

IPv6 Training 101

Why IPv6? IPv6 offers greater benefits

- More Useable Addresses
- Server-less auto(re)configuration with P-n-P
- More efficient mobility methods
- Built in IP layer encryption and authentication
- More efficient header formats and Identification
- Support for more options and extensions

More Useable Addresses

- IPv4 uses 32 bits to address the IP which gives about 2³² = 4,294,967,296 unique addresses but in fact only about 3.7 billion addresses are assignable because the IPv4 addressing system separates the addresses into classes and reserves addresses for multicasting, testing, and other specific uses
- IPv6 uses up to 128 bits which provides 2¹²⁸ addresses or approximately 3.4 * 10³⁸ addresses, more than 7.9×10²⁸ times as many as IPv4.

340,282,366,920,938,463,463,374,607,431,768,211,456 in all!

Lets just say that that is really a LOT! \bigcirc

Server-less auto(re)configuration with Plug-n-Play

- PNP can auto configure from a 48bit MAC address into a 64 bit ID
 - Renumbering an existing network for a new connectivity provider with different routing prefixes is a major effort with IPv4. With IPv6, however, changing the prefix announced by a few routers can in principle renumber an entire network, since the host identifiers (the least-significant 64 bits of an address) can be independently self-configured by a host.
- Auto-generated artificially random number
- Possible future enhancements

More efficient mobility methods

- Better support for mobile devices
 - Phones
 - PDA's
- More numbers to support the worlds addressing requirements
- Better roaming support

Built in IP layer encryption and authentication

- IPSec
 - define policies for secure communication in a network
 - describe how to enforce these policies.
 - Security Services
 - Access Control
 - connectionless integrity
 - data origin authentication
 - protection against replays
 - confidentiality (encryption)
 - Data Encryption Standard (DES) 56-bit and Triple DES (3DES) 168bit symmetric key encryption algorithms in IPSec client software.
 - Certificate authorities and Internet Key Exchange (IKE) negotiation
 - Encryption that can be deployed in standalone environments between clients, routers, and firewalls

More efficient header formats and Identification

- Allows for additional types of messaging packets
 - Unicasting
 - acts as an identifier for a single interface
 - Multicast
 - acts as an identifier for a group/set of interfaces that may belong to the different nodes
 - Anycast
 - act as identifiers for a set of interfaces that may belong to the different nodes
 - Broadcast
 - No longer used in IPv6. The previous 3 methods are used to replace Broadcast packets
 - Routing
 - NAT no longer needed
 - Scoped address
 - link-local, site-local and global-address space

Address Types

- IPv4
 - IP address
 - 192.168.2.x
 - SubnetMask
 - 255.255.0.0
 - Gateway
 - 192.168.0.254
- IPv6
 - IP address
 - 1922:0000:0000:0000:0015:0025:007e/64
 - Special characters
 - % / \
 - / is a divider between the address and the prefix indicator 192:2::15:25:7e/64
 - % defines a "Zone ID" binds the IP address to a particular NIC

IPv6 Formatting

- Full IP address
 - IPv6 addresses are denoted by eight groups of hexadecimal quartets separated by colons in between them
 - The initial bits of an IPv6 address (these are identical for all hosts in a network) form the network's prefix
 - 1992:0000:0000:0000:00015:0025:007e/64
 - Prefix or Network ID (/64)
 - /64 is the industry standard
 - » a decimal value representing how many of the left most contiguous bits of the address comprise the prefix
 - Indicates that the first 64 bits are the prefix
 - » 1992:0000:0000:0000:
- Prefix (Network)
 - 1992:0000:0000:0000::
 - The prefix includes the network *and subnet* address
 - Also includes global routing information because addresses are allocated based on physical location
 - The size of bits in a network prefix are separated with a /. For example, 2001:cdba:9abc:5678::/64 denotes the network address 2001:cdba:9abc:5678. This network comprises of addresses rearranging from 2001:cdba:9abc:5678:: up to 2001:cdba:9abc:5678:ffff:ffff:ffff.
- Host / Device ID / Node
 - 0000:0015:0025:007e
 - This is always the least significant 64 bits

IPv6 Shorthand

Because an IP address of

1992:0000:0000:0000:00015:0025:007e/64 looks so foreboding and complex, and is such a long number, several rules were made to simplify the address.

- Preceding 0's will be truncated
 - :0015: will be shorted to :15:
 - 1992:0000:0000:0000:0015:0025:007e becomes 1992:0:0:0:15:25:7e
- Consecutive sections of zeroes are replaced with a double colon (::).
 - :0000:0000:0000: will be shorted to ::
 - This shorthand may only be used ONCE in an address
 - 1992:0:0:0:0:15:25:7e becomes
 1992::15:25:7e

IPv6 Special Addresses

- ::/96
 - The zero prefix denotes addresses that are compatible with the previously used IPv4 protocol
- ::/128
 - all zeroes in it is referred to as an unspecified address and is used for addressing purposes within a software
- ::1/128
 - loop back address used to refer to the local host. Internal Ethernet loopback by the IPv6 stack. The local host address in the IPv4 was 127.0.0.1.
- 2001:db8::/32
 - documentation prefix allowed in the IPv6. All the examples of IPv6 addresses should ideally use this prefix to indicate that it is an example
- fec0::/10
 - site-local prefix. address is valid only within the local organization. the usage has been discouraged by the RFC.
- fc00::/7
 - Unique Local Address (ULA). These addresses are routed only within a set of cooperating sites
- ff00::/8
 - denote the multicast addresses. Any address carrying this prefix is automatically understood to be a multicast address
- fe80::/10
 - link-local prefix offered by IPv6. This address prefix signifies that the address is valid only in the local physical link
- 1XXX:: and XXX
 - These are used for private networks such as the IPv4 192.169.x.x or 10.x.x.x. All public IPv6 addresses have the first three bits set to 001. This means in a practical sense, all Public IPv6 addresses
 - a) begin with either a 2 or a 3 as the most significant hexadecimal digit, and
 - b) the first hextet of the address will be 4 hexadecimal digits long.
- 2XXX:: and 3XXX
 - These are public addresses

Tools

- ICMPv6 (Ping)
- Microsoft Telnet
- PuTTY Telnet
- Web page
- Tracert (TraceRoute)

Other Resources

Wiki

<u>http://en.wikipedia.org/wiki/IPv6</u>

Microsoft

- <u>http://technet.microsoft.com/en-us/network/bb530961.aspx</u>
- <u>http://msdn.microsoft.com/en-us/library/aa921042.aspx</u>

Tutorials

- <u>http://ipv6.com/articles/general/ipv6-the-next-generation-internet.htm</u>
- <u>http://www.tutorialspoint.com/ipv6/ipv6_quick_guide.htm</u>
- <u>http://www.9tut.com/ipv6-tutorial</u>

Fun Facts

Just how many IPv6 addresses are there? Really?

<u>http://rednectar.net/2012/05/24/just-how-many-ipv6-addresses-are-there-really/</u>

Migrating to IPv6

 <u>http://books.google.com/books?id=9_Qn3LSD2t8C&pg=PA64&lpg=PA64&dq=special+characters+in+ipv6&source=bl&ots=zvy0GvMGt2&sig=I-zzcY2im3-WNoRyuoNHBbMdIjg&hl=en&sa=X&ei=GQQFU7_nMIPlyQG9-4HYDw&ved=0CEsQ6AEwBA#v=onepage&q=special%20characters%20in%20ipv6&f=false
</u>

Converting to Literal IP address

<u>http://ipv6-literal.com/</u>

Lets Setup a DeviceMaster

- Overview
- Determine your network
- Enable IPv6 and assign an address in the DeviceMaster
- Enable IPv6 and assign an address in the Driver
- Test

Determine your network

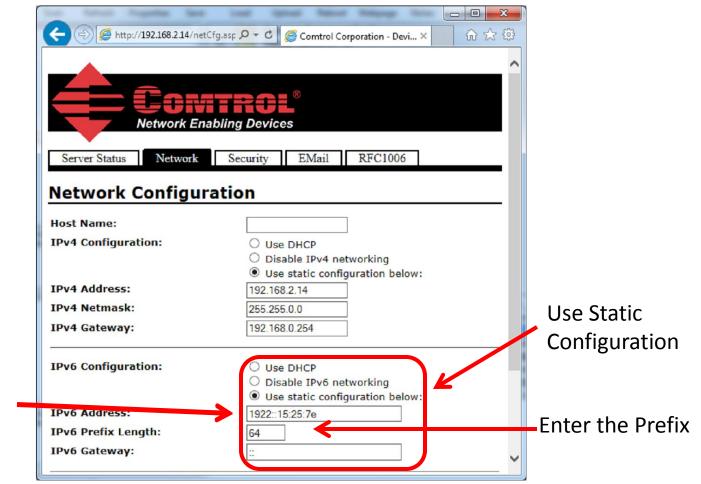
- In this example I am using part of my old IP address and the MAC address of my node as parts of my new IPv6 address
 - Prefix (Network ID)
 - 192.168.2.x will become 1922:0000:0000:0000
 - Shorthand to 1922::
 - Node Identifier (Device ID)
 - I will use the MAC address last three octets
 - 00:c0:4e:**15:25:7e** will become 0000:00**15**:00**25**:00**7e**
 - » Shorthand to 15:25:7e
 - Complete IP address
 - 1922:0000:0000:0000:0015:0025:007e/64
 - Shorthand to 1922::15:25:7e/64

PC IPv6 example

Local Area Connection Properties	×
Networking	
Connect using:	
Proadcom NetXtreme 57xx Gigabit Controller	
Configure	
This connection uses the following items:	
🗹 🏪 Client for Microsoft Networks	
🗹 🚚 QoS Packet Scheduler	
🗹 🚚 File and Printer Sharing for Microsoft Networks	=
PortVision Plus Protocol Driver	
DeviceMaster NDIS Protocol	
Internet Protocol Version 6 (TCP/IPv6)	
Internet Protocol Version 4 (TCP/IPv4)	
Install Uninstall Properties	
Description	
TCP/IP version 6. The latest version of the internet protocol that provides communication across diverse interconnected networks.	
ОК Са	ncel

ternet Protocol Version 6 (TCP/IPv6) I	Properties	? ×
General		
	omatically if your network supports this capability. ork administrator for the appropriate IPv6 settings.	
Obtain an IPv6 address automatic	ally	
Use the following IPv6 address:		
IPv6 address:	1922::7b:75:4c	
Subnet prefix length:	64	
Default gateway:		
Obtain DNS server address autom	atically	
• Use the following DNS server add	resses:	
Preferred DNS server:		
Alternate DNS server:		
Validate settings upon exit	Adva	nced
	ок (Cancel

Enable IPv6 and assign an address in the DeviceMaster Network web page

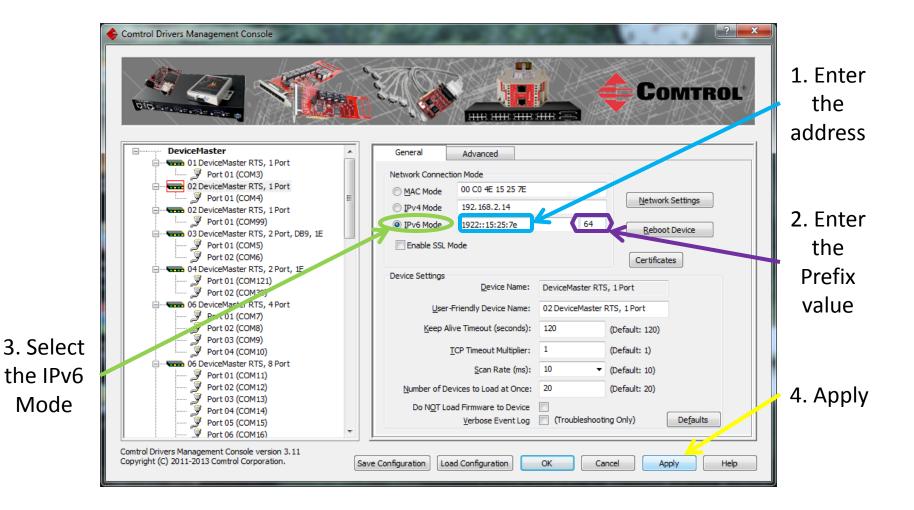


Enter the IPv6 Address using full address or Shorthand

Command Line Interface use

₽ 192.168.2.18 - PuTTY	J
	ך
dm> ip6	
IPv6 Mode: disable	
IPv6 Address: ::	
IPv6 Prefix Length: 0	
IPv6 Gateway: ::	
dm> ip6 static 1922::21:8:be	
IPv6 Mode: static	
IPv6 Address: 1922::21:8:be	
IPv6 Prefix Length: 0	
IPv6 Gateway: ::	
IPv6 configuration stored, reset to take effect.	
dm> ip6 prefix 64	
IPv6 Mode: static	
IPv6 Address: 1922::21:8:be	
IPv6 Prefix Length: 64	
IPv6 Gateway: ::	
IPv6 configuration stored, reset to take effect.	
dm>	

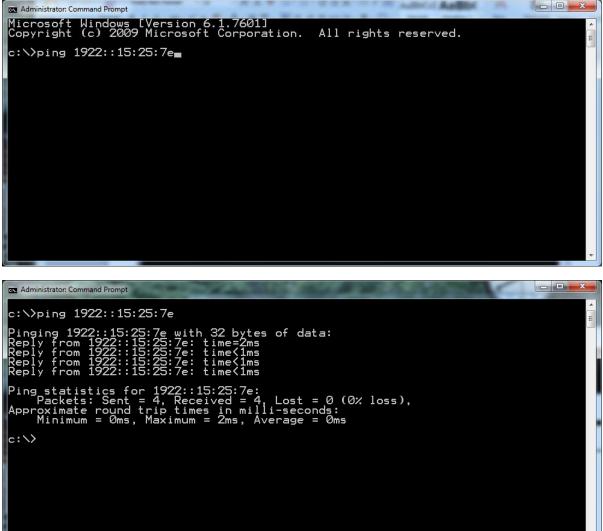
Open Comtrol Driver Management Console



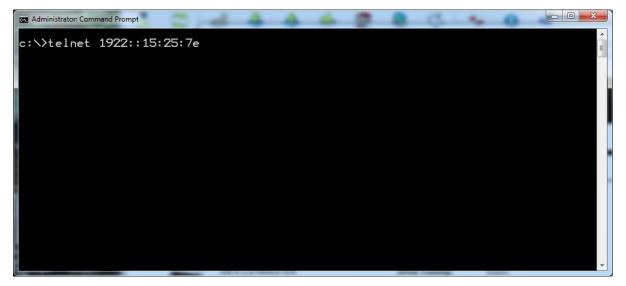
Testing Our IPv6 Installation

- Conventions
 - In some cases the IPv6 address will need to be in square brackets [] (most browsers)
- Ping and tracert
- Microsoft Telnet
- PuTTY Telnet
- Browser
- Driver / serial port Testing

Ping



Microsoft Telnet





PuTTY

R PuTTY Configuration	? ×	Reputity Configuration	<u> २ ×</u>
Category: Session Logging Terminal Keyboard Bell Features	Basic options for your PuTTY session Specify the destination you want to connect to Host Name (or IP address) Port 0 Connection type:	Category: Session Logging Terminal Keyboard Bell Features	Basic options for your PuTTY session Specify the destination you want to connect to Host Name (or IP address) Port 1922::15:25:7e 23 Connection type:
 Window Appearance Behaviour Translation Selection Colours Connection Data Proxy Telnet Rlogin SSH 	Raw Telnet Rlogin SSH Serial Load, save or delete a stored session Saved Sessions Default Settings Load Save Default Settings Default Settings Default Default Settings Default	Window Appearance Behaviour Translation Colours Connection Connection Proxy Telnet Rlogin SSH	Raw Telnet Rlogin SSH Serial Load, save or delete a stored session Saved Sessions Default Settings Load Save Default Settings Delete
Envision Serial	Close <u>wi</u> ndow on exit: Always Never Only on clean exit Open <u>C</u> ancel	Enal	Close <u>wi</u> ndow on exit: Always Never Only on clean exit <u>Open</u>

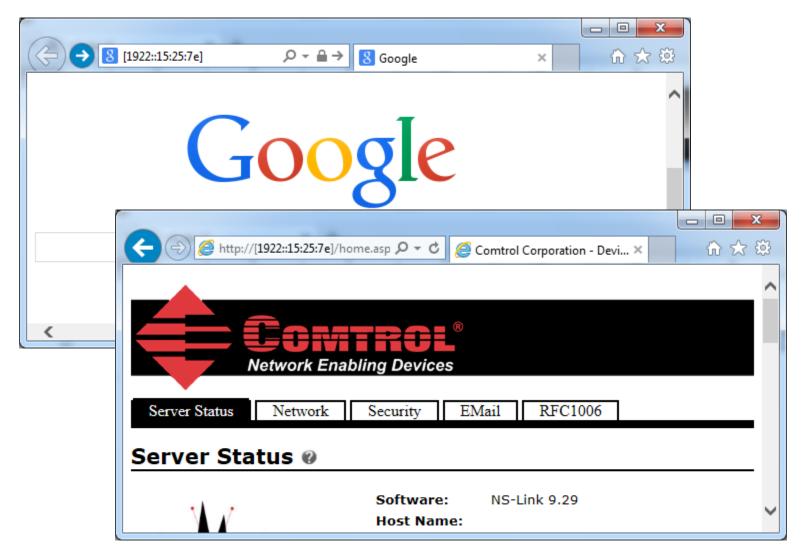
Internet Explorer

Without Required []

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	G	oogle
	- I https	://www.google.com/sea 🔎 – 🔒 🖒 🙁 1922::15:25:7e - Google Sear ×
	Google	1922::15:25:7e
<		Web Maps Shopping Images Videos More - Search tools
		About 75,600 results (0.21 seconds)
		Table of Contents — May 1922, 15 (Med Sect) intl-jrs.sagepub.com/content/15/Med_Sect.toc ▼ 15+ items - Institution: Google Indexer. sign in icon Sign In; ; My Tools Dr. W. Gordon 6 7 10.1177/003591572201500703.
	<	>

Internet Explorer

With Required []



NS-Link Driver

Comtrol Drivers Management Console	•													
DeviceMaster 01 DeviceMaster RTS, 1 Port	-	General Advanced												
Port 01 (COM3)		Network Connection Mode												
O2 DeviceMaster RTS, 1 Port		MAC Mode 00 C0 4E 15 25 7E ▼												
Port 01 (COM4)	=	Network Settings												
O2 DeviceMaster RTS, 1 Port		○ IPv4 Mode 192.168.2.14												
Port 01 (COM99)		IPv6 Mode 1922::15:25:7e 64 Reboot Device												
Port 01 (COM5)		Enable SSL Mode												
Port 02 (COM6)		Certificates												
Port 01 (COM121)		Device Settings Device Name: DeviceMaster RTS, 1 Port												
Port 02 (COM38)		Bevice Hamer BeviceHaster KTS, 1Port												
 G DeviceMaster RTS, 4 Port Port 01 (COM7) 		User-Friendly Device Name: 02 DeviceMaster RTS, 1 Port												
Port 01 (COM7)														Keep Alive Timeout (seconds): 120 (Default: 120)
Port 03 (COM9)														(Default: 120)
Port 04 (COM10)		ICP Timeout Multiplier: 1 (Default: 1)												
06 DeviceMaster RTS, 8 Port		Scan Rate (ms): 10												
Port 01 (COM11)														
🦻 Port 02 (COM12) 📝 Port 03 (COM13)		Number of Devices to Load at Once: 20 (Default: 20)												
Port 03 (COM13)		Do NOT Load Firmware to Device												
Port 05 (COM15)		Verbose Event Log (Troubleshooting Only) De <u>f</u> aults												
Port 06 (COM16)	Ŧ													
Comtrol Drivers Management Console version 3.11 Copyright (C) 2011-2013 Comtrol Corporation.	Sav	ave Configuration OK Cancel Apply Help												

NS-Link Device Status

Comtrol Drivers Management Console	General Advanced Device Status
 O3 DeviceMaster RTS, 2 Port, DB9, 1E Port 01 (COM5) Port 02 (COM6) O4 DeviceMaster RTS, 2 Port, 1E Port 01 (COM121) Port 02 (COM38) Port 02 (COM38) Port 01 (COM7) Port 02 (COM8) Port 03 (COM9) Port 04 (COM10) Port 04 (COM10) Port 02 (COM12) Port 03 (COM13) Port 04 (COM14) Port 05 (COM15) Port 07 (COM17) Port 08 (COM18) Port 08 (COM18) 	Device is active and OK. Refresh History Network Statistics PC Network Interface Details Device Network Interface Dgtails
Comtrol Drivers Management Console version 3.11 Copyright (C) 2011-2013 Comtrol Corporation.	ave Configuration OK Cancel Apply Help

Driver / serial port Testing

All normal serial port testing procedures may now be done without regard to how the driver and the DeviceMaster are communicating

Please note that in all of these examples that drivers and firmware used are not released. Driver version 1.11

Comtrol Driver Management Console v3.16+