

The Coming of IPv6

(taking longer than we thought...)

Christopher Miller
MacAdmins Conference
2013

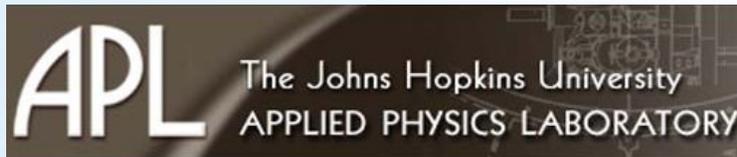
To Be Covered

*What's to be covered?

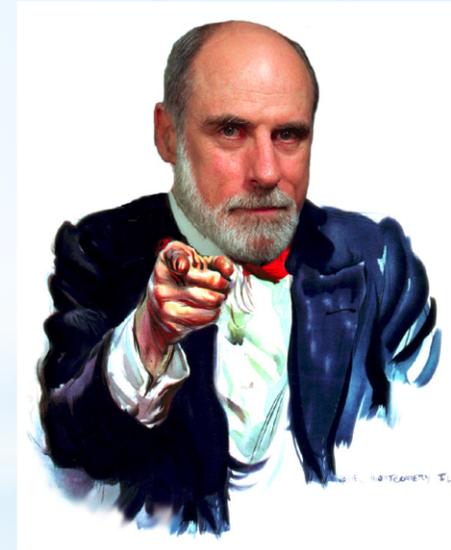
- * A Little history on IPv4 and IPv6
- * How the protocols are alike and different
- * Where can and can't you use IPv6 today
- * How the transition will likely proceed
- * Whose making the shift now and whose falling behind
- * A quick, easy method for getting IPv6 working, now, @home and on your stuff!

Introductions

- * Hello, I've been a Mac Dude and geek for 20+ years.
- * Originally from Lancaster County PA, now living near Baltimore in Towson MD.
- * Work for Johns Hopkins University, Applied Physics Lab in Laurel, MD as part of the Mac team and special guru.



* “If you do just one thing after leaving here, ask your ISP what their IPv6 rollout plans are...let them know that you're interested.” -Vint Cerf



**I WANT YOU
TO USE IPv6**

A great little Analogy

(courtesy of Uncle Buck)



←- No, not this guy!

This Guy ->
Former Aerospace
Engineer at NASA



* ...A long time ago. Phones used a simpler number system (Towson3-2181)

* Then Prefixes and party lines came about (371-2181)

* Now we're using Area-Prefix-Home (410-371-2181)
What's next ???



The History of IPv4

(in the beginning)

- * Developed in the late 1970's as TCP,IP, FTP, etc.
- * 19830101- Ronald Reagan and the death of Network Control Protocol (switched in ONE day) on <1000 hosts.
- * Created for potential of 4.3 billion hosts, as something of an experimental test protocol. That's right a test...



- 1991 - The WWW is developed at CERN, Europe
- 1992 - Hosts number >1 million
- 1994 - Internet begins explosive growth, no more free registration...

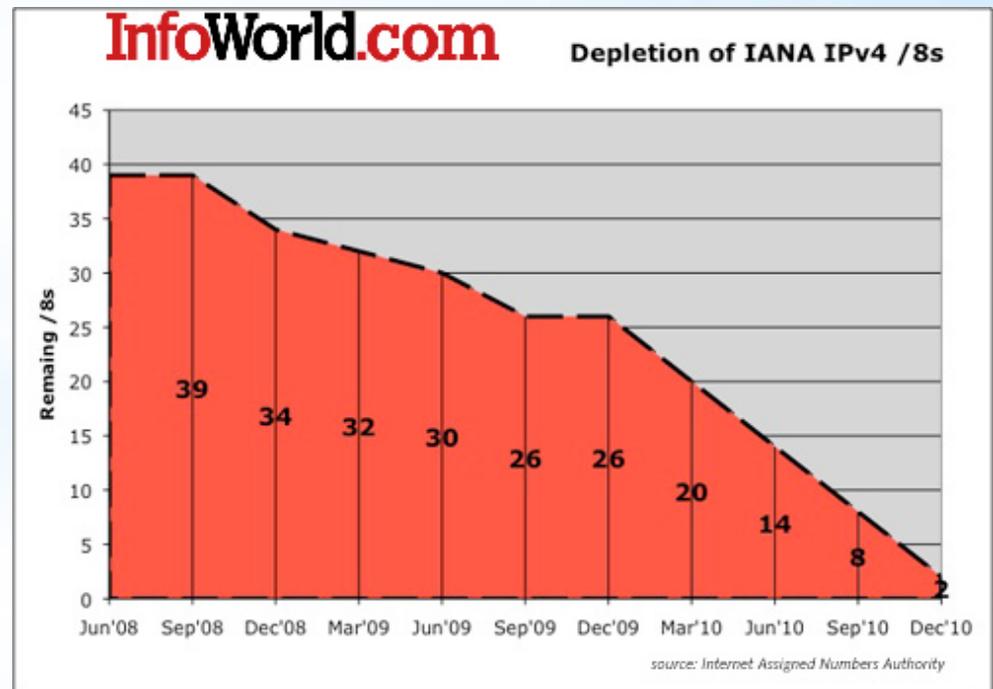


The History of IPv4

(it's been great, but it's also over)

- * 1994 - Prediction of IPv4 exhaustion between 2005~2011, recommendation for successor
- * 1990's - birth of .com bubble and online commerce
- * 2000's - explosion of personal phones and connections needed
- * 2000's cont'd - Web, Email and Social media drives billions onto an online presence
- * 20110201 - The last block of IPv4 addresses is registered

:_(



The History of IPv6

(a minimal timeline)

- * 1994 - Need for evolution of TCP/IP recognized
- * 1995 - Publication of IPv6 proposal is first documented and work begins to standardize.
- * 19980810 - The core set of IPv6 protocol is accepted by the Internet Engineering Task Force (IETF)
- * ...and support, implementation and migration for most vendors languishes.

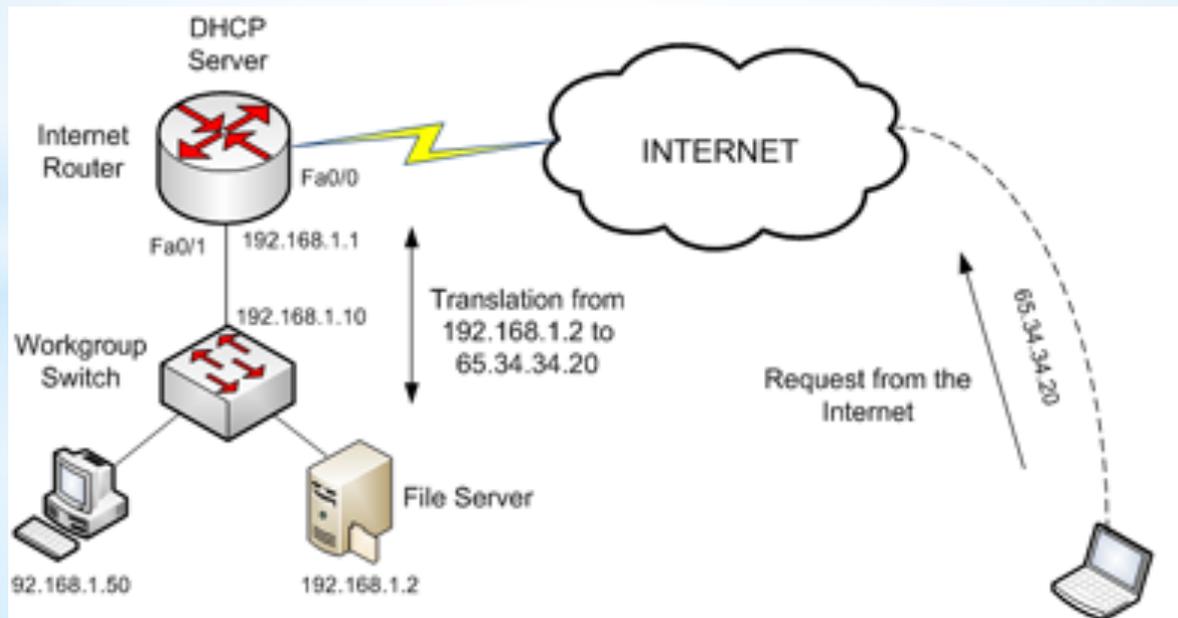
~~~~~

- \* 2003 - US Government mandate for IPv6 Backbone
- \* Mid-2000's - Holy Cow we're running out of numbers!

# How IPv4 Works

(a typical example)

- A system comes online and requests an IP# (DHCP)
- A DHCP/DNS server responds and hands out a leased address
- The address is decimal allocated and limited to  $2^{32}$   
a routine example {128.183.144.123}
- ~4.3 billion theoretical addresses, not likely
- IPv4 relies heavily on NAT and Network Classes: A,B,C

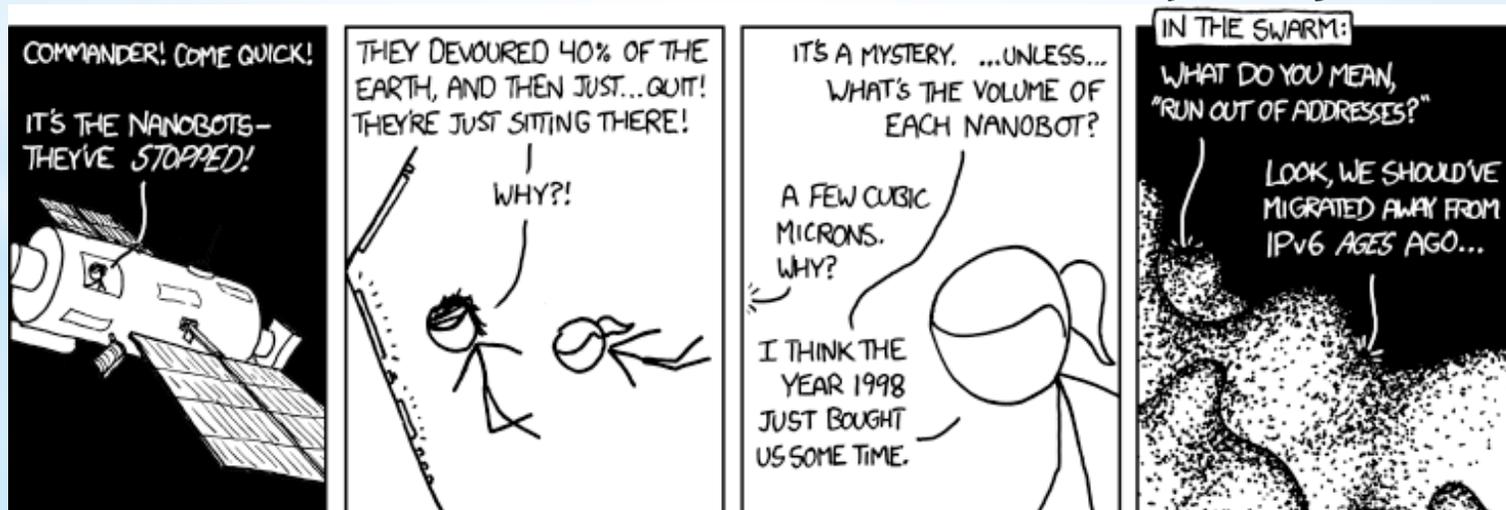


# How IPv6 works

(a minimal approach)

- A system comes online and requests configuration info
- A (RADVD) “Router ADvertisement Daemon” server responds and provides network info, the client uses this info and its MAC address to generate its own Hexadecimal IP#.
- Because the # is completely unique a clear path is made.
- IPv6 is classless, needs no NAT and makes  $2^{128}$  addresses

That's 3.4 undecillion or  $3.4 \times 10^{36}$ , human body has just  $10^{14}$



# Why is this any better?

(several reasons actually)

- \* Did we mention the number of numbers?
- \* 128-bit packets vs. 32-bit lengths (speed)
- \* Greatly reduced latency (clear host paths)
- \* IPsec built-in to protocol (encrypted datagrams)
- \* Supported standard and gaining more adoption
- \* Better world communications (Asia, Europe)
- \* Suited for future uses (VOIP)(Video)



# So, what's an IPv6 # look like?

Glad you asked

Perfectly valid versions of the same address:

2001:3a16:0000:0000:0000:001f:5b3e:8d10

2001:3a16:0:0:0:01f:5b3e:8d10 (reduction of zeros)

2001:3a16::1f:5b3e:8d10 (collapsing of zeros)

The image shows a Windows Network Connections window for an Ethernet adapter. The IPv4 settings are configured to use DHCP, with an IP address of 192.168.1.104, subnet mask 255.255.254.0, and router 192.168.1.1. The IPv6 settings are configured to be automatic, with an IPv6 address of 2001:0470:0008:0c62:0203:93ff:fe53:e740 and a prefix length of 64. The router for IPv6 is fe80:0000:0000:0000:021c:10ff:fe49:ce13. A 'Renew DHCP Lease' button is visible next to the IPv4 settings.

Overlaid on the bottom right is a command prompt window titled 'C:\WINDOWS\system32\cmd.exe'. It displays the following output:

```
Ethernet adapter Local Area Connection:  
Connection-specific DNS Suffix . :  
IP Address . . . . . : 192.168.1.120  
Subnet Mask . . . . . : 255.255.254.0  
IP Address . . . . . : 2001:470:8:c62:6087:b94c:a4ba:2045  
IP Address . . . . . : 2001:470:8:c62:2b0:d0ff:fe3e:d038  
IP Address . . . . . : fe80::2b0:d0ff:fe3e:d038%4  
Default Gateway . . . . . : 192.168.1.1  
fe80::21c:10ff:fe49:ce13%4  
  
Tunnel adapter Teredo Tunneling Pseudo-Interface:  
Connection-specific DNS Suffix . :  
IP Address . . . . . : fe80::ffff:ffff:fffd%5  
Default Gateway . . . . . :  
  
Tunnel adapter Automatic Tunneling Pseudo-Interface:  
Connection-specific DNS Suffix . :  
IP Address . . . . . : fe80::5efe:192.168.1.120%2  
Default Gateway . . . . . :  
  
C:\Documents and Settings\Miller>
```

# So, what runs IPv6?

(still glad you asked)

\* Mac OS X, since 10.2 Jaquar and Apple Routers



\* Apple's iOS since version 4, iPod, iPad, iPhone



\* Android OS, since at least version 2



\* Linux OS, support for some time and most distros



\* Windows, starting with NT4 testing and fully in XP or later



\* Unix/Solaris based OS



\* ...more and more hardware



\* What doesn't support IPv6 yet and might never

\* Most game consoles, Wii, Xbox, Sony Playstation

\* Blackberry OS Phones



Wii



PS3

# So who's offering IPv6?

(the usual suspects)



~ ltd. areas one address or 6 to 4, Now offering dual-stack to business customers.



~ ltd. Wireless, no immediate plans for DSL.



~ ltd. Residential testing in 2013, using 6 to 4 commercial ltd. Dual-stack.



~ still in upgrade mode, using some 6rd Tunneling\*



~ Backbone only, commercial DS, home tunnels

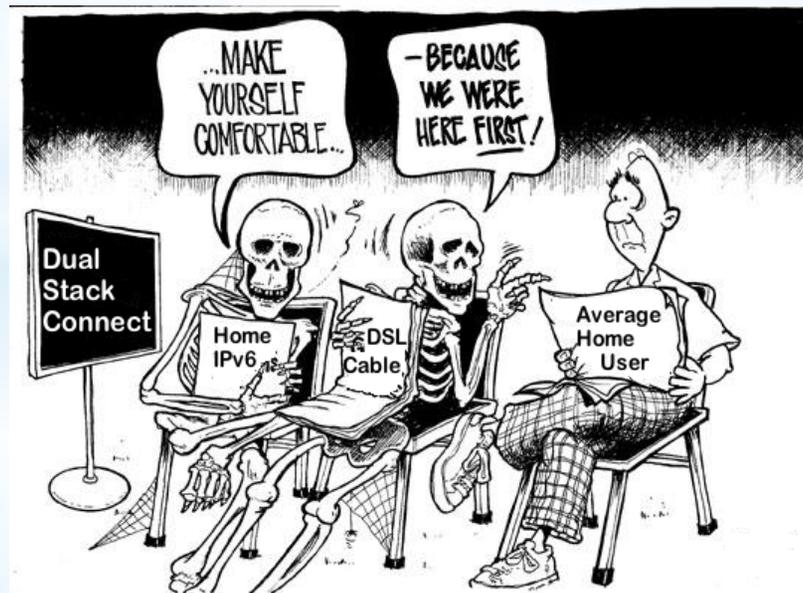


~ yes, offering dual-stack connections

# I'm stuck waiting on my ISP?

(the escape tunnel)

- \* Dual-Stack is the preferred way to go, but until then...
- \* Several tunneling techniques are being used now.
- \* Teredo/Miredo, 6 to 4, 6 in 4, 6 over 4.., 6rd  
whatever you're using it's wrapping IPv6 into IPv4
- \* They're still just cheats, but clever cheats and can let you  
Get your feet wet in the new protocol.



# \* Making your IPv6 Tunnel

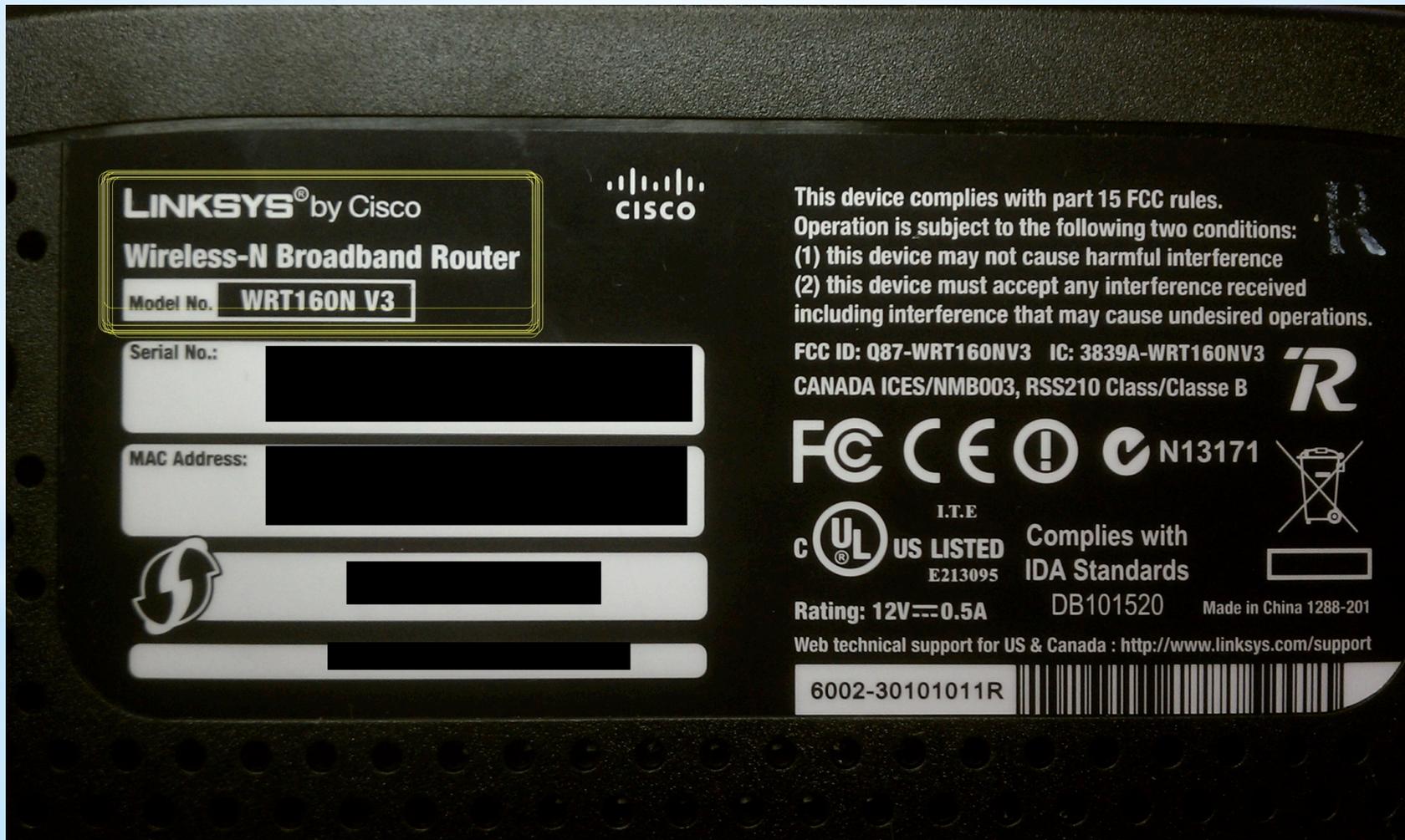
(no shovel or pickaxe)

- \* Two biggest tools for making your tunnel happen and they're both FREE: DD-WRT firmware and Hurricane Electric
  - DD-WRT is available for many popular consumer Routers
  - Hurricane Electric offers free tunnel accounts
  - BEFORE making changes to your home setup, record all settings.
  - Once you start there's NO going back!



# Get your hardware Ready

(take a hard look)



# Pay a visit to DD-WRT

(lookup your device)

The screenshot shows the dd-wrt.com website interface. At the top left is the logo 'dd-wrt.com'. Below it is a 'DD-WRT PRIVACY' section with a shield icon and the text 'Regain your internet freedom'. The main navigation area is divided into two columns: 'Professional' on the left and 'Support' on the right. The 'Professional' column contains links for 'Customization Services' (with subtext 'Get Your Own DD-WRT Version'), 'DD-WRT Shop' (with subtext 'Professional Soft- & Hardware'), and 'Activation Center'. The 'Support' column contains links for 'Router Database' (with subtext 'Check Router Support & Downloads'), 'Documentation' (with subtext 'Learn How To Setup & Configure'), and 'FAQ'. A yellow arrow points from the 'Support' header to the 'Router Database' link. Another yellow arrow points from the 'Customization Services' link to the 'Router Database' link.

<http://www.dd-wrt.com>

# Download and prepare

(avoid making bricks)

Professional Support Community Contact

Router Database Documentation FAQ Other Downloads

### Router Database

Linksys  
(Click into the search field to return to the list)

### Linksys WRT160N 3.0

**Router details**

Chipset BCM4716  
RAM 32 MB  
FLASH 4 MB

Supported by **v24 preSP2 [Beta] Build 14896**

**Additional information**

- DD-WRT Wiki: [Linksys WRT150N & WRT160N](#)

**Latest DD-WRT Releases**

Latest stable release  
**v24 SP1 (Build10020)**

Latest development release  
**v24 preSP2 (Build13064)**

**Remarks**

For more information regarding installation and configuration please refer to the following sources:

- DD-WRT Wiki
- DD-WRT User Forum

| Description             | Filename                                                          | Date       | Size    |
|-------------------------|-------------------------------------------------------------------|------------|---------|
| NEWD K2.6 Mini Generic  | <a href="#">dd-wrt.v24-14896_NEWD-2_K2.6_mini.bin</a>             | 2010-08-09 | 3,29 MB |
| NEWD K2.6 NoKaid Small  | <a href="#">dd-wrt.v24-14896_NEWD-2_K2.6_std_nokaid_small.bin</a> | 2010-08-09 | 3,35 MB |
| NEWD K2.6 OpenVPN Small | <a href="#">dd-wrt.v24-14896_NEWD-2_K2.6_openvpn_small.bin</a>    | 2010-08-09 | 3,18 MB |
| NEWD K2.6 VoIP Small    | <a href="#">dd-wrt.v24-14896_NEWD-2_K2.6_voip_small.bin</a>       | 2010-08-09 | 3,46 MB |

# Flash your Router

(and be patient!)



**LINKSYS**® by Cisco Firmware Version: v3.0.02

**Wireless-N Broadband Router**    WRT160Nv3

**Administration**    Setup    Wireless    Security    Access Restrictions    Applications & Gaming    Administration    Status

Management | Log | Diagnostics | Factory Defaults | Firmware Upgrade

**Firmware Upgrade**

Please select a file to upgrade the firmware:  dd-wrt.v2...\_mini.bin [Help...](#)

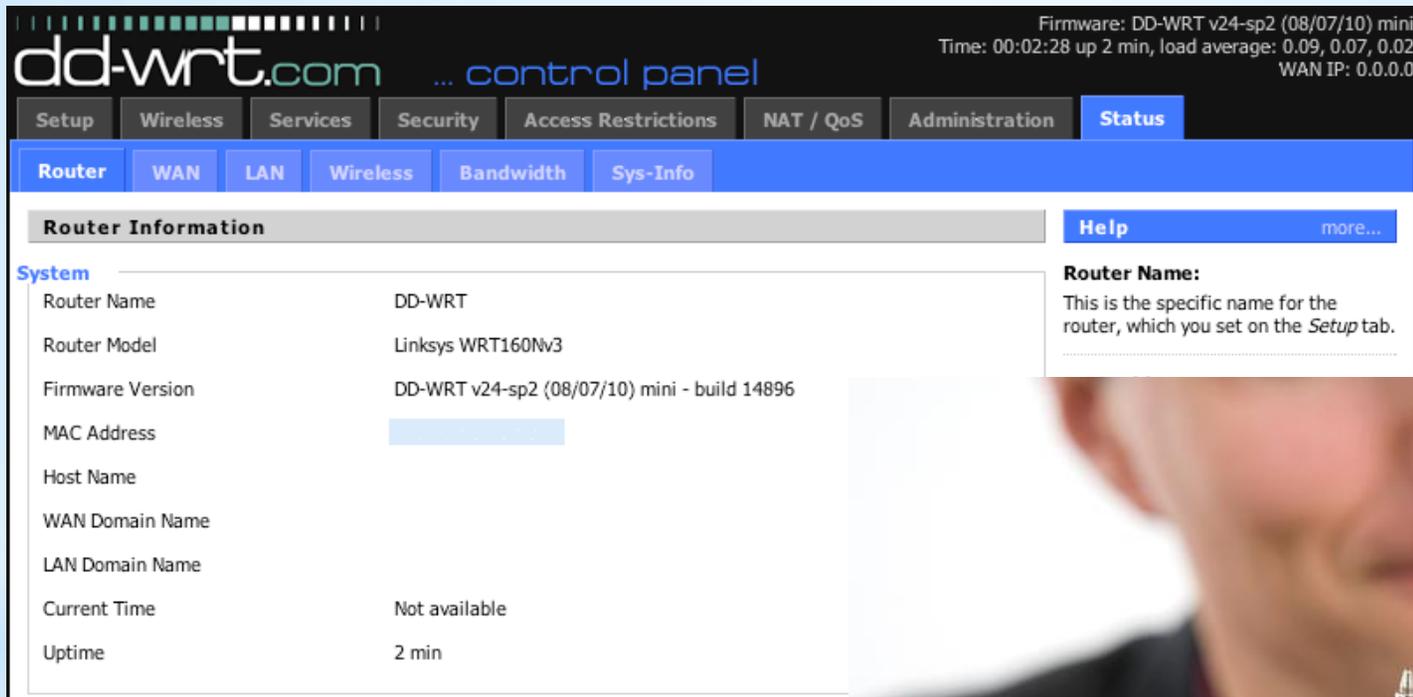
**Warning:** Upgrading firmware may take a few minutes, please don't turn off the power or press the reset button.

**Upgrade must NOT be interrupted !!**



# Check for a good flash

(then reset 30-30-30)



The screenshot shows the dd-wrt.com control panel. At the top right, it displays system information: Firmware: DD-WRT v24-sp2 (08/07/10) mini, Time: 00:02:28 up 2 min, load average: 0.09, 0.07, 0.02, and WAN IP: 0.0.0.0. The navigation menu includes Setup, Wireless, Services, Security, Access Restrictions, NAT / QoS, Administration, and Status. The Status page is active, showing tabs for Router, WAN, LAN, Wireless, Bandwidth, and Sys-Info. The Router Information section is expanded, showing a table of system details. A help box for Router Name is also visible.

| Router Information |                                              |
|--------------------|----------------------------------------------|
| <b>System</b>      |                                              |
| Router Name        | DD-WRT                                       |
| Router Model       | Linksys WRT160Nv3                            |
| Firmware Version   | DD-WRT v24-sp2 (08/07/10) mini - build 14896 |
| MAC Address        |                                              |
| Host Name          |                                              |
| WAN Domain Name    |                                              |
| LAN Domain Name    |                                              |
| Current Time       | Not available                                |
| Uptime             | 2 min                                        |

**Router Name:**  
This is the specific name for the router, which you set on the *Setup* tab.

- Your Router is like new again!
- Take the time to re-enter settings
- Check that everything works



# Pay a visit to HE.com

(a damn fine broker)



Internet Backbone and Colocation Provider

## Hurricane Electric



Global IPv6 & IPv4 Internet Transit

### Free IPv6 Certifications!



<http://ipv6.he.net/certification>

### Hurricane Electric Tunnel Broker

*"Our free tunnel broker service enables you to reach the IPv6 Internet by tunneling over existing IPv4 connections from your IPv6 enabled host or router to one of our IPv6 routers. Try it now!"*

<http://tunnelbroker.net>



Colocation

<http://www.he.com>

# Create your account

(it's a freebie)



HURRICANE ELECTRIC  
INTERNET SERVICES

## Hurricane Electric Free IPv6 Tunnel Broker

Name: Christopher Miller

User ID: [REDACTED]

### Tunnel Broker News:

⊕ Update - 18 January 2012

[January 18, 2012]

⊕ Update - 13 January 2012

[January 13, 2012]

⊕ UPDATE - 16 October 2011

[October 16, 2011]

⊕ UPDATE - Sept. 27th, 2010

[September 27, 2011]

⊕ Dyn-compliant Endpoint Updates

[September 16, 2011]

HE.NET  
IPv6  
Certified  
**No Cert Yet**  
crlmiller

Tunnel [ 1 / 5 ]

Routed /64

Routed  
/48

Description

[REDACTED]  
tserv13.ash1.ipv6.he.net

2001:470:8:e03::/64 None

Home DD-WRT  
Router

## Tunnelbroker Login

Username:

Password:

Login

Register

## Quick Links

[Network Map](#)

[Looking Glass](#)

[Route Server](#)

[Free IPv6 Tunnel Broker](#)

[Global IPv6 Deployment](#)

[World IPv6 Day](#)

[Advice about IPv6](#)

[New Colocation Facility](#)

<http://tunnelbroker.net>

# Create your Tunnel!

(allow WAN pings!)

## User Functions

Combine Tunnels  
Create Regular Tunnel  
Create BGP Tunnel  
IPv6 Portscan



HURRICANE ELECTRIC  
INTERNET SERVICES

### Create New Tunnel

You currently have 1 of 5 tunnels configured.

- If you are trying to reclaim a tunnel simply use your last IPv4 address here. If you have any issues please email [ipv6@he.net](mailto:ipv6@he.net).
- If you have a public ASN and wish to setup a full BGP feed, please use [this form](#) instead.

IPv4 Endpoint (Your side):

You are viewing from:

128.244.9.9

We recommend you use:

Checking...

Available Tunnel Servers:

Asia

|                                     |                |
|-------------------------------------|----------------|
| <input type="radio"/> Hong Kong, HK | 216.218.221.6  |
| <input type="radio"/> Singapore, SG | 216.218.221.42 |
| <input type="radio"/> Tokyo, JP     | 74.82.46.6     |

Europe

|                                     |              |
|-------------------------------------|--------------|
| <input type="radio"/> Amsterdam, NL | 216.66.84.46 |
|-------------------------------------|--------------|

IPv4 Endpoint (Your side):

128.244.9.9

IP is a potential tunnel endpoint.

You are viewing from:

128.244.9

We recommend you use:

Checking

Available Tunnel Servers:

Asia

|                                     |               |
|-------------------------------------|---------------|
| <input type="radio"/> Hong Kong, HK | 216.218.221.6 |
|-------------------------------------|---------------|

configured.

IPv4 address here. If you have  
ed, please use [this form](#) instead.

# Note your tunnel settings

(you're gonna need 'em)



### Hurricane Electric Free IPv6 Tunnel Broker

Name: Christopher Miller  
User ID: [REDACTED]

**Tunnel Broker News:**  
Update - 18 January 2012 [January 18, 2012]  
Update - 13 January 2012 [January 13, 2012]  
UPDATE - 16 October 2011 [October 16, 2011]  
UPDATE - Sept. 27th, 2010 [September 27, 2011]  
Dyn-compliant Endpoint Updates [September 16, 2011]

HE.NET  
IPv6  
Certified  
**No Cert Yet**  
crlmiller

| Tunnel [ 1 / 5 ]                  | Routed /64          | Routed /48 | Description        |
|-----------------------------------|---------------------|------------|--------------------|
| [REDACTED]tser13.ash1.ipv6.he.net | 2001:470:8:e03::/64 | None       | Home DD-WRT Router |

### Tunnel Details

IPv6 Tunnel | Example Configurations | Advanced

Tunnel ID: [REDACTED] [Delete Tunnel](#)  
Creation Date: Apr 26, 2012  
Description: [REDACTED]

#### IPv6 Tunnel Endpoints

Server IPv4 Address: 216.66.22.2  
Server IPv6 Address: 2001:[REDACTED]  
Client IPv4 Address: [REDACTED]  
Client IPv6 Address: 2001:[REDACTED]

#### Available DNS Resolvers

Anycasted IPv6 Caching Nameserver: 2001:470:20::2  
Anycasted IPv4 Caching Nameserver: 74.82.42.42

#### Routed IPv6 Prefixes

Routed /64: 2001:470:8:1292::/64  
Routed /48: [Assign /48](#)

Print or copy/paste account and tunnel information into a simple file

# An altogether awesome Script

(smarter than myself)

```
#v1.4 Feb 29, 2012
#*****
#Settings start here
#*****

#basic connection settings
SERVER_IP4_ADDR="enter ip here"
CLIENT_IPV6_ADDR="enter ip here"
ROUTED_64_ADDR="enter ip here"

#account info to auto update endpoint
USERID="enter your hex user id. NOT text username"
PASSWD="your plain text password"
TUNNELID="your numeric tunnel id"

#####Optional/Advanced Settings#####

#IPv6 OpenDNS IPv6 Resolver
ENABLE_OPENDNS_IPV6_DNS=1

#HE's endpoint verification server ip to add to whitelist
HE_VERIFY_SERVER_IP="66.220.2.74"

...and so forth
```

<-Grab you're Account and Tunnel info  
<-Insert, as needed into the script

See the link below for the full script

Some suggestions:

- Use option for get WAN IP# from NVRAM
- Add code for updating HE info @ 4 AM
- Set Router WLAN timing to '0'
- Set Router to auto restart each day
- Enable IPv6 on your systems
- SAVE settings, then Apply
- Reboot Router and systems
- Check for IPv6 and test !!!

<http://www.testipv6.com>

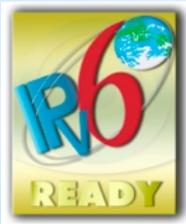
\* [http://www.dd-wrt.com/wiki/index.php/IPv6\\_setup\\_Hurricane\\_Electric\\_Tunnel\\_Broker](http://www.dd-wrt.com/wiki/index.php/IPv6_setup_Hurricane_Electric_Tunnel_Broker)

# Ok, it's working now what?

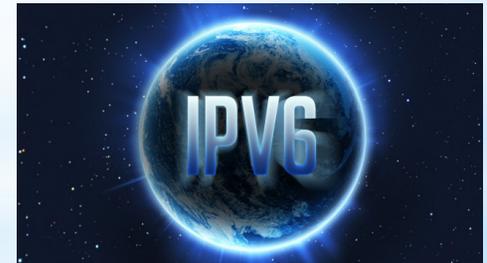
(whoo-pee-dee-doo)



- Well you've now access to IPv6 only pages: v6.facebook.com, ipv6.google.com, etc.
- Certain services like, ahem, BitTorrent connect with Asian and European clients ;)



- IPv6 enabled pages tend to load faster, thanks to reduced latency.
- You're ready for IPv6



# Taking care of Business...

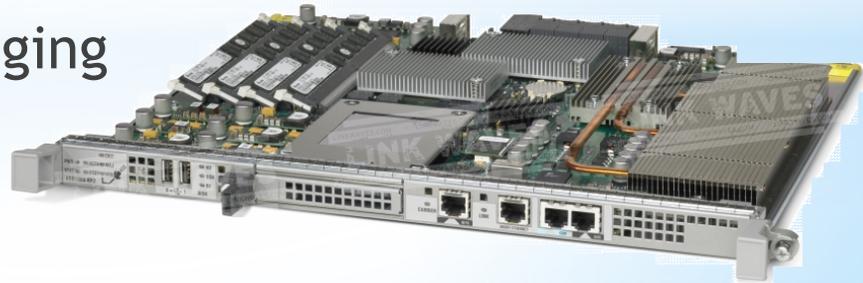
(Exercise care before you dare)

\* Hardware is now being offered for implementing IPv6 solutions for both Dual-Stacking between both protocols and implementing enterprise wide tunnels.

\* Tunneling appliances such as GoGoNet's Gogo6 server for enterprise networks.



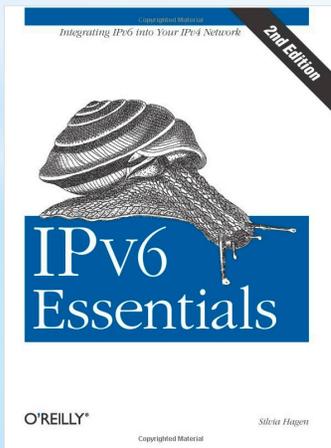
\* Dual Stack and Crossing/Bridging with Cisco's ASR1000



# As Time Goes By...

(play it again Sam)

- \* Adoption of IPv6 is gathering steam, and speed!
- \* Begin making plans & start getting ready NOW!
- \* Read and Learn, Experiment!
- \* Contact vendors and ask about IPv6 support!
- \* Dual stack will be around for quite some time, but eventually...
- \* It's a big World out there and everyone want's to be connected; especially your business, university, facility, home.



\* Questions ?

ISBN-10: 0596100582

ISBN-13: 978-0596100582

# One Last Thing

(??? the mystery box ???)

If you're interested in a little IPv6  
experimenting

Riddle me this...?