN_RECEIVED state: 60 seconds
- SYN_SENT state: 120 seconds
- TIME_WAIT state: 120 seconds
- UDP packet: 300 seconds (adjustable)
- ICMP packet: 60 seconds

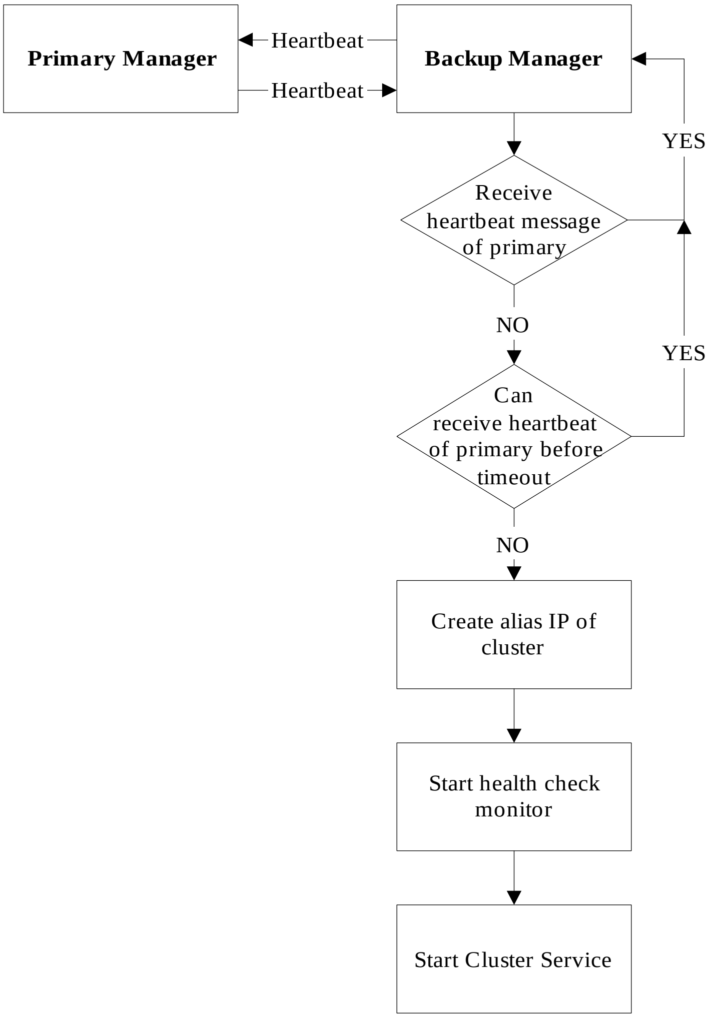
You can change the timeout value by issuing "ctimer" command from CLI. This command always takes 3 parameters, representing the timeout values (in seconds) for TCP sessions (ESTABLISHED state), TCP sessions after receiving a FIN packet (FIN_WAIT state), and UDP packets, respectively. A timeout value 0 means that the current timeout value of the corresponding entry is preserved.

5. Manager Failover with Heartbeat

5.1. Heartbeat Protocol

In order to create a High Availability service, LB-8000 uses heartbeat protocol to create a failover protection between primary and backup manager. This structure is an active-standby model. That means, the primary LB-8000 is the active manager, and backup LB-8000 is the standby waiting to take over the jobs of primary when primary fails.

The heartbeat protocol uses UDP port 694 to send a UDP message from network 1 interface to other LB-8000. The following figure shows the procedures of failover from primary to backup:



Primary Manager
Heartbeat
Heartbeat
Backup Manager
YES
Receive heartbeat message of primary
NO
YES
Can receive heartbeat of primary before timeout
NO
Create alias IP of cluster
Start health check monitor
Start Cluster Service

Fig. 16 The failover from primary to backup

The LB-8000 manager will send heartbeat message according to the value of keepalive setting (The keepalive setting is used on CLI, it is the same as "How many seconds to send a heartbeat?" on GUI). If backup manager can not receive the heartbeat after the timeout value (the timeout value is 3 times of the value of keepalive, for example, if the value of keepalive is 3 seconds, the timeout value will be 3 x 3 = 9 seconds). Then backup manager will take over to provide the service. But if backup manager can receive the heartbeat message from primary manager before the timeout value, the backup manager won't take over.

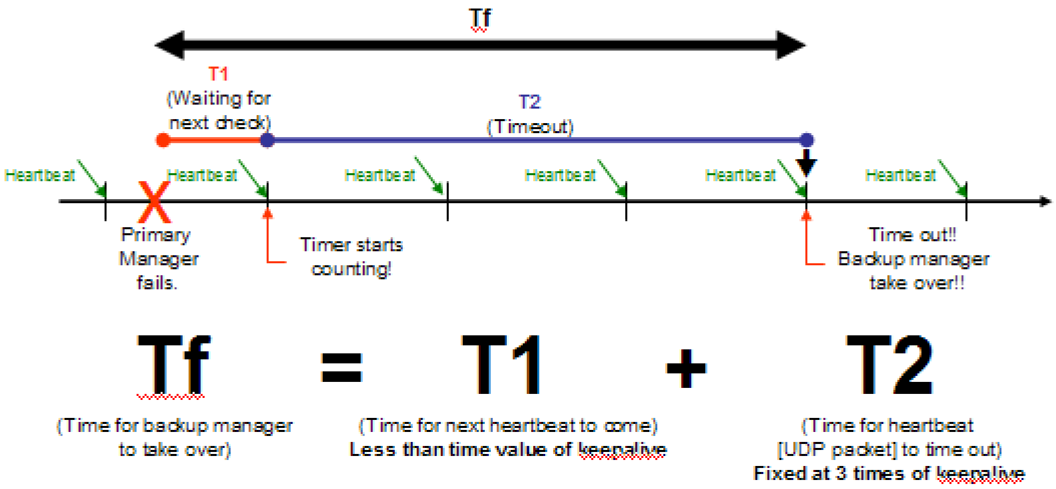
The procedures of service up on backup manager are:

(1) Create the alias IPs for virtual server and virtual gateway (if your virtual server is NAT model)

(2) Start the service of health check.

(3) Start the cluster service.

Here is the time for backup manager to take over:


Tf
T1
(Waiting for next check)
T2
(Timeout)
Heartbeat
Heartbeat
Heartbeat
Heartbeat
Heartbeat
Heartbeat
Primary Manager fails.
Timer starts counting!
Time out!! Backup manager take over!!
Tf = T1 + T2
(Time for backup manager to take over)
(Time for next heartbeat to come) Less than time value of keepalive
(Time for heartbeat [UDP packet] to time out) Fixed at 3 times of keepalive

The value of keepalive could be 1 to 9 seconds. So, the time for backup manager to take over will be minimize to 3 seconds and maximize to 36 seconds.

When primary manager is alive again, it will synchronize the connection table, log files and configuration files from backup manager first. Then after 10 seconds, primary manager will start the heartbeat protocol and take over the service from backup manager. So, before the primary manager to take over from backup manager, the primary manager will need more than 10 seconds to synchronize. If the log files are bigger, the primary manager need more time to synchronize. But, the time for primary manager to take over from backup manager will less than 1 second.

In LB-8000, the heartbeat protocol will send the heartbeat message via network 1 interface. If there is any fail on network cable or interface on primary manager, the backup manager will start to take over the cluster service, because the backup manager can’t receive the heartbeat message from primary manager.

5.2. Stateful Failover

In order to make LB-8000 failover transparent to client applications, the primary manager needs to synchronize its state information (e.g., connection information) to the backup manager. When the backup manager takes over the service after the primary fails, the backup manager will have the state of most connections, so that almost all connections can continue to access the service through the backup manager.

LB-8000 uses UDP multicast to propagate the creation/changes of connections from the primary manager to backup manager. The primary manager saves the changes of connections in the sync queue. A syncmaster daemon is started inside the kernel on the primary manager, and it multicasts connection state in the queue when a new TCP connection is established.. A syncbackup daemon is started inside the kernel on backup manager, and it accepts multicast messages to create/change corresponding connections.

The syncmaster multicasts messages to the backup manager in the following format:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Count Conns  |    Reserved   |             Size              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                   LB-8000 Sync Connection (1)                 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                            .                                  |
|                            .                                  |
|                            .                                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                   LB-8000 Sync Connection (n)                 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

And, the information of each connection is:

<Protocol, CIP:CPort, VIP:VPort, RIP:RPort, Flags, State>

5.3. Configure the heartbeat and role of LB-8000

The default time interval of heartbeat (value of keepalive) is one second. And if a manager can't receive a heartbeat message after the timeout value (three times of the value of keepalive), the manager will send an alert. You also can encrypt the heartbeat message by issuing a specific string.

Before you configure the heartbeat, it is better for you to configure the role of manager. If you have two LB-8000s, you can configure one LB-8000 as primary manager and the other is backup manager. When you configure the role of LB-8000, you should configure the host name and the domain name of LB-8000. A good host name will be understood easily, especially when you receive a mail alert from the manager.

Currently, the synchronization between two managers is bi-direction. They will synchronize the log files and configuration files according to the time of last modification. So, you can modify any configuration from primary manager or backup manager. They will synchronize with the newest configuration files.

The first time of synchronization will synchronize the time of primary manager to backup manager. And then, primary manager will synchronize the time to backup manager at the midnight everyday. In this way, LB-8000 can ensure to synchronize with newest files which are located on primary manager or backup manager.

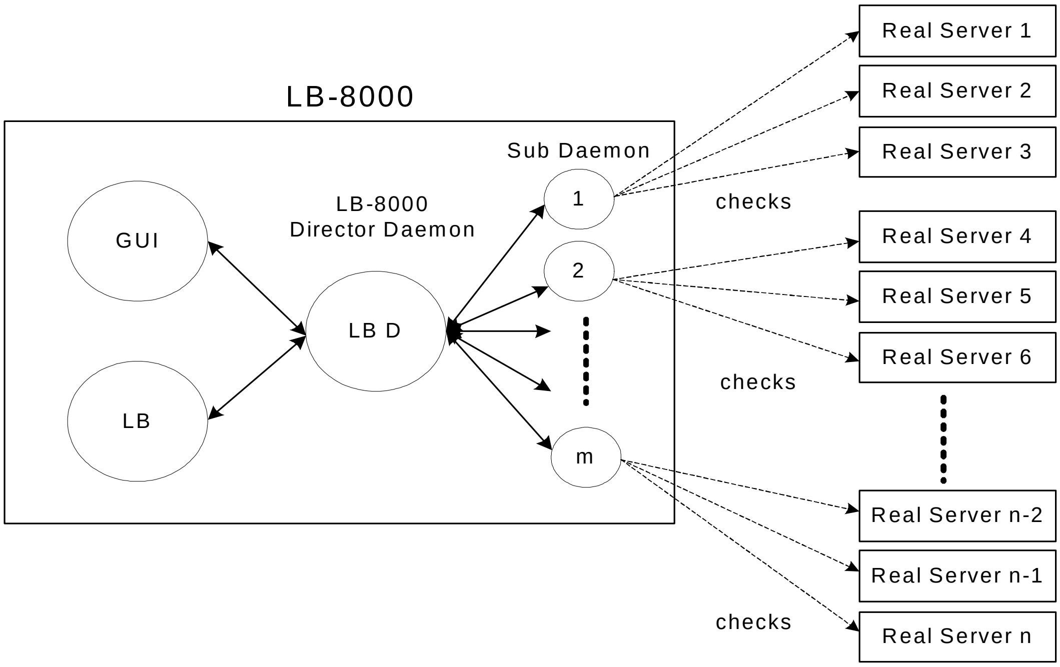
6. Health Check and Monitor of Real Server

In order to provide High Availability service, LB-8000 will check the health of realservers and the service that realservers provide. If you create a virtual server for HTTP or HTTPS service, LB-8000 also provides the way to check the content of web servers.

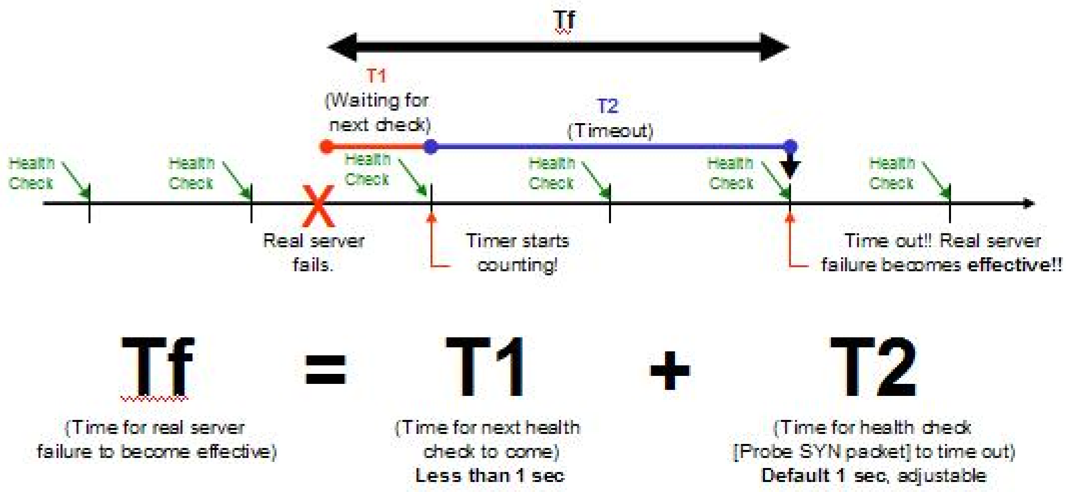
If LB-8000 finds a realserver that can't provide the required service, LB-8000 will remove this realserver from the forwarding table. Then there will be no requests to be forwarded to this realserver.

Note *The check interval is the same as heartbeat interval, and the default value is one second. That is to say LB-8000 will do the check every second.*

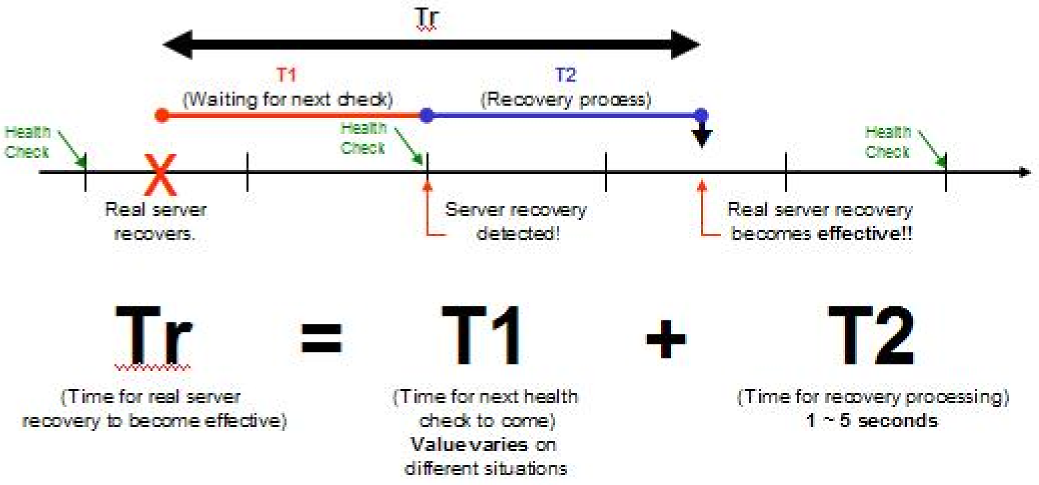
LB-8000 provides a module called "LB-8000 Director Daemon" to control the load balancer, system monitor, and health check. Besides, it mail alert and send SNMP trap when some thing wrong. In the new architecture, LB-8000 Director Daemon will fork up to 10 sub daemons, and averaged all real servers into several groups. Each sub daemon will check a group of real servers and then tell the LB-8000 Director Daemon about the status of each real server in the group. Sub daemon checks a real server at a time. LB-8000 Director Daemon checks all sub daemons at a time. The default number of sub daemons is ten, and it can be changed from the GUI or CLI. The health check interval is the same with heartbeat. So, the LB-8000 Director Daemon can avoided sending needless checks to real servers and shortens the time of failover.



Here is the time for server failure to take effective:


Tf
T1
(Waiting for next check)
T2
(Timeout)
Health Check
Health Check
Health Check
Health Check
Health Check
Health Check
Real server fails.
Timer starts counting!
Time out!! Real server failure becomes effective!!
Tf = T1 + T2
(Time for real server failure to become effective)
(Time for next health check to come)
Less than 1 sec
(Time for health check [Probe SYN packet] to time out)
Default 1 sec, adjustable

And here is the time for server recovery to take effective:


Tr
T1
(Waiting for next check)
T2
(Recovery process)
Health Check
Health Check
Health Check
Real server recovers.
Server recovery detected!
Real server recovery becomes effective!!
Tr = T1 + T2
(Time for real server recovery to become effective)
(Time for next health check to come)
Value varies on different situations
(Time for recovery processing)
1 ~ 5 seconds

LB-8000 provides 5 level of health check, includes:

- No health check
- L2 health check (ARP check)
- L3 health check (ICMP check)
- L4 health check (port check)
- L7 health check (content check)

When a real server is down, the sub daemon will only send ICMP check to detect the status of the real server. It will not send any content check or port check when the real server is down.

The following sections will describe these methods of health checking.

6.1. No Health Check

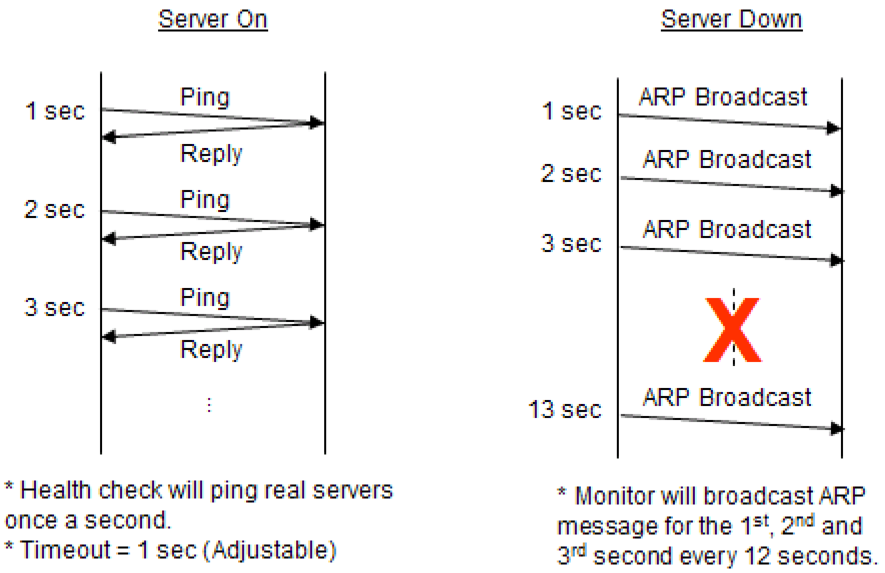
If we use the “none” (don’t check), LB-8000 will not send any packet to check the health of realservers.

6.2. L3 Health Check (ICMP Check)

LB-8000 uses the ICMP protocol, the “Ping” function, to monitor the realserver. If LB-8000 can’t receive the echo message returned from a realserver after a configured timeout, LB-8000 will generate an alarm message that will be sent to the pre-set email address(s).

But LB-8000 just monitors the realserver is alive or not, it won’t remove the realserver from the forwarding table if the realserver does not reply any echo messages.

Here is the packet flow when server is on or down:



* Health check will ping real servers once a second.
* Timeout = 1 sec (Adjustable)

* Monitor will broadcast ARP message for the 1st, 2nd and 3rd second every 12 seconds.

6.3. L4 Health Check (Port Check)

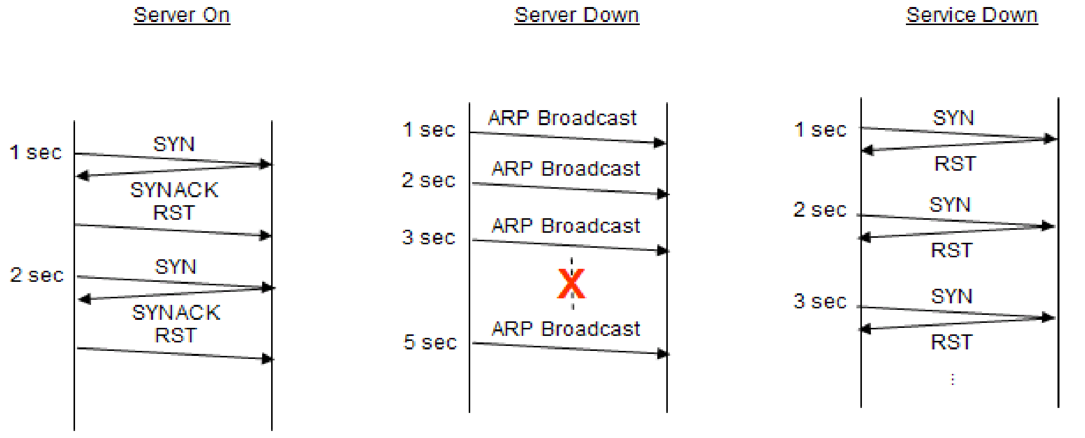
About the L4 health check (port check), LB-8000 used the method by opening a socket to check the service port. If LB-8000 can’t open the specified socket of realserver after a configured timeout, LB-8000 will think the service of realserver is down and remove this realserver from the forwarding table.

If the service type that you selected is RTSP, MMS, or FTP, the LB-8000 will only check the main port. The following table shows the default port of services that are provided on the LB-8000 management system to be checked:

Service Protocol	Port to be checked
FTP	21
SMTP	25
HTTP	80
POP3	110
IMAP	143
HTTPS	443
RTSP	554
MMS	1755

If you select the service protocol to be “other”, then LB-8000 will check the port that you specified. You also can modify the port number if you choose the service protocol from the drop-down menu on the LB-8000 management system, then LB-8000 will check the port that you specified and won’t check the default port of the protocol. For example, if you create a cluster service of HTTP, you can modify the service port of realserver from 80 to 8080, then LB-8000 will check the port 8080 not the default port 80.

Here is the packet flow when service is up or down:



Server On

Server Down

Service Down

* Timeout = 1 sec (adjustable, for SYN only)

* Health check will broadcast ARP message for the 1st, 2nd and 3rd second every 4 seconds.

* Health check will send SYN to real servers once a second.

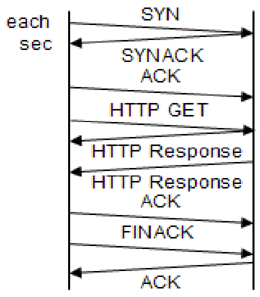
6.4. L7 Health Check (Content Check)

If your service type of cluster is HTTP or HTTPS, you also can check the content of specified web page. This is very useful when another server provides the content of web server. For example, it is from a database server.

After you specify the web page and the string to be checked, LB-8000 will issue a HTTP/GET command to get this web page, for example, “test.html”. And LB-8000 will try to find the string you specified is in this web page. If LB-8000 can’t find the string or can’t get this web page, LB-8000 will think the service is down. And remove this realserver from the forwarding table.

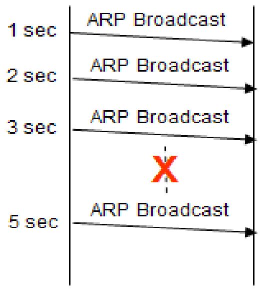
Here is the packet flow of L7 health check for HTTP protocol:

Server On



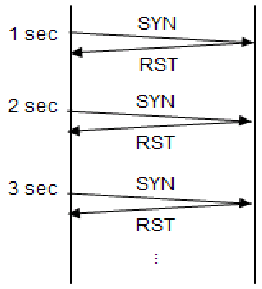
* Timeout = 1 sec (adjustable, for SYN only)

Server Down



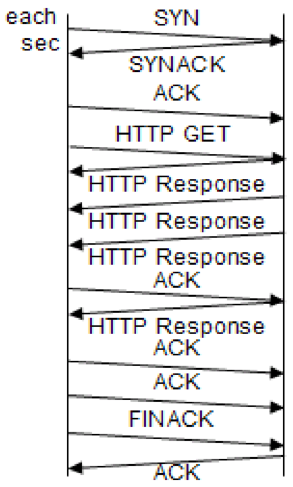
* Health check will broadcast ARP message for the 1st, 2nd and 3rd second every 4 seconds.

Service Down



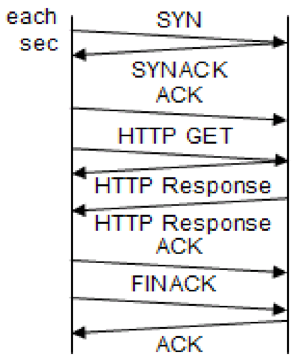
* Health check will send SYN to real servers once a second.

No checked page found



* Timeout = 1 sec (adjustable, for SYN only)

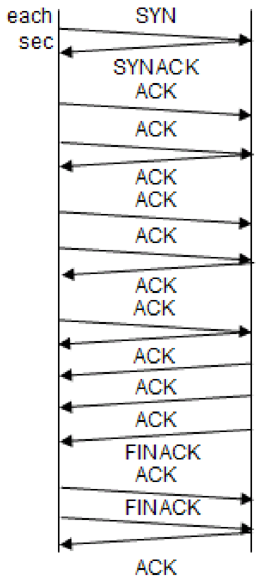
No keyword (pattern) found



* Timeout = 1 sec (adjustable, for SYN only)

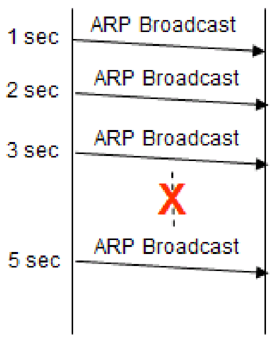
And here is the packet flow of L7 health check for HTTPS protocol:

Server On



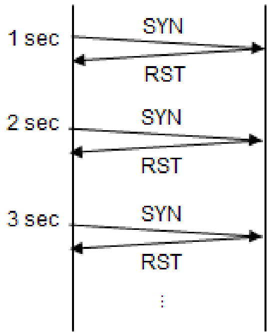
* Timeout = 1 sec (adjustable, for SYN only)

Server Down



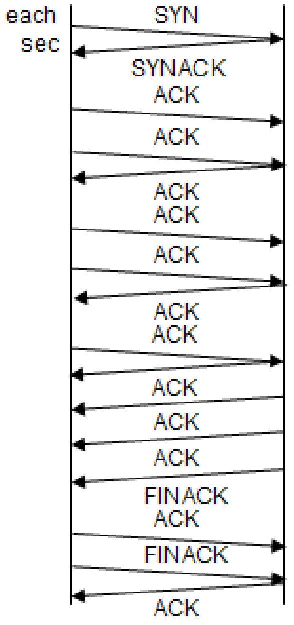
* Health check will broadcast ARP message for the 1st, 2nd and 3rd second every 4 seconds.

Service Down



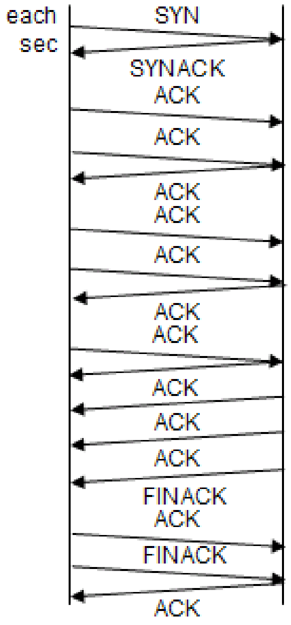
* Health check will send SYN to real servers once a second.

No checked page found



* Timeout = 1 sec (adjustable, for SYN only)

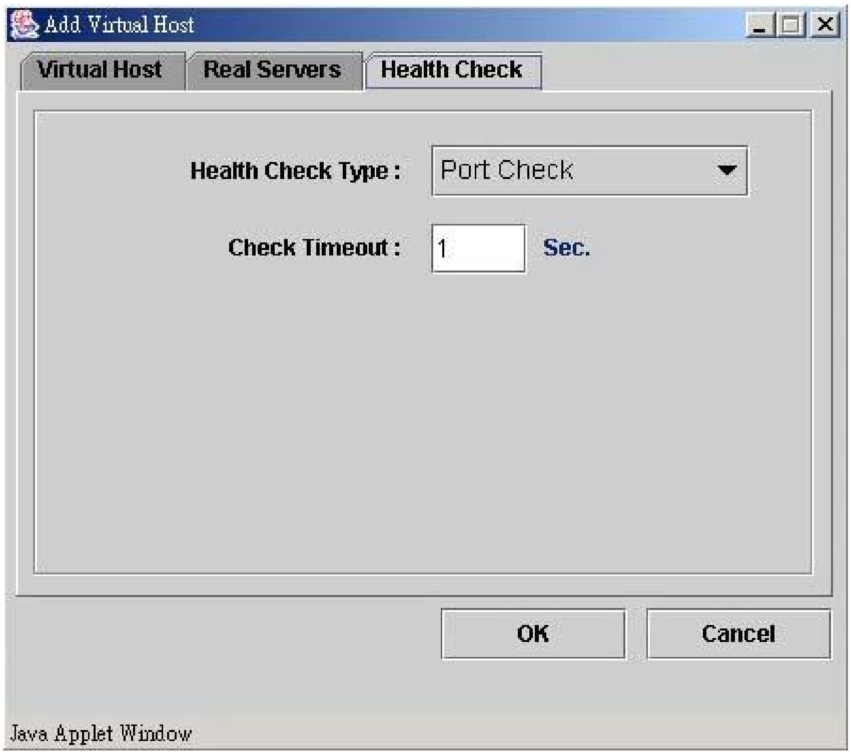
No keyword (pattern) found



* Timeout = 1 sec (adjustable, for SYN only)

6.5. How to configure the health check?

The default health check interval is one second. If you choose “content check”, you also need to define the check page and check pattern (please refer to *User Guide for LB-8000*). You also can define the check method when you issue “cluster” command on CLI. You can configure the health check interval from 1 to 99 seconds. Here is the sample screen of configuring the health check:



Health Check Type : Port Check

Check Timeout : 1 Sec.

Fig. 17 Configuring the health check

7. Persistence Connection

In the normal cluster system, each network connection is independent of every other connection, so that each connection can be assigned to a server independently of any past, present or future assignments. However, it will be required that two connections from the same client must be assigned to the same server either for functional or for performance reasons.

FTP is an example for a functional requirement for connection affinity. The client establishes two connections to the server: one is a control connection (port 21) to exchange command information, the other is a data connection (usually port 20) that transfer bulk data. For active FTP, the client informs the server the port that it listens to; the server from the server's port 20 and the client's port initiate the data connection. LB-8000 could examine the packet coming from clients for the port that client listens to, and create an entry in the hash table for the coming data connection. But for passive FTP, the server tells the clients which port it listens to; the client initiates the data connection connecting to that port. For the DR model and IP Tunneling model, it is impossible for LB-8000 to get the port from the packet that goes to the client directly.

SSL (Secure Socket Layer) is an example of a protocol that has connection affinity between a given client and a particular server. When an SSL connection is made, port 443 for secure Web servers, a key for the connection must be chosen and exchanged. After that all connections from the same client will use the same SSL key during the connection life span for data exchange.

7.1. Browser / Database / TCP/IP persistence

Persistent connection outside of LB-8000 is described in http persistent connection and is an application level protocol. Here the TCP/IP connection is kept open when there is a reasonable possibility of the client requesting more information. (Database persistent connection works in a similar way).

It works this way:

In a normal http (or database connection), after the server sent its reply, it shuts down the TCP/IP connection. This makes your session with the server stateless - the server has no record of previous packets/data/state sent to it. If the payload is small (e.g., 1 packet), then you've gone through a lot of handshakes and packet exchanges to deliver one packet. To solve this, http persistent connection was invented. Both the client and server must be persistence-enabled for this to work. At connect time, the client and server notify each other that they support persistent connection. The server uses an algorithm to determine when to drop the connection (timeout, needs to recover file handles...). The client can drop the connection at anytime without consulting the server. This requires more resources from the server, as file handles can be open for much longer than the time needed for a TCP/IP transfer.

7.2. LB-8000 persistence

LB-8000 persistence makes a client connect to the same realserver for *different* TCP/IP connections. The LB-8000 persistent connection is at the layer4 protocol level.

There are some situations that need to be considered before using the LB-8000 persistence (as explained below). It's useful when some state information must be maintained on the realserver, *e.g.,* for https key exchanges, where the session keys are held on the realserver and the client must always reconnect with that realserver to maintain the session.

The consequences of LB-8000 persistence are:

- A returning client will be sent to the same realserver on subsequent reconnection. The return must occur within a user defined timeout period otherwise the connection will be treated as a new (non-persistent) connection.
- LB-8000 provides the persistence on multiple ports services. When you configure a virtual server to use these services, you don’t need to configure the persistence. LB-8000 will forward the requests that come from the same client but different ports to a same realserver. These services are:
    - FTP service for NAT model.
    - Active FTP service for DR and IP Tunneling model
    - Port 554, 7070, 8080 and 6970 to 7170 for real-time streaming protocol
    - Port 1755 and 1024 to 5000 for Microsoft Media Server

In the following situation, you should enable the persistence:

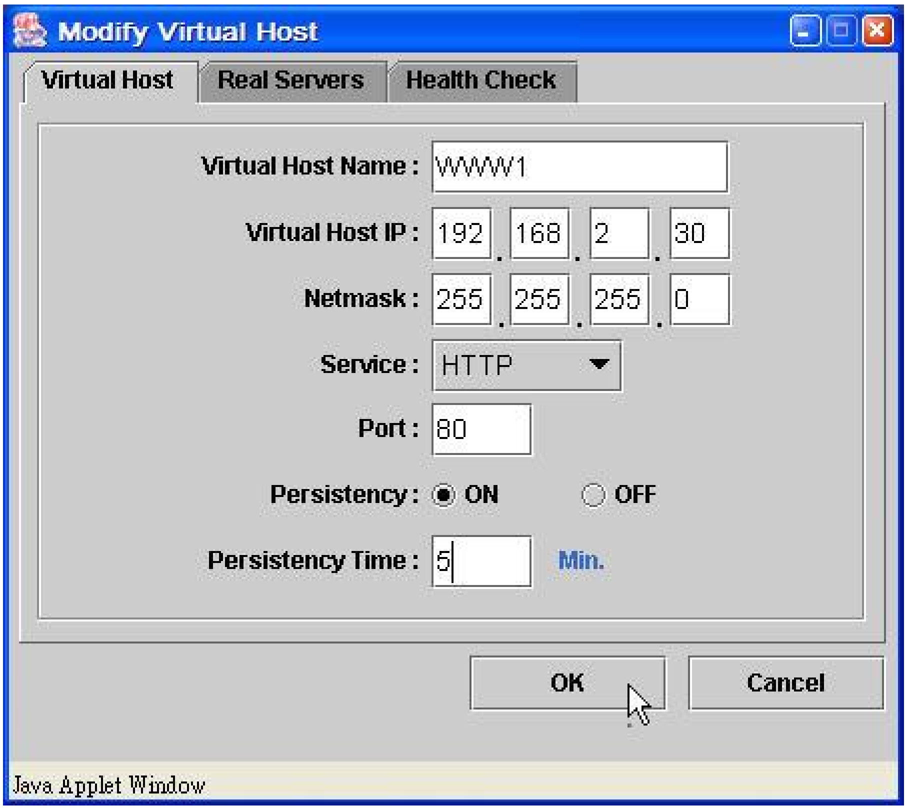
- Passive FTP service (port 21 and above 1024) for DR and IP Tunneling model.
- E-COM service (port 80 and 443) for all network models.

The working principle of persistence in LB-8000 is as follows:

- A persistent template is used to keep the persistence between the client and the server.
- When the first connection from a client, the LB-8000 will select a server according to the scheduling algorithm, and then create a persistent template with the connection entry. The control of the connection entry is the template.
- The later connections from the clients will be forwarded to the same server, as long as the template doesn't expire. The control of their connection entries is the template.
- If the template has its controlled connections, it won't expire.
- If the template has no controlled connections, it expires in its own timer.

7.3. How to configure the persistence?

You can configure the persistent time when you configure a cluster. The default value is none.



Virtual Host Name : WWW1

Virtual Host IP : 192 . 168 . 2 . 30

Netmask : 255 . 255 . 255 . 0

Service : HTTP

Port : 80

Persistency : ● ON ○ OFF

Persistency Time : 5 Min.

Fig. 18 Configuring the persistence

8. ARP Problem

In the DR model and IP Tunneling model, the Virtual IP (VIP) addresses are shared by both the LB-8000 and real servers, because they all configure the VIP address on one of their interfaces. In some configurations that real servers are on the same network from which the load balancer accepts request packets. If real servers answer ARP request for the VIP, there will be race condition for answering the request, no winner. Packets for the VIP may be sent to the load balancer at one time, to a real server at another time. Then everything will be in a mess, and the whole LB-8000 cluster won't work. Therefore, in the DR model and IP Tunneling model, we must guarantee that only the LB-8000 answers ARP request for the VIP to accept incoming packets for virtual service, and all the real servers (in the same network of LB-8000) won't answer ARP request for the VIP but can process packets destined for the VIP locally.

With DR and IP Tunneling model, all the machines (managers, realservers) in the cluster of LB-8000 have an extra IP, the VIP. In DR model, all machines and IPs are on the same physical network (*i.e.,* they are using the same link layer and can hear each other's broadcasts).

When the client requests a connection to the VIP, it must connect to the VIP on the LB-8000 and not the VIP on the realservers.

The LB-8000 acts as an IP router, accepting packets destined for the VIP and then sending the requested pockets to the desired realserver (where the real work is done and a reply is generated). When the client (or router) sends out the ARP request as "who has VIP, tell client", the client/router must receive the MAC address of the LB-8000 to work. After receiving the ARP reply, the client will send the connect request to the LB-8000. (The LB-8000 will update its connection tables to keep track of the connections and then forward the connect request packet to the chosen realserver).

If not, the client gets the MAC address of one of the realservers, then the packets will be sent directly to that realserver, bypassing the LB-8000. If the client's packets are consistently sent to the same realserver, then the client will have a normal session connected to that realserver. You can't count on this happening, the MAC address might change in the middle of a session and a new realserver will start getting packets for connections (the realserver will send tcp resets). If nothing is done to direct ARP requests for the VIP specifically to the LB-8000, then in some setups, one particular realserver's MAC address will be in the client/router's ARP table for the VIP and the client will only see one realserver. In other setups where the realservers are identical, the client will connect to different realservers each time the ARP cache times out. The client's connection will hang, as the new realserver will be presented with packets from an established connection that it knows nothing about. If the LB-8000 always gets its MAC address in the router ARP table, then the LB-8000 will work without any changes to the realservers, although this may not be a reliable solution for production.

Providing the MAC address of the LB-8000 (instead of the realservers) to the client when the client/router sends an ARP request is the key to solve the "ARP problem".

Currently, we know Microsoft Windows NT/2000 won’t send ARP through its loopback device, but if you use Linux as the realservers, you will face the ARP problem.

Several ways have been produced in order to solve the ARP problem. They involve either

- Stopping the realservers from replying to ARP requests for the VIP.
- Hiding the VIP on the realservers so that they don't see the ARP requests.
- Priming the client/router in front of the director with the correct MAC address for the VIP.
- Allowing the realserver to accept a packet with dest=VIP even though the realserver does not have a device with this IP (*i.e.,* the host has nothing to do with replying an ARP request).
- Stopping ARP requests for the VIP to the realservers.

8.1. Hidden interface on Linux based realserver

In order to hide the interface for ARP problem, we provide the following configuration instructions. (These instructions can be used under Linux Kernel R2.2.x, if you use Linux Kernel R2.4.x, then you should patch the kernel and recompile kernel to support hidden function, you can download the required patch from http://www.linux-vs.org/~julian/#hidden):

```
# Start the hiding interface functionality
echo 1 > /proc/sys/net/ipv4/conf/all/hidden
# Hide all addresses for this interface
echo 1 > /proc/sys/net/ipv4/conf/<interface_name>/hidden
```

Note that once an interface is set hidden, all the addresses of the interface are hidden from ARP broadcast and being included in the ARP response of other addresses. So, it is not good to configure VIP on the aliases of real Ethernet interfaces and make it hidden in the same time, unless you have an unused Ethernet interface.

For DR model, it is good to configure VIPs on the aliases of dummy or loopback device and hide the corresponding device. Then, you can configure as many VIPs as you want.

For IP Tunneling model, first you need to configure tunl0 device up, then configure VIPs on the aliases of tunnel/dummy/loopback device and hide that device. A configuration example is as follows:

```
# Insert the ipip module
insmod ipip
# Make the tunl0 device up
ifconfig tunl0 up
# Start the hiding interface functionality
echo 1 > /proc/sys/net/ipv4/conf/all/hidden
# Hide all addresses for this tunnel device
echo 1 > /proc/sys/net/ipv4/conf/tunl0/hidden
# Configure a VIP on an alias of tunnel device
ifconfig tunl0:0 <VIP> up
```

Note that configuring the tunl0 device up is to make the kernel decapsulate the received ipip packets correctly. Now, you can configure as many VIPs as you want for IP Tunneling model.

9. Log Management

9.1. Log messages

LB-8000 provides the following five types of log:

- System log: the event of system service up and down. Includes the following services:
  - Web server of LB-8000.
  - Cluster Management System daemon.
  - SNMP agent.
  - Sendmail service.
  - Static routing daemon.
  - PPTP (VPN) daemon.
  - PowerChute (APC UPS) network daemon.
  - NTP (Network Time Protocol) daemon.
  - DNS Proxy service.
  - IP forwarding service.
  - Network Interface.
  - Heartbeat daemon.
- Management log: the activities on cluster management system (CMS) and command line interface (CLI). Includes:
  - Login / logout event.
  - Configuration modification.
  - Reset, backup, restore, upgrade, reboot, shutdown event.
- HA log: the events of high availability. Includes:
  - The event of high availability service start / stop
  - The event of director daemon start / stop
  - The event of modifying the configuration files of cluster and realservers.
  - The event of enable / disable realservers and clusters.
- Connection log: the connection count and network flow on every hour.
- Alert log: the events of manager, realserver or service status. Includes:
  - The event of LB-8000 manager up and down.
  - The event of the network link of LB-8000 up and down.
  - The event of realservers up and down.
  - The event of the services of realservers up and down.

- The event of mailing out alert messages.

9.2. Mail Alert

LB-8000 will generate a mail alert by the configuration value of heartbeat:

- If LB-8000 detects a problem of network interface, system will generate a mail alert.
- If LB-8000 cannot receive the heartbeat message of other manager, system will generate a mail alert.
- If LB-8000 cannot get the response from realserver according to the health check after the timeout value, system will generate a mail alert too.

The administrator can configure the members of contact list to different clusters. For example, member A can be set to cluster WWW, and member B can be set to cluster FTP. So, if there is a problem with cluster WWW, system will send a mail alert to A, but won’t send to B.

LB-8000 has a default group named “@LB8000”, this group is used for receiving the mail alert about the event of LB-8000 manager, not for the clusters. By the way, all logs will be maintained for one month. If the log events are kept longer for one month, they will be mailed to the member of @LB8000 and then deleted.

If administrator configures the email address of emergency call, an alert email will be sent to the desired email address when an alert is generated. There are three types of information in this mail:

- Mail is generated from which manager.
- Which server or manager has problem.
- When the problem is happened.

Here is the sample mail:

System warning message from LB-8000 (lb8000p) !

The "WWW" application under server "192.168.20.33" is out of service.

Date : 2003/3/3 Time : 11:31:31

10. SNMP Support

LB-8000 supports SNMP function and provides the following functions:

- Provide an SNMP agent with a community string to allow access to LB-8000 SNMP information. And the SNMP agent can be disabled / enabled when needed.
- Provide a manager-IP list, from which LB-8000 SNMP agent can accept requests for SNMP information. The manager-IP list can be modified when needed.
- Provide Trap function to send trap to the desired manager(s) when there is an alert event. The trap messages are as the same as mail alert and alert log. The Trap function can be disabled / enabled when needed.

The SNMP agent in LB-8000 is based on Net-SNMP project.
(http://net-snmp.sourceforge.net/)

10.1. MIB

The version number of the SNMP agent in LB-8000 is v4.2. The agent in LB-8000 supports standard MIB-II files which includes:

- AGENTX-MIB: for the SNMP Agent Extensibility Protocol (AgentX). The master agent will implement this MIB module.
- DISMAN-SCHEDULE-MIB: defines a MIB which provides mechanisms to schedule SNMP set operations periodically or at specific points in time.
- DISMAN-SCRIPT-MIB: defines a set of objects that allow delegating management scripts to distributed managers.
- EtherLike-MIB: describes generic objects for Ethernet-like network interfaces.
- HCNUM-TC: containing textual conventions for high capacity data types.
- HOST-RESOURCES-MIB: for use in managing host systems. The term `host' is construed to mean any computer that communicates with other similar computers attached to the Internet and that is directly used by one or more human beings.
- HOST-RESOURCES-TYPES: registers type definitions for storage types, device types, and file system types.

- IANA-ADDRESS-FAMILY-NUMBERS-MIB: defines the AddressFamilyNumbers textual convention.
- IANA-LANGUAGE-MIB: registers object identifier values for well-known programming and scripting languages. Every language registration MUST describe the format used when transferring scripts written in this language.
- IANAifType-MIB: defines the IANAifType Textual Convention, and thus the enumerated values of the ifType object defined in MIB-II's ifTable.
- IF-INVERTED-STACK-MIB: provides the Inverted Stack Table for interface sub-layers.
- IF-MIB: describe generic objects for network interface sub-layers.
- INET-ADDRESS-MIB: defines textual conventions for representing Internet addresses. An Internet address can be an IPv4 address, an IPv6 address or a DNS domain name. This module also defines textual conventions for Internet port numbers, autonomous system numbers and the length of an Internet address prefix.
- IP-FORWARD-MIB: for the display of CIDR multi-path IP Routes.
- IP-MIB: for managing IP and ICMP implementations, but excluding their management of IP routes.
- IPV6-ICMP-MIB: for entities implementing the ICMPv6.
- IPV6-MIB: for entities implementing the IPv6 protocol.
- IPV6-TC: definition of textual conventions
- IPV6-TCP-MIB: for entities implementing TCP over IPv6.
- IPV6-UDP-MIB: for entities implementing UDP over IPv6.
- RFC-1215
- RFC1155-SMI
- RFC1213-MIB
- RMON-MIB: Remote Network Monitoring MIB
- SMUX-MIB
- SNMP-COMMUNITY-MIB: defines objects to help support coexistence between SNMPv1, SNMPv2c, and SNMPv3.
- SNMP-FRAMEWORK-MIB: The SNMP Management Architecture MIB
- SNMP-MPD-MIB: for Message Processing and Dispatching
- SNMP-NOTIFICATION-MIB: defines MIB objects which provide mechanisms to remotely configure the parameters used by an SNMP entity for the generation of notifications.
- SNMP-PROXY-MIB: defines MIB objects which provide mechanisms to remotely configure the parameters used by a proxy forwarding application.
- SNMP-TARGET-MIB: defines MIB objects which provide mechanisms to remotely configure the parameters used by an SNMP entity for the generation of SNMP messages.

- SNMP-USER-BASED-SM-MIB: The management information definitions for the SNMP User-based Security Model.
- SNMP-VIEW-BASED-ACM-MIB: The management information definitions for the View-based Access Control Model for SNMP.
- SNMPv2-MIB: for SNMP entities.
- SNMPv2-SMI
- SNMPv2-TC: definition of textual conventions
- SNMPv2-TM: for SNMP transport mappings.
- TCP-MIB: for managing TCP implementations.
- UCD-DEMO-MIB: The UCD-SNMP Demonstration MIB.
- UCD-DISKIO-MIB: defines objects for disk IO statistics.
- UCD-DLMOD-MIB: defines the MIB objects for dynamic loadable MIB modules.
- UCD-IPFWACC-MIB: defines MIB components for reading information from the accounting rules IP Firewall.
- UCD-SNMP-MIB: defines the private UCD SNMP MIB extensions
- UDP-MIB: for managing UDP implementations

LB-8000 also provides three MIBs for SNMP manager to retrieve the information and status of LB-8000:

- LB-MIB1: This is an enterprise MIB that contains specific information for properties associated with specific LB-8000 system functionalities. These information are:
  - The configuration of LB-8000 includes the version of LB-8000, timeout value of TCP state.
  - The information about cluster and realservers.
  - The statistics of connection and network flow.
- NOTIFICATION-LB-MIB1: This is an enterprise MIB that contains information about SNMP trap message.
- PLANET-MIB1

10.2. SNMP Monitor

In the web management system of LB-8000, you can monitor the following information of manager.

- CPU usage
- Memory usage

- Network flow

And if your realserver also have SNMP agent, you also can monitor the network flow information of realservers.

The default community string for SNMP is “public”. You can modify the community string from LB-8000 management system. LB-8000 also uses this community string “public” to gather the network flow information of realserver. So, if you want to monitor the network flow information of realserver, you should install a SNMP agent on realserver. And set the community string of SNMP agent of realserver to be the same as LB-8000, “public”.

If you modify the community string to be others, for example, “test”, the community string of SNMP agent on LB-8000 has been modified to be “test”. And you should also modify the community string of SNMP agent on realserver to be the same, “test”, string.

Here is the configuration file of SNMP agent on LB-8000:

```
#####################################################################
# snmpd.conf: An configuration file for ucd-snmp.
";
#####################################################################
# First, map the community name (COMMUNITY) into a security name
# (local and mynetwork, depending on where the request is coming
#       sec.name  source         community
com2sec local     localhost       public
com2sec mynetwork 192.168.2.0/24  public
com2sec mynetwork 192.168.3.0/24  public

# Second, map the security names into group names:
#           sec.model  sec.name
group MyRWGroup v1        local
group MyRWGroup v2c       local
group MyRWGroup usm       local
group MyROGroup v1        mynetwork
group MyROGroup v2c       mynetwork
group MyROGroup usm       mynetwork

# Third, create a view for us to let the groups have rights to:
#          incl/excl subtree                     mask
view all   included  .1                          80

# Finally, grant the 2 groups access to the 1 view with different
# write permissions:
#             context sec.model sec.level match  read   write  notif
access MyROGroup ""     any      noauth   exact  all   none    none
access MyRWGroup ""     any      noauth   exact  all   all     none
# -------------------------------------------------------------------
#####################################################################
# System contact information
# It is also possible to set the sysContact and sysLocation system
# variables through the snmpd.conf file:
```

```
syslocation Right here, right now.
syscontact Me <me@somewhere.org>
# -------------------------------------------------------------------
#  Make sure mountd is running
proc mountd
#  Make sure there are no more than 4 ntalkds running, but 0 is ok too.
proc ntalkd 4
#  Make sure at least one sendmail, but less than or equal to 10 are running.
proc sendmail 10 1
# -------------------------------------------------------------------
# a simple hello world
exec echotest /bin/echo hello world
# Check the / partition and make sure it contains at least 10 megs.
# -------------------------------------------------------------------
# Check for loads:
load 12 14 14
# -------------------------------------------------------------------
```

11. Manage Server Content

When user configures the LB-8000 with DR model or IP Tunneling model, there will be no problem when user wants to maintain the content of realserver. But if user configures the LB-8000 with NAT model, there will be some problems to maintain the content of realserver.

11.1. How to connect to realserver?

Consider the following simple NAT model:

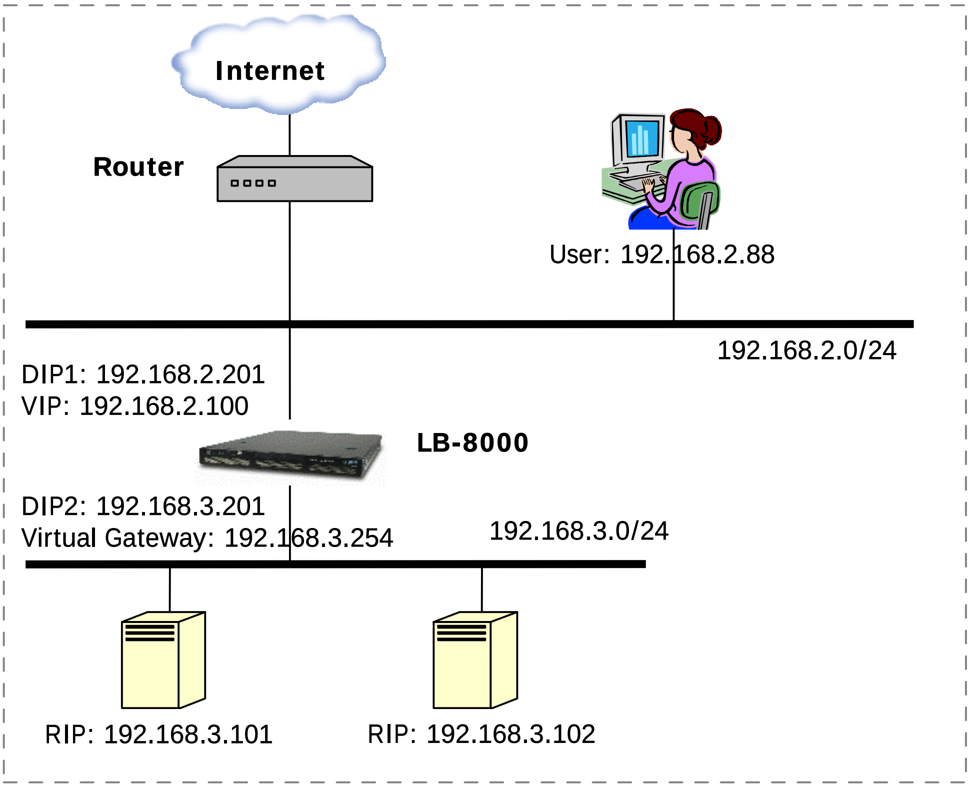


Fig. 19 Real Server content management

In this model, user has three methods to connect to the realservers:

(1) Client uses VIP as the default gateway. For example, the gateway IP of client has been set to 192.168.2.200. Then user can connect to realserver directly.

(2) Client uses the router as the default gateway. And there is a rule of static route that all packets will be forwarded to LB-8000. Then user will also be able to connect to

realserver.

(3) Client creates a VPN connection to LB-8000. This is useful for security concern. When client can connect to LB-8000 via a VPN, then user can connect to realserver.

11.2. Static Route

LB-8000 also provides the ability to add the rule of static route. For example, there is another network segment 192.168.4.0/24 that is directly connected to internal network segment 192.168.3.0/24 via a router. If user wants to connect to the database server that is located on the 192.168.4.0/24 segment, we can add a rule of static route on LB-8000. Then all packets with the destination IP as 192.168.4.100 will be send to LB-8000, LB-8000 will forward these packets to internal router and to the database server.

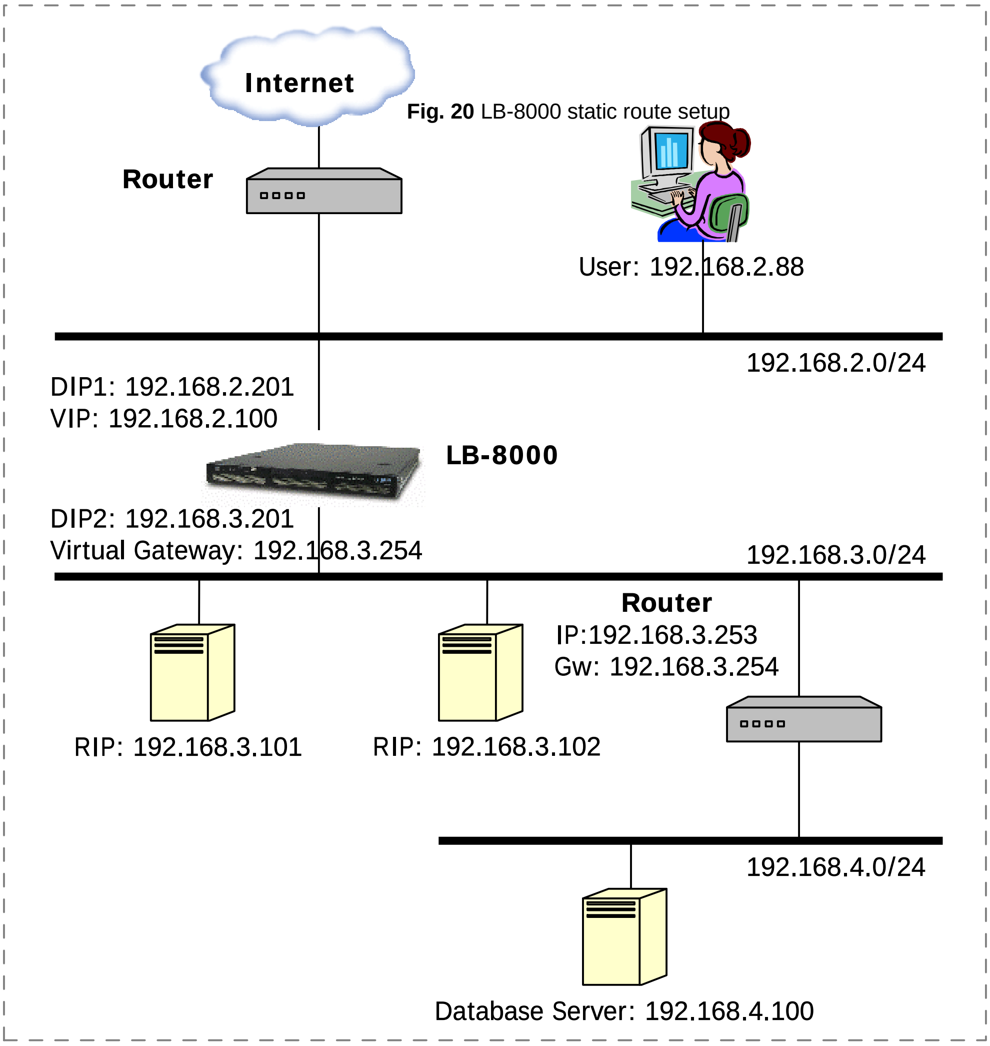
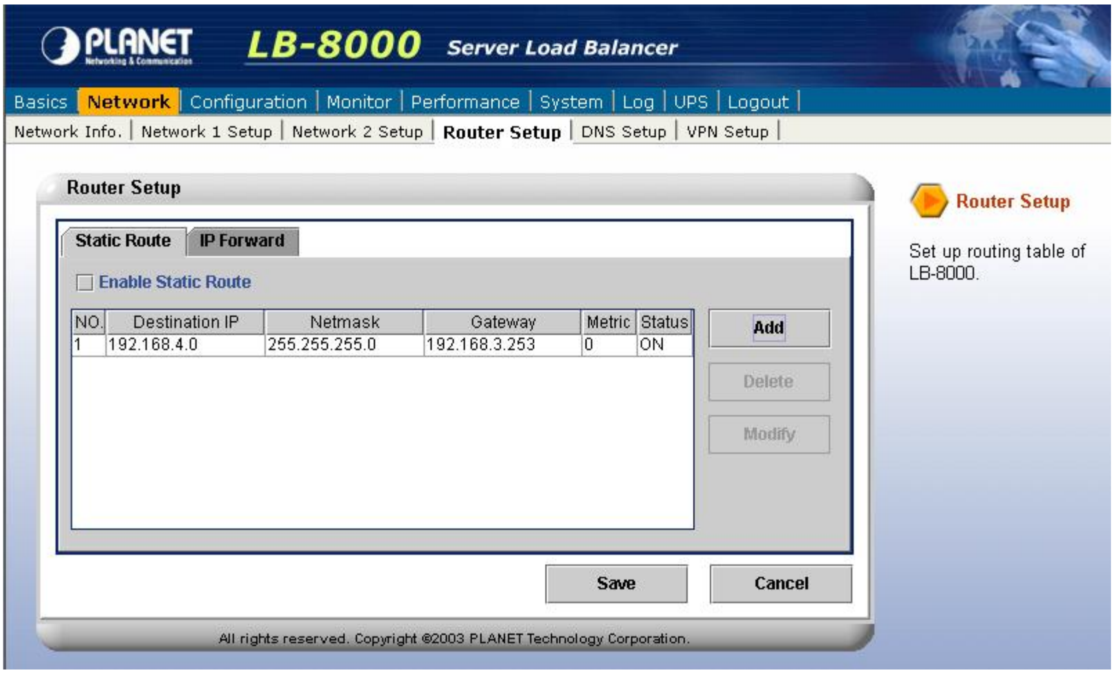


Fig. 20 LB-8000 static route setup

Here is the sample screen to add a new rule of static route.


PLANET Networking & Communication
LB-8000 Server Load Balancer
Basics | Network | Configuration | Monitor | Performance | System | Log | UPS | Logout
Network Info. | Network 1 Setup | Network 2 Setup | Router Setup | DNS Setup | VPN Setup
Router Setup
Static Route
IP Forward
Add
Delete
Modify
Save
Cancel
Router Setup
Set up routing table of LB-8000.
All rights reserved. Copyright ©2003 PLANET Technology Corporation.

□ Enable Static Route

NO.	Destination IP	Netmask	Gateway	Metric	Status
1	192.168.4.0	255.255.255.0	192.168.3.253	0	ON

Fig. 21 LB-8000 Router setup screen.

11.3. Inbound / Outbound Limitation

LB-8000 can enable / disable the network flow of inbound / outbound traffic. The default value is infinity. If internal server and outer client are all using LB-8000 as the gateway, then internal realservers can connect to outer client, and outer client can connect to internal realservers too. The administrator can disable the inbound or outbound traffic. This is useful for security concern. For example, if you don’t want outer client can connect to internal realserver directly, you can disable the inbound traffic, then outer clients will not be able to connect to internal realserver even if outer client use LB-8000 as the gateway.

11.4. NAT Router

LB-8000 also provides a NAT router function. If user enables the NAT router, then the clients can be located on internal network. And client can connect to outer network or Internet with no limitation. For example, the following diagram shows the NAT router and clients:

When you enable the NAT router, then clients can connect to Internet via LB-8000 as the gateway. And the IP address of any packet will be transfer from the client's IP (192.168.3.88) to the IP of LB-8000 (192.168.2.201)

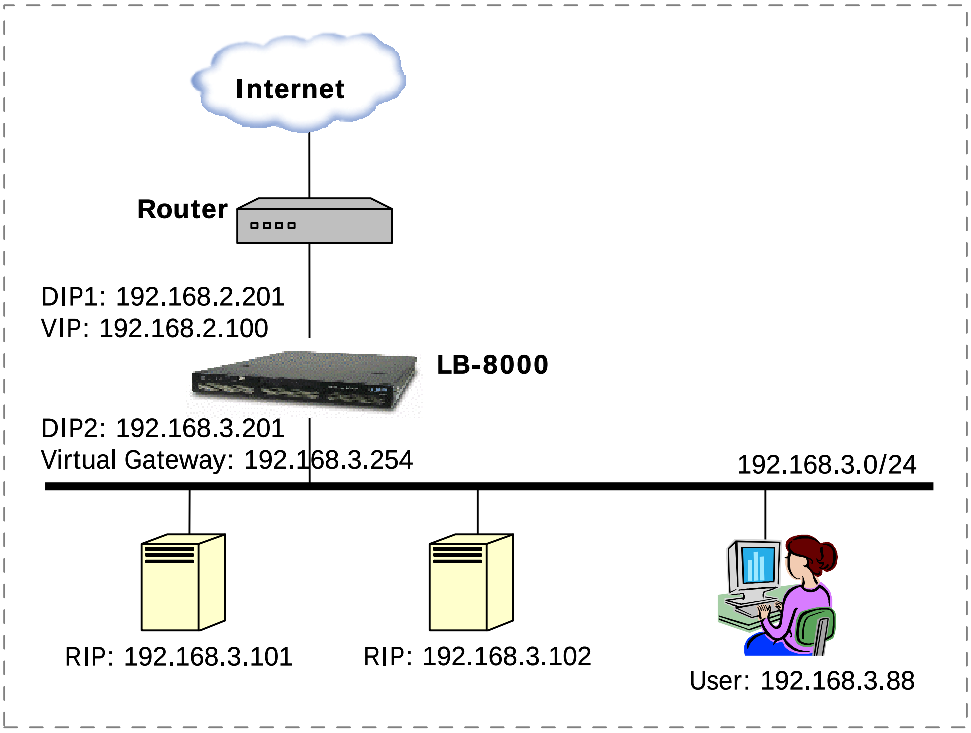


Fig. 22 LB-8000 as a NAT router