DHCPatriot Version 5.1.0 DHCPv6 Primer

DHCPv6 / IPv6 Support on the way!

Recently, the tech industry has been abuzz with news of the coming exhaustion of the IPv4 address space. The solution to this problem is a new version of address space called IPv6. With its new addressing structure it has the ability to greatly overwhelm IPv4 address volume. Over the next two to five years, network providers of all kinds will be implementing IPv6 on their equipment. First Network Group wants our customers to be prepared for this emerging technology.

Only a few network providers are using the IPv6 address space to any appreciable degree in production. RFC's are still being refined and written for several aspects of IPv6 technology as a whole. Part of this process is interoperability testing and debugging to allow the technology grow and solidify. To that end, the DHCPatriot system, in release 5.1.0, will support IPv6 addressing and DHCPv6 address assignment!

DHCPv6

For those that don't know: IPv6

IP version 4 (IPv4) addressing began in 1981 and since then has seen many subdivisions to expands its addressing capacity, however we are reaching the limit of this natural capacity. IPv4The IP addresses that we have come to know are about to run out. IPv4 has around 4 billion addresses. With the rapid expansion of the internet staring in the 1990s, the Internet Engineering Task Force (IETF) started to research and design a suitable replacement for what was then simply known as the "Internet Protocol" (IP). They (quite accurately) predicted that we would run out of IPv4 addresses sometime between 2010 and 2017. To combat the address exhaustion and bottle-necking that would occur, IP version 6 (IPv6), was created. It's basic form was completed, tested and available for production staring in 1999. IPv6 has 340,282,366,920,938,463,463,374,607,431,768,211,456 addresses. Let us compare the number of IPv4 vs. IPv6 addresses:

IPv4: 4,294,967,296 or 2^{32}
IPv6: 340,282,366,920,938,463,463,374,607,431,768,211,456 or 2^{128}

IPv4 was a 32 bit addressing scheme. IPv6 is a 128 bit addressing scheme. This creates an exponential increase in the number of IP addresses available. A real world comparison would be if the IPv4 addressing capacity was the size of a golf ball, then IPv6 addressing capacity would be the size of the entire planet.

It helps to understand that there is a fundamental philosophy change in IPv6. We no longer think in terms of a single address. We think in terms of subnets. And by subnet, we mean a single physical network to which hosts that can communicate directly with each other are connected. With both IPv4 and IPv6, a subnet is defined by a network prefix, which is the number of bits that define the network. In IPv4, common prefixes were /24,/25,/29, etc., and you normally had to specify a netmask to configure a device (255.255.255.0, 255.255.255.128, 255.255.255.248 for the previous prefix examples) We no longer need to specify netmasks for IPv6 networks (well, technically they still exist behind the scenes, but we won't need to express them that way). For instance, it is currently recommended that any single subnet anywhere should have a 64 bit prefix length. This would be written like this, for example: 2001:db8:0:0::/64 A host in such an subnet might be expressed like this, for example: 2001:db8:0:0::1/64. You would likely see this kind of notation directly on the interface when viewing interface information. A single 64 bit prefix length contains many more than the IP addresses of the entire IPv4 space (2^{64} vs. 2^{32}). We usually express these as powers of two as the numbers are so huge. If we were to write the numbers:

IPv4: 4,294,967,296 or 2^{32}
IPv6 (/64): 18,446,744,073,709,551,616 or 2^{64}

You might be tempted to think that we are going to run out of IPv6 addresses in a hurry if we setup each subnet as a /64. Currently, however, there are about 7 billion people on the earth. That is somewhat less than 2^{33} . There are 2^{64} /64 subnets in the IPv6 space. This means that we could give every man woman and child on the earth 2^{31} /64 subnets. So, each person on the earth could have approximately 2 billion subnets all to themselves before we ran out of IPv6 addresses. Current population projections have the world population growth leveling off around 9 billion. That is slightly more than 2^{33}. As you will learn later in the document, conventional wisdom states that we do use DHCP to award each household/business a /48 for use on the local network. There are 2^{48} (or 281,474,976,710,656) /48 subnets in the entire IPv6 space. That is still well beyond the expected 9 billion people on the planet and far beyond the number of households and businesses.

Here is a simple chart showing IPv6 size:

	Prefix	RPL	# of this prefix length in IPv6 space	# of addresses in this prefix length
/128	128	0	340,282,366,920,938,463,463,374,607,431,768,211,456	1
/96 (IPv4 space)	96	32	79,228,162,514,264,337,593,543,950,336	4,294,967,296
/64 (Subnet)	64	64	18,446,744,073,709,551,616	18,446,744,073,709,551,616
/48	48	80	281,474,976,710,656	1,208,925,819,614,629,174,706,176
/32	32	96	4,294,967,296	79,228,162,514,264,337,593,543,950,336
/16	16	112	65,536	5,192,296,858,534,827,628,530,496,329,220,096
/8	8	120	256	1,329,227,995,784,915,872,903,807,060,280,344,576
/4	4	124	16	21,267,647,932,558,653,966,460,912,964,485,513,216
/0	0	128	1	340,282,366,920,938,463,463,374,607,431,768,211,456
World Pop (2012) (est)			7,000,000,000	
World Pop (2050) (est)			9,000,000,000	
World ISP Count (est)			15,000	

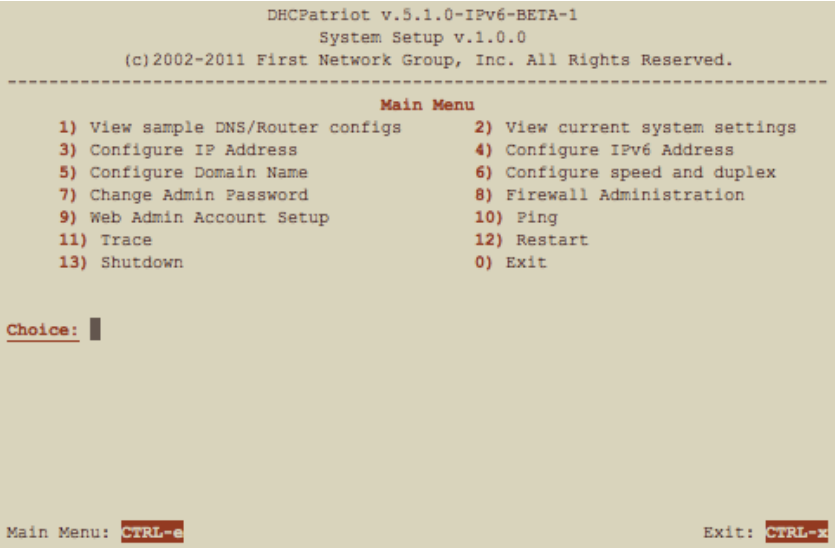
IPv6 and the DHCPatriot

In this new release (v5.1.0) the DHCPatriot devices will be able to be configured for IPv6 addressing. This will make a network operators job a little easier as the transition to IPv6 begins. As will be required during the transition to IPv6 in the foreseeable future, the DHCPatriot supports dual stacking so that it can be addressed at IPv4 and IPv6 at the same time! Full firewall support for IPv6 is integrated into the system as well.

Each relevant service now listens on the configured IPv6 addresses. Services like NTP, SSH and Web accept connections on the IPv6 address configured on each device.

Tools have been added to the administration interfaces for configuration of the DHCPatriot for IPv6 addresses and firewall protection in the IPv6 address space.

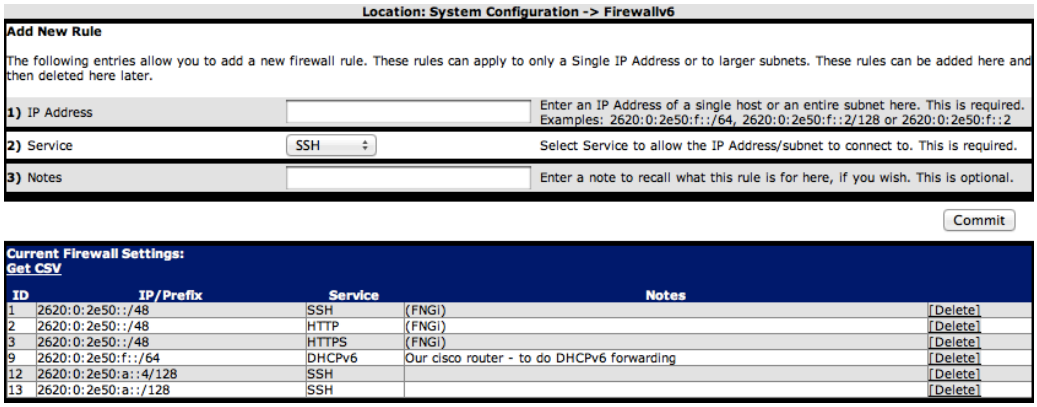
The Command Line Interface (CLI) menu has an additional choice called 'Configure IPv6 Address'. Accessing this option allows the specification of an IPv6 IP, Prefix length and Gateway address for the device. After configuration of the IPv6 address is completed, a reboot is required.



From the main CLI menu screen, press 4 to enter the IPv6 address assignment area. The current IPv6 network settings are shown here. Press 1 to proceed and configure the address. You will first be asked for the IP address, this should be entered as address/prefix length (ex: 2001:db8:0:0:1/64). Press enter to continue. Then the gateway will be requested. This must be an address in the same subnet as the IP address entered previously. Press enter to continue. A summary will then be shown asking if you would like to proceed. Press 1 and then enter to proceed. Then a reboot must be performed to complete the process and set the IP address. Return to the main menu (CTRL+x) and use option 12 to reboot.

IPv6, being a completely separate network stack, does require a completely separate set of firewall rules. To this end, we have added a new configuration area for allowing access to the DHCPatriot via IPv6 addressing. The IPv6 firewall, like the IPv4 firewall, is a white list firewall. All traffic not explicitly allowed is denied. The DHCPatriot system does automatically allow access to necessary services, such as DHCP, by clients in the configured networks on the system. All you have to worry about is allowing access to administrative services from administrative devices or subnets. This is easily done with the Firewallv6 area on the Web Administration Interface.

To configure the IPv6 firewall, open the Firewallv6 configuration by going to System Configuration -> Firewallv6. To add a rule, enter an IP address (or subnet in the form of 2001:db8:0:0::1/64), choose a service and add a note if desired. Click on Commit.



Location: System Configuration -> Firewallv6

Add New Rule

The following entries allow you to add a new firewall rule. These rules can apply to only a Single IP Address or to larger subnets. These rules can be added here and then deleted here later.

1) IP Address		Enter an IP Address of a single host or an entire subnet here. This is required. Examples: 2620:0:2e50:f::/64, 2620:0:2e50:f::2/128 or 2620:0:2e50:f::2
2) Service	SSH	Select Service to allow the IP Address/subnet to connect to. This is required.
3) Notes		Enter a note to recall what this rule is for here, if you wish. This is optional.

Commit

Current Firewall Settings:
Get CSV

ID	IP/Prefix	Service	Notes	
1	2620:0:2e50::/48	SSH	(FNGI)	[Delete]
2	2620:0:2e50::/48	HTTP	(FNGI)	[Delete]
3	2620:0:2e50::/48	HTTPS	(FNGI)	[Delete]
9	2620:0:2e50:f::/64	DHCPv6	Our cisco router - to do DHCPv6 forwarding	[Delete]
12	2620:0:2e50:a::4/128	SSH		[Delete]
13	2620:0:2e50:a::/128	SSH		[Delete]

A list of the current firewall rules are shown at the bottom. Clicking Delete on any of these rules will remove them from the DHCPatriot system. Either adding or deleting will affect both devices in the system, not just the device you are administering.

For those that don't know: DHCPv6

Most current clients that support IPv6 will have at least two modes of operation that can be set: manual and automatic. When set to automatic, clients will receive network information from the local router using a special procedure called Router Announcements (RA). This information includes the network prefix to use, the default gateway, and which method should be used to obtain or set an IP address on the client's connected interface.

At this point, the client has already established communication with the link local network. The link local network is a special network that each host becomes a part of just by having IPv6 enabled. Addresses are created based on the MAC address on the connected interface of machinery connected to the network. Systems on the network can communicate with each other via these addresses. The gateway for the client will normally be set to the router's link local address, although at this time, it varies by router manufacturer.

The router, if configured as such, will tell the client to get its address via DHCPv6. The client will then ask the DHCP server for an address via a special local multi-cast address (To simplify we will assume a local DHCP server). The DHCP server will give the client an address to use for a specified time range.

The client, if it needs to provide addresses to equipment connected to it on another interface (such as is the case with a customer home router), may also ask for a prefix delegation. Prefix delegation refers to assigning a network to be used by a router on the local subnet for connected devices on another subnet. This is necessary as Network Address Translation (NAT) is no longer available, or needed, in IPv6 and all equipment that needs Internet access must have a globally routable (in IPv4 language a "public") address. Please note that most customer equipment (and much of the carrier equipment) is not ready to deploy IPv6 at this time. As IPv6 fully matures over the coming years more devices will employ these capabilities.

DHCPv6 is currently the only method in IPv6 for providing such a delegated network.

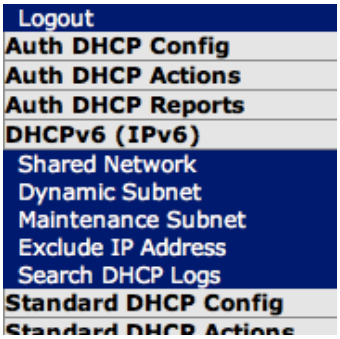
The current prevailing wisdom among network operators, regarding the size of the prefix that should be assigned to each, is to assign a /48 prefix length per end-user. This may sound like a lot. Indeed it is larger than the entire IPv4 address space which is 2^{32} IP addresses. A /48 is 2^{80} IP addresses. However, it is designed to provide for future expansion in the end-user's network. Current standards also state that any subnet on any network will be a /64.

And while all major computer operating systems have built-in support for IP addressing, consumer equipment has been slow to adopt firmware that supports most, if any, of the IPv6 constructs. Newly emerging consumer routers from manufacturers such as D-Link are able to receive the prefix delegation and select a /64 for use internally. It is expected that future consumer routers will have the capability, not only of maintaining several discreet /64 subnets, but also of aggregating subnets to other equipment in the household or business for various purposes. Each of these discreet internal subnets will also require a /64 and a beginning subnet, received via Prefix Delegation, of sufficient size so that the aggregation may occur.

In most cases an ISP will receive at least a /32 (a very small ISP - less than 4096 customers and less than 4 POPs). In a /32 there are 2^{16} /48 subnets. An ISP can split the /32 into 2^4 /36 subnets for use in their core network as well as in outlying pops. Each subnet would be of size /64. Each POP with customers would also need a /40, for example, for distribution of /48 subnets to customers. At most small ISPs this should be an entirely reasonable allocation policy. This model also scales as medium and large ISPs will receive appropriately larger allocations.

DHCPv6 and the DHCPatriot

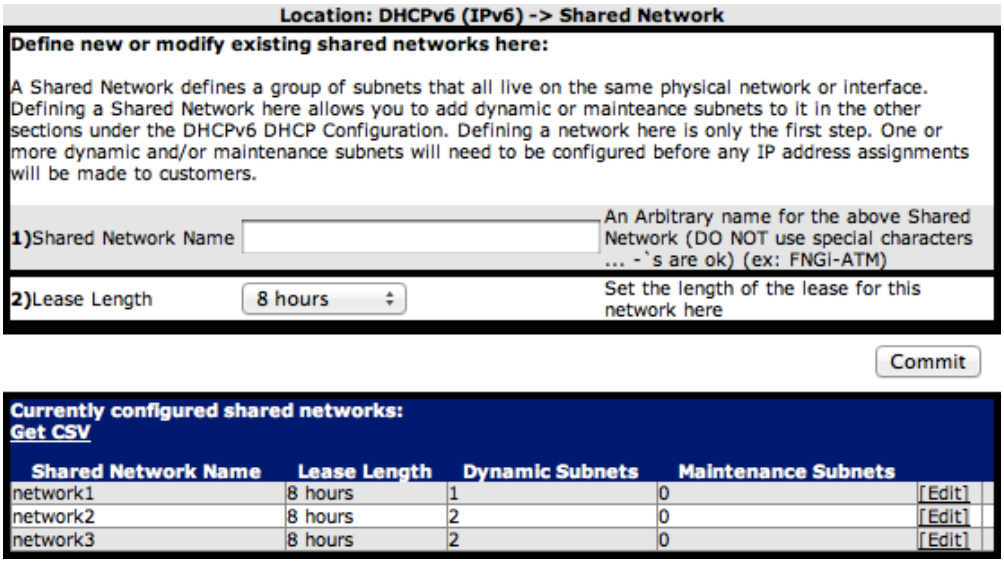
To help you begin getting your feet wet with IPv6 and DHCPv6 we have began supporting these constructs in this new version (v5.1.0) so you can begin testing the deployment within your networks.We at First Network Group wanted to, as quickly as possible, provide support for DHCPv6 so that our DHCPatriot customers could begin testing IPv6 deployment on their networks. To that end, in version 5.1.0, we have added support for DHCPv6.



The DHCPatriot system now supports DHCPv6 including Prefix Delegation. A new configuration menu called DHCPv6 (IPv6) has been added with several areas for configuring networks and subnets related to DHCPv6.

Currently DHCPv6 standards and the ISC DHCP server have some limitations which prevent the tracking of sessions and authentication. Customers taking advantage of the DHCPv6 features in the DHCPatriot system should do so with testing in mind, and understand that they may not want to do so on production networks. We are actively working and engaged in the community as the RFC's for these constructs are finalized and made ready for implementation.

When setting up a brand new DHCPv6 network on the DHCPatriot system, the first thing to do is to enter the Shared Network area under the DHCPv6 menu. A Shared Network is a container that will hold all of the subnets that exist together on a particular customer facing network. The name and lease length are set here.



Location: DHCPv6 (IPv6) -> Dynamic Subnet

Define new or modify existing DHCPv6 dynamic subnets here:

One or more DHCPv6 dynamic subnets may be configured for use with any DHCPv6 capable device.

1)Shared Network	Select One	Select the Shared Network that this DHCPv6 dynamic subnet will be a part of.
2)Subnet		Enter the dynamic subnet here. Example: 2620:0:2E50:E8::/64
3)Router		Enter the address of the router in the dynamic subnet. Example: 2620:0:2E50:E8::1
4)Prefix Delegation (optional)		Enter the Prefix Delegation subnet here (if any). Prefix Delegation is dynamic assignment of subnets to routers connected to the DHCPv6 network. Example: 2620:0:2e50:F000::/52
5)Delegation Size (optional/conditional)		Enter the size of prefix that should be delegated. This tells the DHCP server what size of prefix should be given to each router on the dynamic DHCPv6 network. If Prefix Delegation was entered, then this will need completed as well. Example: 56

Commit

Currently configured DHCPv6 subnets:
Get CSV

Shared Network	Subnet	Router	Prefix Delegation	Delegation Size	
network1	2620:0:2E50:E8::/64	2620:0:2E50:E8::1	2620:0:2e50:F000::/52	/56	[Edit][Delete]
network2	1234:0:0:0::/64	1234:0:0:0::1			[Edit][Delete]
network2	5678:0:0:0::/64	5678:0:0:0::1	ffff:0::/32	/48	[Edit][Delete]
network3	1492:0:0:0::/64	1492:0:0:0::1	cccc:0::/32	/48	[Edit][Delete]
network3	9101:0:0:0::/64	9101:0:0:0::1	aaaa:0::/32	/48	[Edit][Delete]

A DHCPv6 network would not be much without a subnet of addresses that is to be handed out to customers dynamically. After creating a Shared Network, the next step is to add a dynamic subnet via the Dynamic Subnet sub menu. All that is required here is to choose the Shared Network that the subnet should belong to and a subnet declaration and the router address in that subnet. Optionally, a prefix delegation may be specified here. The DHCPatriot system will take care of the rest allocating ranges etc. It is recommended that the subnet have a 64 bit prefix length and that the delegated prefix (Delegation Size on the form) be of 48 bit length, although any values will work. Press commit and you are done.

Sometimes the relay agent that is forwarding the DHCP packets to the DHCPatriot may not be in the same subnet as the dynamic subnet that was specified previously. If this is the case, what we call a maintenance subnet may be specified. The Maintenance Subnet area under the DHCPv6 menu is provided for this purpose. Simply choose the Shared Network that the Maintenance Subnet should belong to. Type the maintenance subnet and press commit.

Location: DHCPv6 (IPv6) -> Maintenance Subnet

Define new or modify existing DHCPv6 maintenance subnets here:

One or more DHCPv6 maintenance subnets are necessary if devices that should be providing addresses out of a certain shared network source traffic, such as relayed DHCP, from a different subnet that is not part of this shared network. For example, if a router has a primary IP address in a subnet that is not covered here as a dynmaic subnet that is part of this shared network, then the subnet would be added here as a maintenance subnet. This tells the DHCPatriot that the subnet belongs with this shared network. Otherwise, the DHCPatriot would not know what shared network it belonged with. Add or edit the DHCPv6 maintenance subnet for the chosen network below.

1)Shared Network	Select One	Select the Shared Network that this DHCPv6 maintenance subnet will be a part of.
2)Subnet		Enter the DHCPv6 maintenance subnet here. For example: 2620:0:2E50:ffff::/64

Commit

Currently configured DHCPv6 maintenance subnets:
Get CSV

Shared Network	Subnet		
network3	8765:0:0:0::/64	[Edit]	[Delete]

Location: DHCPv6 (IPv6) -> Exclude IP Address

Add new excluded IP addresses here:

An excluded IP address means that the IP address will not be handed out dynamically.

1)Exclude IP Address		Enter the IP address to be excluded.
2)Note (optional)		Enter a description if desired.

Commit

Currently configured excluded IP addresses:
Get CSV

IP Address	Note	
2620:0:2e50:e8::35		[Delete]

From time to time, it may be necessary to stop a certain IP address from being allocated to a client. This could be necessary due to an address conflict, placement of an administrative device in the subnet that is normally all dynamically assigned via DHCPv6, or simply because you need a client to vacate a certain IP address for other purposes. The DHCPatriot supports excluding an IP address from being assigned dynamically. Enter the Exclude IP

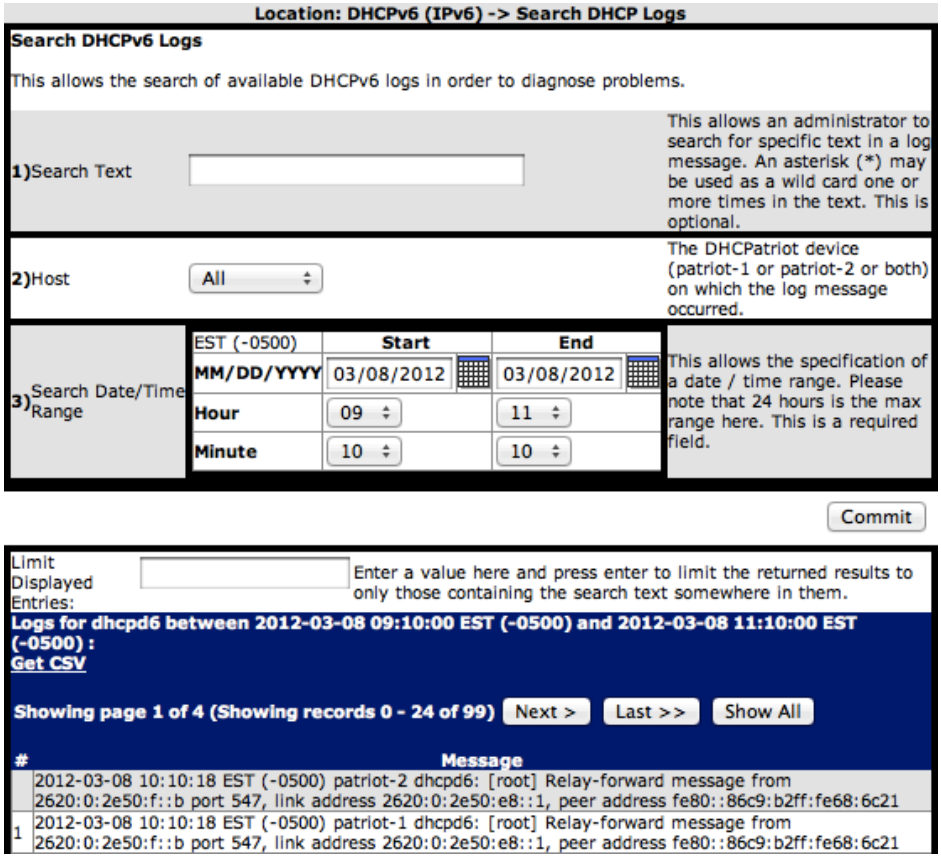
Address area under the DHCPv6 menu. Type the address that you wish to exclude. Add a note if desired and press commit. This address will then be excluded from dynamic assignment.

DHCPv6 has a completely different logging structure at the present time. The logs are not nearly as verbose as they were in DHCPv4.

```
Mar  8 21:06:47 patriot-2 dhcpd: Relay-forward message from 2001:db8:0:f::b port 547,
link address 2001:db8:0:e8::1, peer address fe80::250:daff:fecf:ff7f
Mar  8 21:06:47 patriot-2 dhcpd: Picking pool address 2001:db8:0:e8:ffff:ffff:ffff:fffe
Mar  8 21:06:47 patriot-2 dhcpd: Sending Relay-reply to 2001:db8:0:f::b port 547
```

Exchanges, such as this one above, can be useful for noting that there was a DHCPv6 exchange involving a certain relay agent but may not always be useful for diagnosing a particular client's problems. As DHCPv6 is finalized we are pursing options to address these issues.

The DHCPatriot system provides access to these logs now. To access these logs, enter the Search DHCP Logs area under the DHCPv6 menu. Time period, host and text to search are all available parameters to perform the search. Results are displayed at the bottom in reverse chronological order.



Summary

Version 5.1.0 allows you to take the first step forward into the world of IPv6 and DHCPv6 with the DHCPatriot. Supporting IPv6 and in particular DHCPv6 will help our customers continue to evolve their service offering in the future. This important first step in that journey will let customers begin testing IPv6 deployments for future planning right now.

Configuring IPv6 addresses is easily done on the DHCPatriot using the CLI menu interface. This allows immediate placement of the DHCPatriot in the core network's IPv6 address space. This also allows management of the DHCPatriot

system via the IPv6 addresses configured. The commercial grade firewall on the DHCPatriot is available for all IPv6 work. This full white-list firewall is configurable via the web administration interface.

What would IPv6 support bring to the DHCPatriot system without DHCPv6 support? To that end, support for DHCPv6 has been integrated into the system. Several configuration areas have been added to the DHCPatriot for configuring DHCPv6. Please note that DHCPv6 as well as areas of IPv6 in general have not been standardized and finalized and some of these interfaces may change as the industry approaches full IPv6 and DHCPv6 standard completion.

We hope to support many ISPs in their IPv6 rollout efforts with version 5.1.0 of the DHCPatriot software. Contact First Network Group today (800-578-6381 opt. 3) for further information!

Full Patch Notes

Version 5.1.0 introduced the following:
Release Month-Year:

1. Due to overwhelming public outcry, it is now possible to Search Sessions (Authenticated and Standard) for longer than 24 hour time periods IF a username or MAC address is supplied.
2. Back by popular demand. User devices can now be authenticated with either the MAC address or the current unauthenticated IP address.
3. A description of why API calls fail is now displayed two lines down from the RETURN=# line.
4. Leases can now only be updated once per second. Some clients in the past have sent lease updates at a much higher rate than once per second. Subsequent messages in the same second are now ignored.
5. Clicking 'Show All' on the search results will now show all results at once instead of 25 results per page.
6. Static IPs previously didn't work with built-in authentication. This has been repaired.
7. Menu text size has been increased as some were having trouble clicking on the correct items.
8. Default DNS and time servers (for the DHCPatriot device use, not the customer's) are now set to some dedicated devices at FNGi offices. Previously, we were attempting to use the DNS and time servers that are for internal office use. This did not work well outside of our network. In most cases, this shouldn't have ever been an issue unless the local ISP did not have DNS servers that the DHCPatriot could access.
9. The DHCPatriot system now runs ISC DHCP 4.2.3-p1
10. Some extra log messages regarding RADIUS attributes received have been suppressed.
11. IPv6/DHCPv6 support has been added to the DHCPatriot. At this point it should be used for testing only, and not actual customers. There are some crashing issues with the DHCPv6 server as well as no way to do authentication presently due to weakness in the protocol that should be addressed by the IETF soon. Also, sessions cannot yet be tracked due to features that have not yet been implemented in ISC DHCP.
    1. A DHCPv6 server (ISC DHCP 4.2.3-p1) now listens for DHCPv6 requests on port 547 (the default DHCP server port).
    2. Daemons for the control and log capturing of the DHCPv6 server have been added.
    3. A front end configuration mechanism has been added to the web administration interface.
        1. A new menu has been added to the web administration interface called DHCPv6 (IPv6).
        2. A Shared Network configuration area was added in the DHCPv6 (IPv6) menu.
        3. A Dynamic Subnet configuration area was added in the DHCPv6 (IPv6) menu.
        4. A Maintenance Subnet configuration area was added in the DHCPv6 (IPv6) menu.
        5. An Exclude IP Address configuration area was added in the DHCPv6 (IPv6) menu.
        6. DHCPv6 specific logs can be searched in the Search DHCP Logs area in the DHCPv6 (IPv6) menu.
    4. System Configuration->General settings on the web administration interface now includes options for adding primary, secondary and tertiary DNS servers at IPv6 addresses.
    5. System Configuration->Firewallv6 on the web administration interface allows the addition of IPs or subnets that may access the DHCPatriot's services via IPv6.
    6. The CLI menu now has an option to configure an IPv6 address on the DHCPatriot devices. Each device must be configured individually the same as with IPv4 addresses.
    7. The default IPv6 configuration on the DHCPatriot is fd2b:c9ec:250a::/64 patriot-1 is at fd2b:c9ec:250a::fff1, patriot-2 is at fd2b:c9ec:250a::fff2. The default gateway expected is fd2b:c9ec:250a::aaa1. This can be used to configure the DHCPatriot initially, if desired.
    8. All relevant services now listen on the IPv6 addresses as well as the IPv4 addresses. DHCPv6 only listens on the IPv6 addresses as it is not able to listen on IPv4 addresses as per the protocol specification.

How to Buy

The DHCPatriot may be purchased direct, or through one of our reseller partners. If purchased direct, no discount from MSRP will be available.

To purchase through a reseller, please contact your reseller of choice. For a current list of resellers, with contact information, please visit https://www.dhcpatriot.com, email DHCPatriot@network1.net or call 800-578-6381 x7 (419-739-9240 if outside the United States of America) with your request.

To purchase direct or receive pre-sale support, please use the following contact information:

DHCPatriot@network1.net

800-578-6381 opt. 3 (419-739-9240 opt. 3 if outside the United States of America)

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