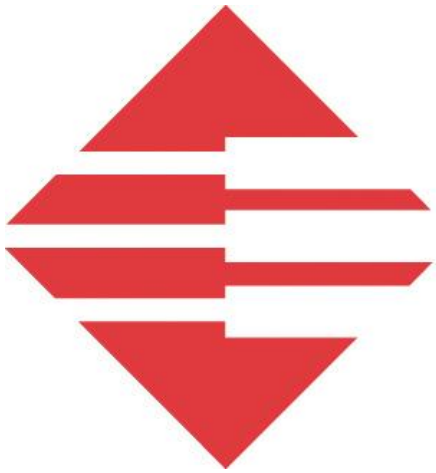


COMTROL®

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 **2^{32} = 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 **2^{128}** addresses or approximately **3.4 * 10^{38}** addresses, more than 7.9×10^{28} 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! ☺

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) 168-bit 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
    - 1922:0000:0000:0000:0000:0015:0025:007e/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
      - \ Have not yet found the \ description

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
  - 1992:0000:0000:0000:0000:0015:0025:007e/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:ffff.
- Host / Device ID / Node
  - 0000:0015:0025:007e
    - This is always the least significant 64 bits

IPv6 Shorthand

Because an IP address of 1992:0000:0000:0000:0000:0015:0025:007e/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:
  - 1992:0000:0000:0000:0000:0015:0025:007e becomes 1992:0:0:0:0:15:25:7e
- 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

- http://en.wikipedia.org/wiki/IPv6

Microsoft

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

Tutorials

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

Fun Facts

Just how many IPv6 addresses are there? Really?

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

Migrating to IPv6

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

Converting to Literal IP address

- http://ipv6-literal.com/

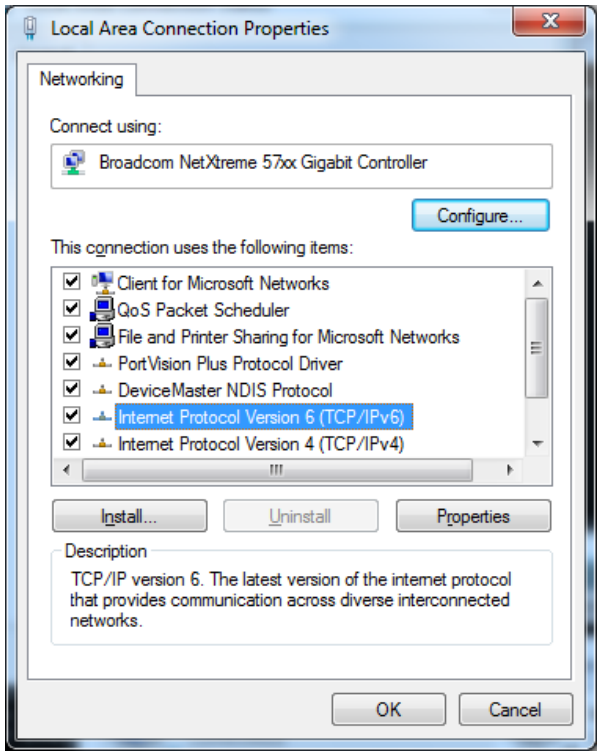
Lets Setup a DeviceMaster

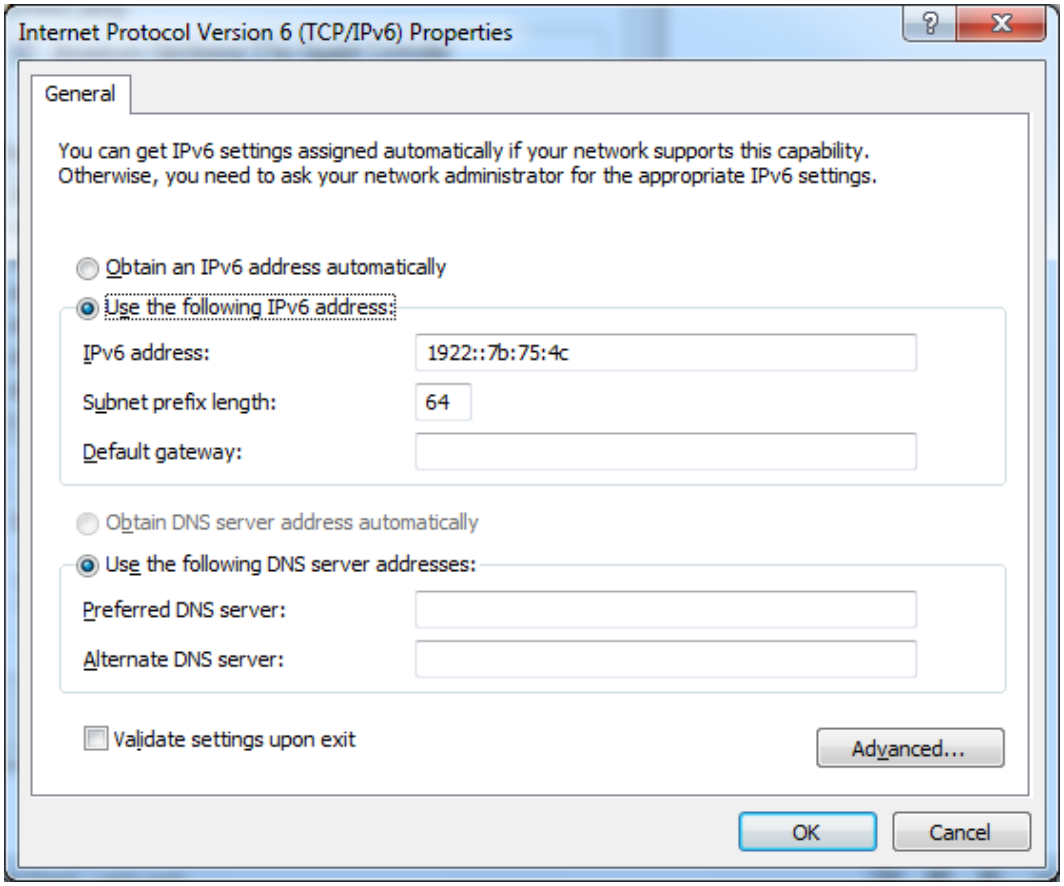
- Overview
- Determine your network
- Enable IPv6 and assign an address in the DeviceMaster
- Enable IPv6 and assign an address in the Driver
- Test

Determine your network

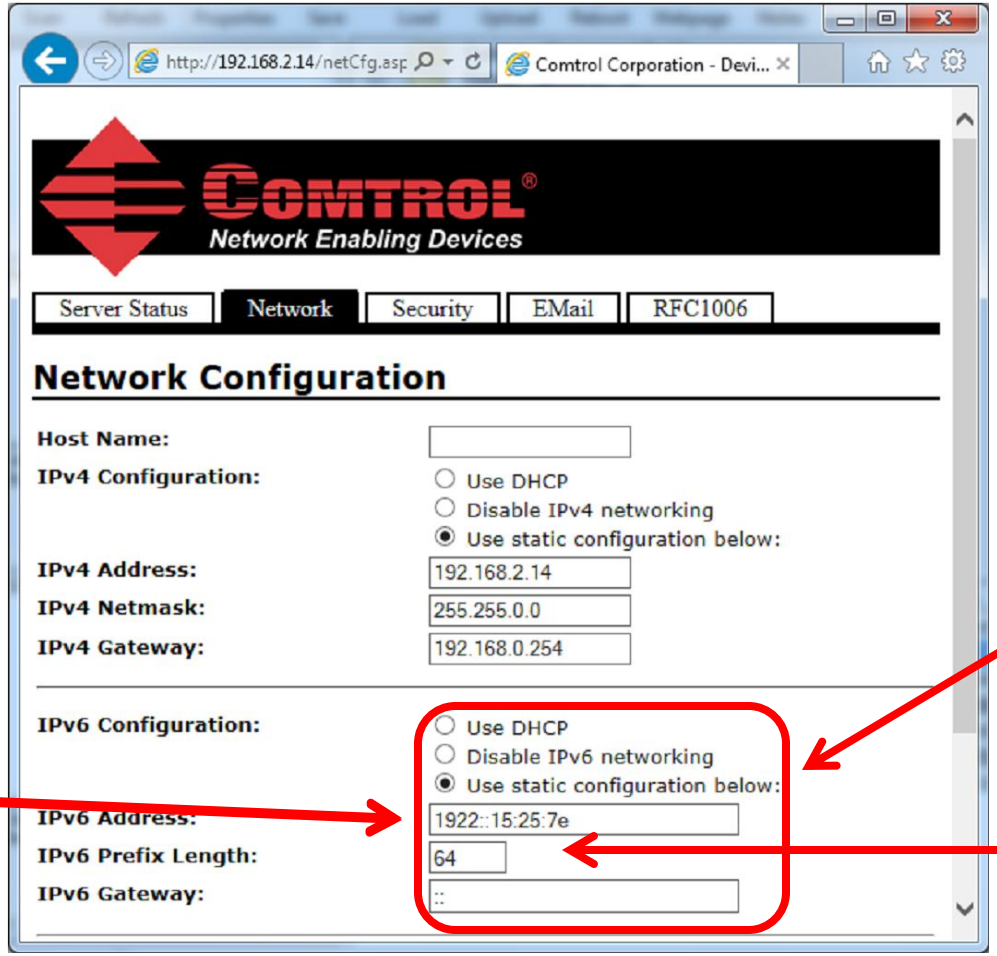
- In this example I am using part of my old IP address and the MAC address of my node as parts of my new IPv6 address
  - Prefix (Network ID)
    - 192.168.2.x will become 1922:0000:0000:0000
      - Shorthand to 1922::
  - Node Identifier (Device ID)
    - I will use the MAC address last three octets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

PC IPv6 example





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

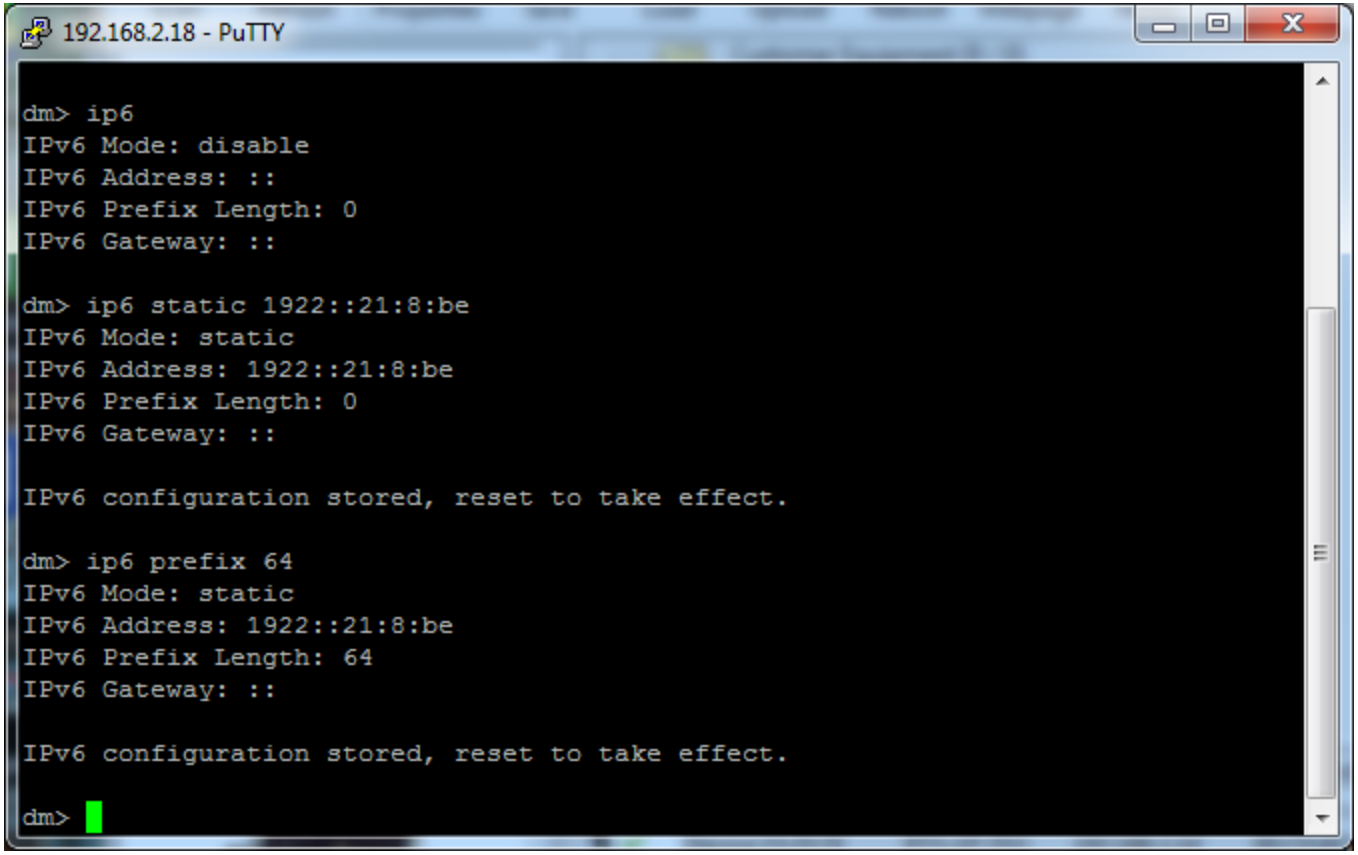


Enter the IPv6 Address using full address or Shorthand

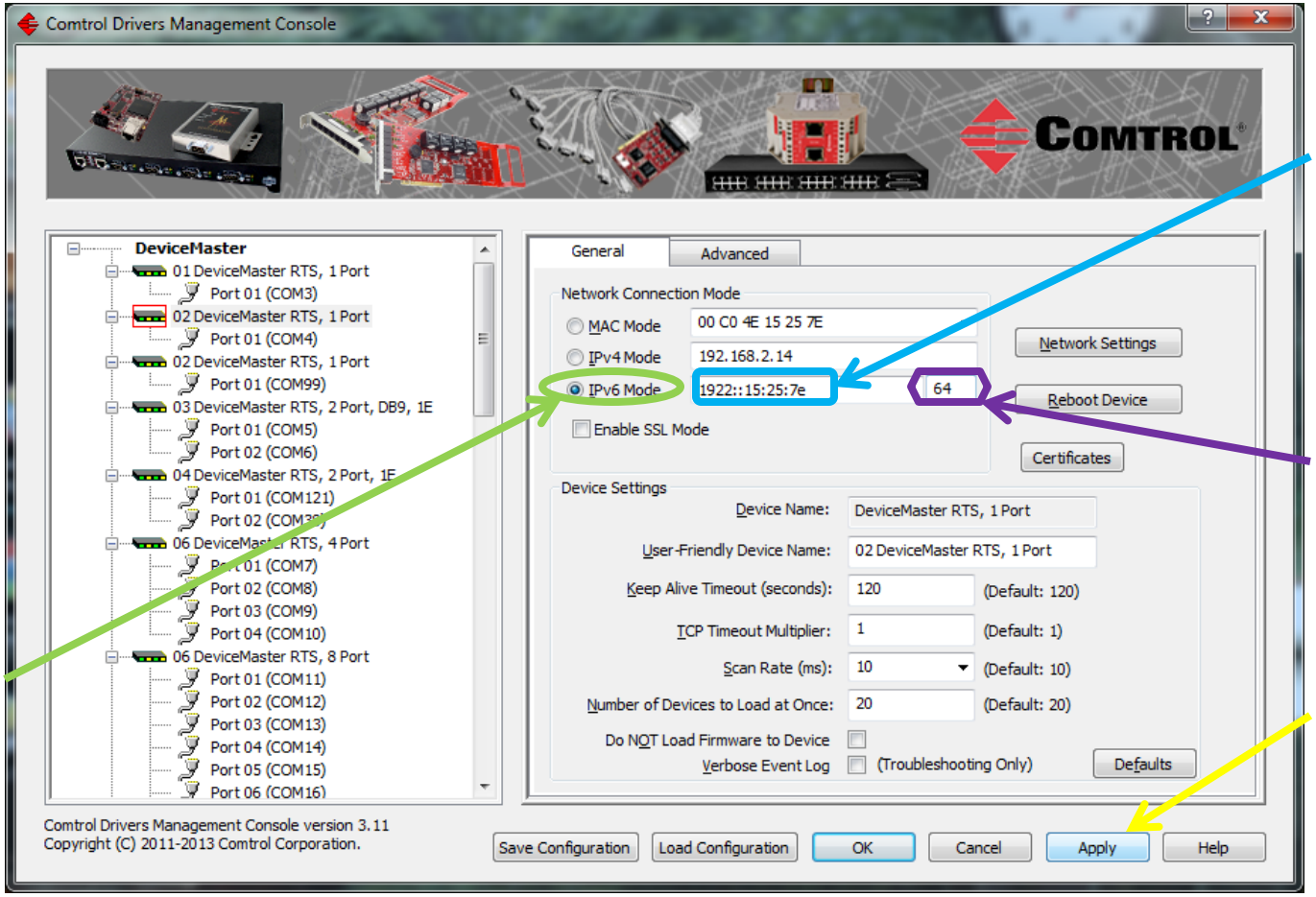
Use Static Configuration

Enter the Prefix

Command Line Interface use



Open Comtrol Driver Management Console



1. Enter the address

2. Enter the Prefix value

3. Select the IPv6 Mode

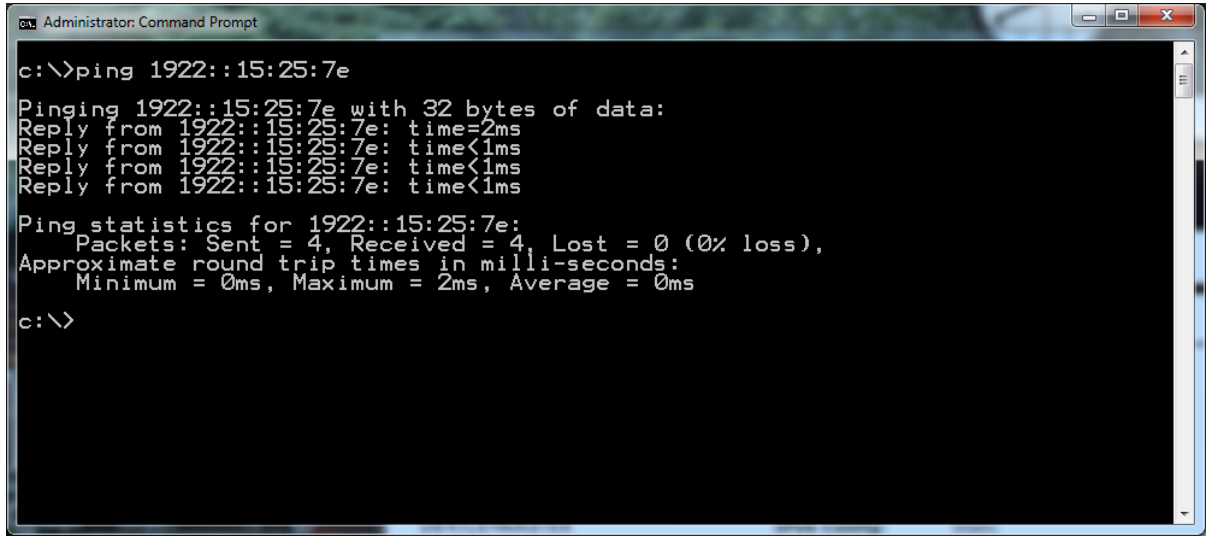
4. Apply

Testing Our IPv6 Installation

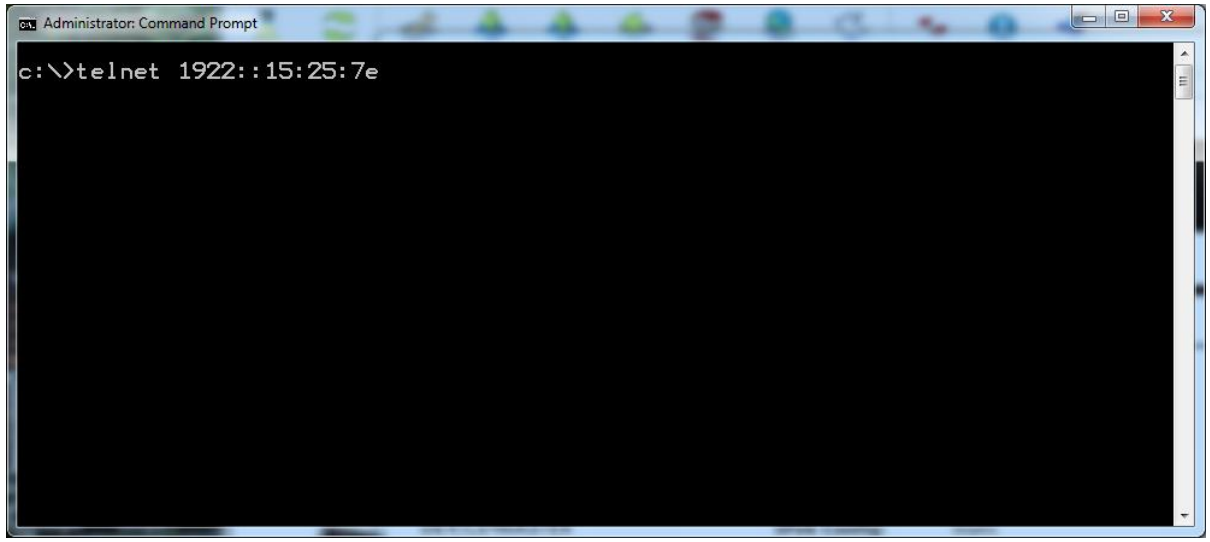
- Conventions
  - In some cases the IPv6 address will need to be in square brackets [ ] (most browsers)
- Ping and tracert
- Microsoft Telnet
- PuTTY Telnet
- Browser
- Driver / serial port Testing

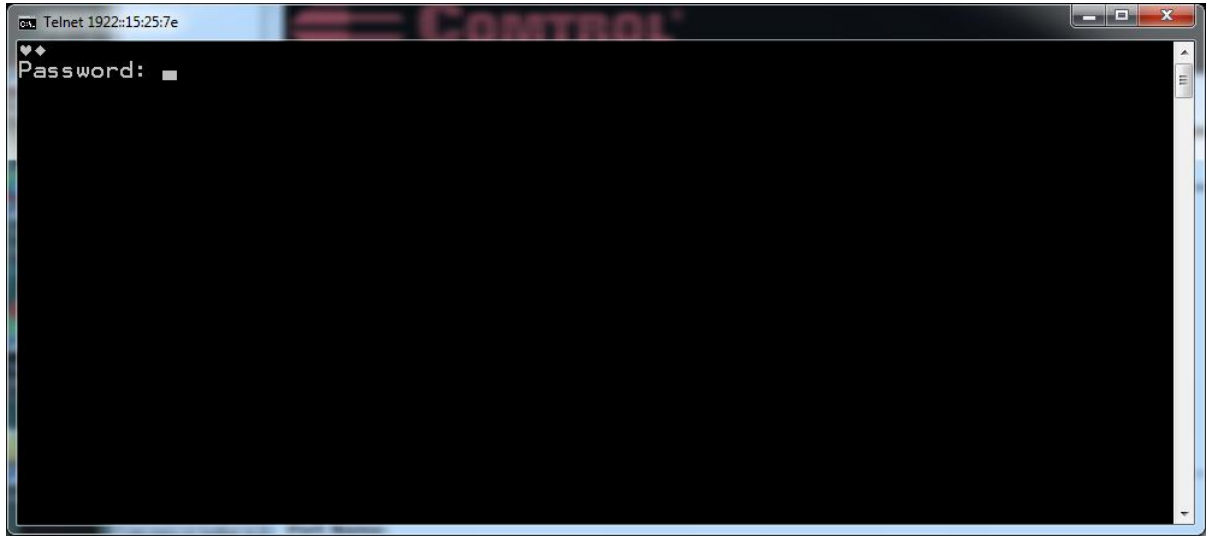
Ping


Administrator: Command Prompt
Microsoft Windows [Version 6.1.7601]
Copyright (c) 2009 Microsoft Corporation. All rights reserved.
c:\>ping 1922::15:25:7e

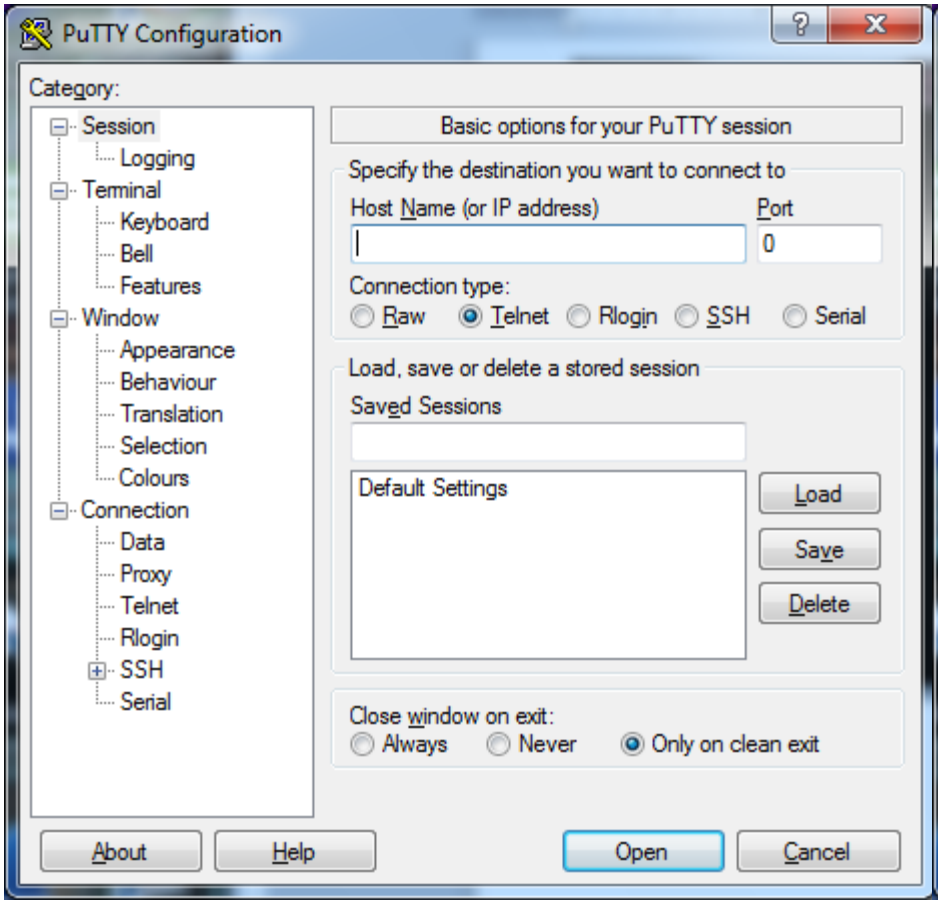

Administrator: Command Prompt
c:\>ping 1922::15:25:7e
Pinging 1922::15:25:7e with 32 bytes of data:
Reply from 1922::15:25:7e: time=2ms
Reply from 1922::15:25:7e: time<1ms
Reply from 1922::15:25:7e: time<1ms
Reply from 1922::15:25:7e: time<1ms
Ping statistics for 1922::15:25:7e:
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
Minimum = 0ms, Maximum = 2ms, Average = 0ms
c:\>

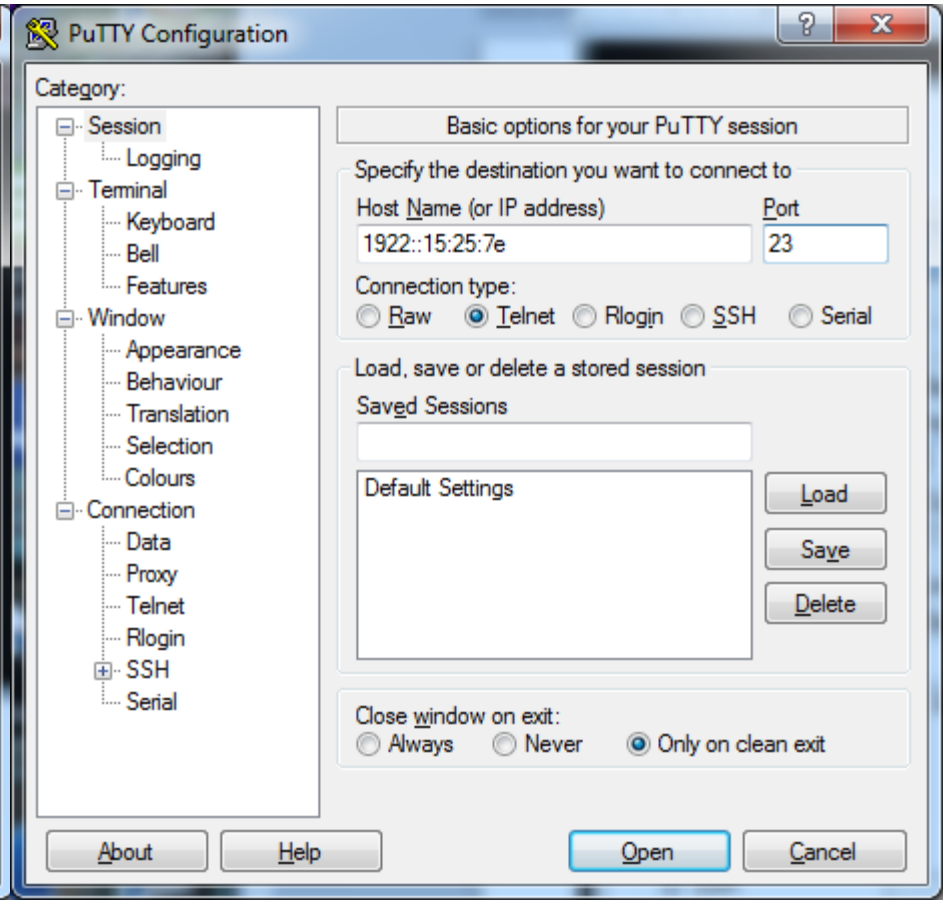
Microsoft Telnet





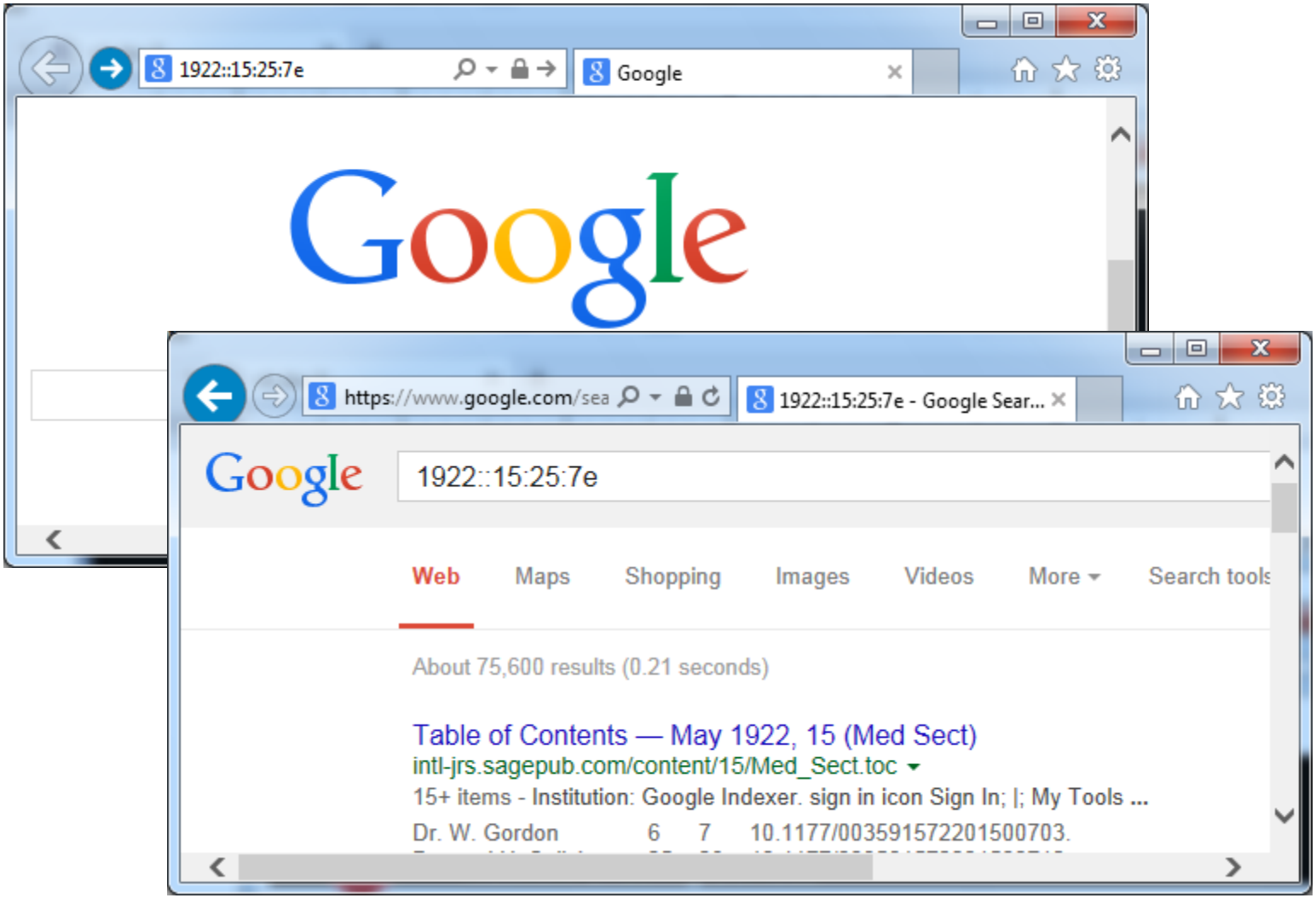
PuTTY


PuTTY Configuration
Category:
Session
Logging
Terminal
Keyboard
Bell
Features
Window
Appearance
Behaviour
Translation
Selection
Colours
Connection
Data
Proxy
Telnet
Rlogin
SSH
Serial
Basic options for your PuTTY session
Specify the destination you want to connect to
Host Name (or IP address)
Port
0
Connection type:
Raw
Telnet
Rlogin
SSH
Serial
Load, save or delete a stored session
Saved Sessions
Default Settings
Load
Save
Delete
Close window on exit:
Always
Never
Only on clean exit
About
Help
Open
Cancel


PuTTY Configuration
Category:
Session
Logging
Terminal
Keyboard
Bell
Features
Window
Appearance
Behaviour
Translation
Selection
Colours
Connection
Data
Proxy
Telnet
Rlogin
SSH
Serial
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:
Raw
Telnet
Rlogin
SSH
Serial
Load, save or delete a stored session
Saved Sessions
Default Settings
Load
Save
Delete
Close window on exit:
Always
Never
Only on clean exit
About
Help
Open
Cancel

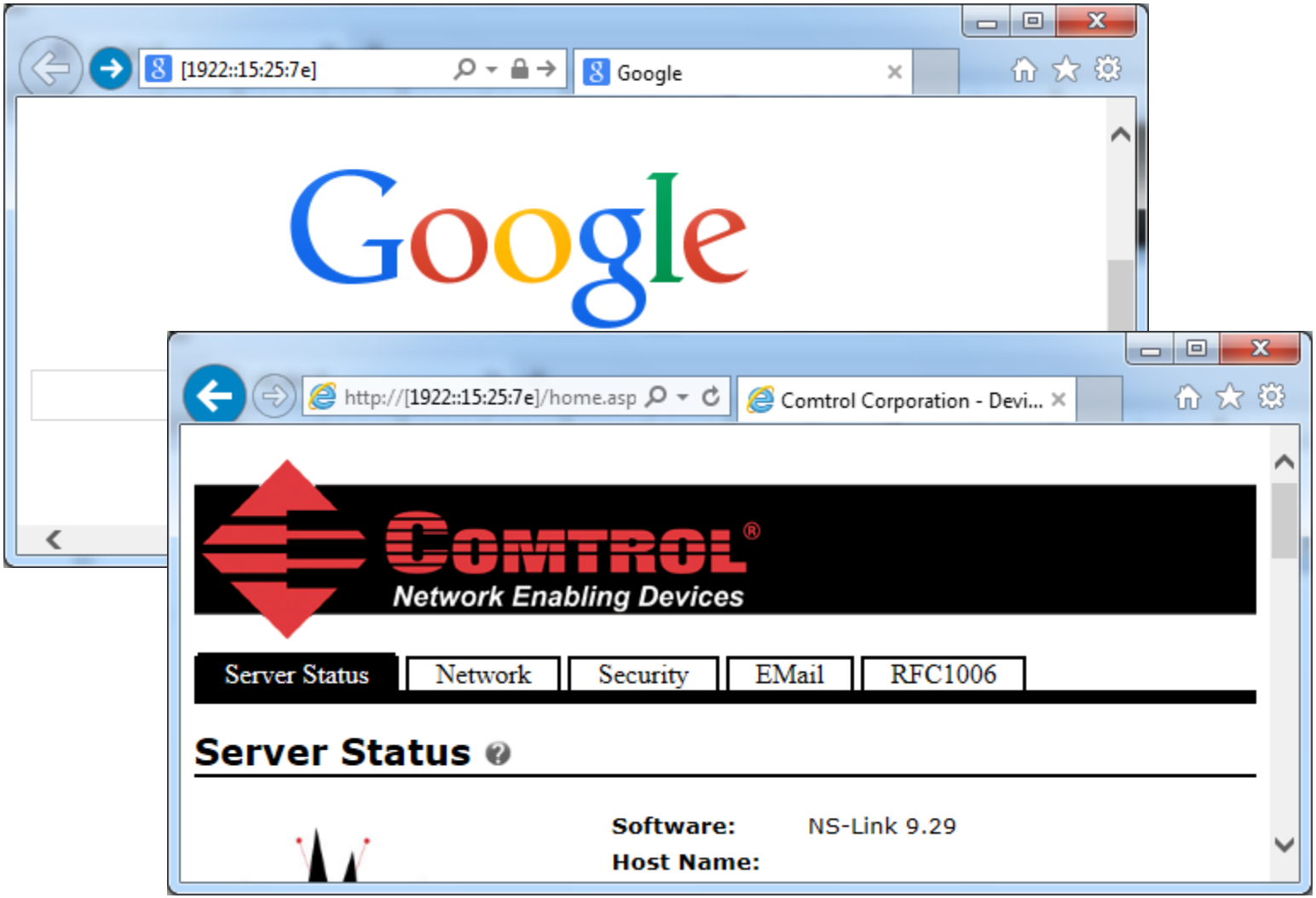
Internet Explorer

Without Required [ ]

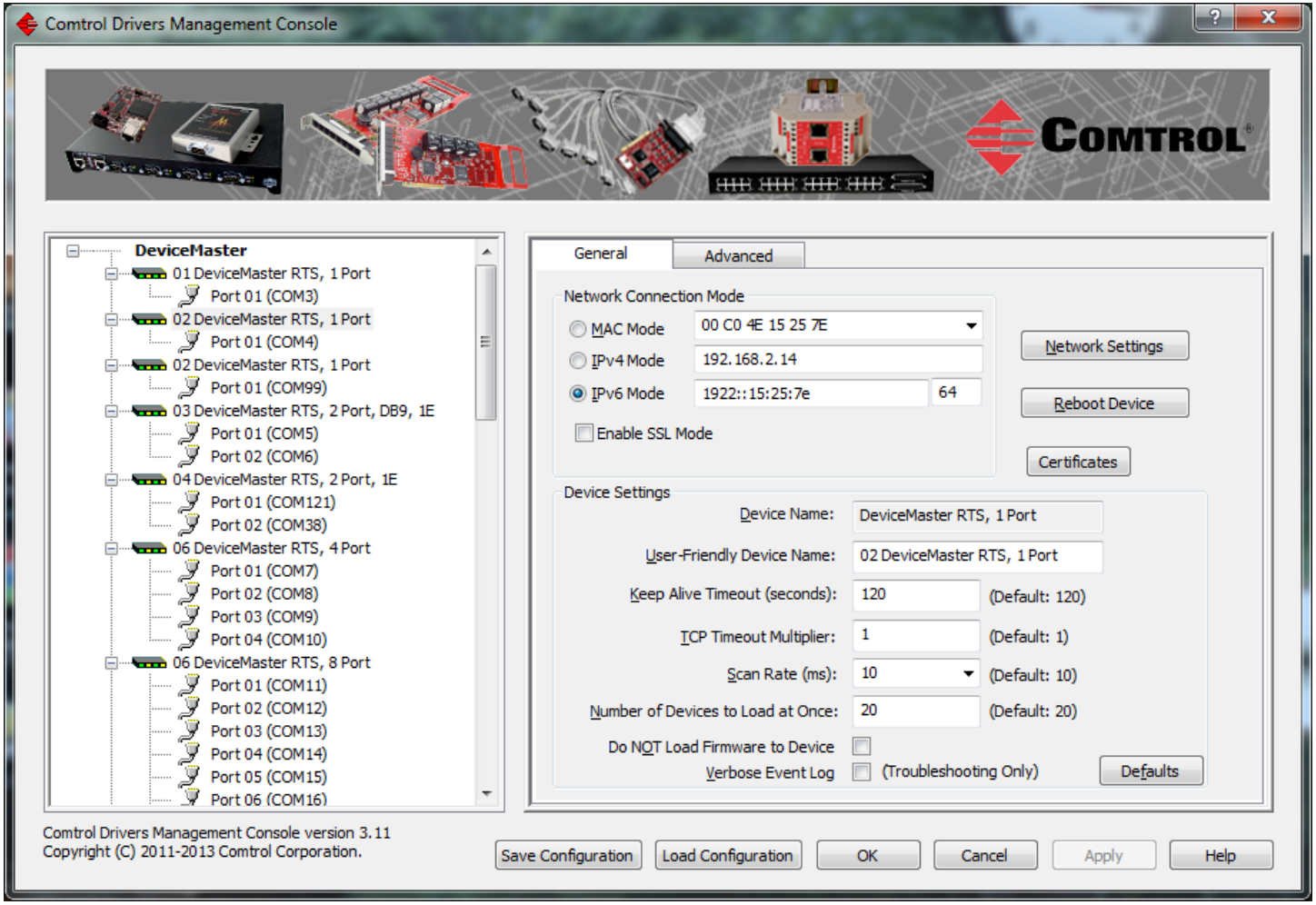


Internet Explorer

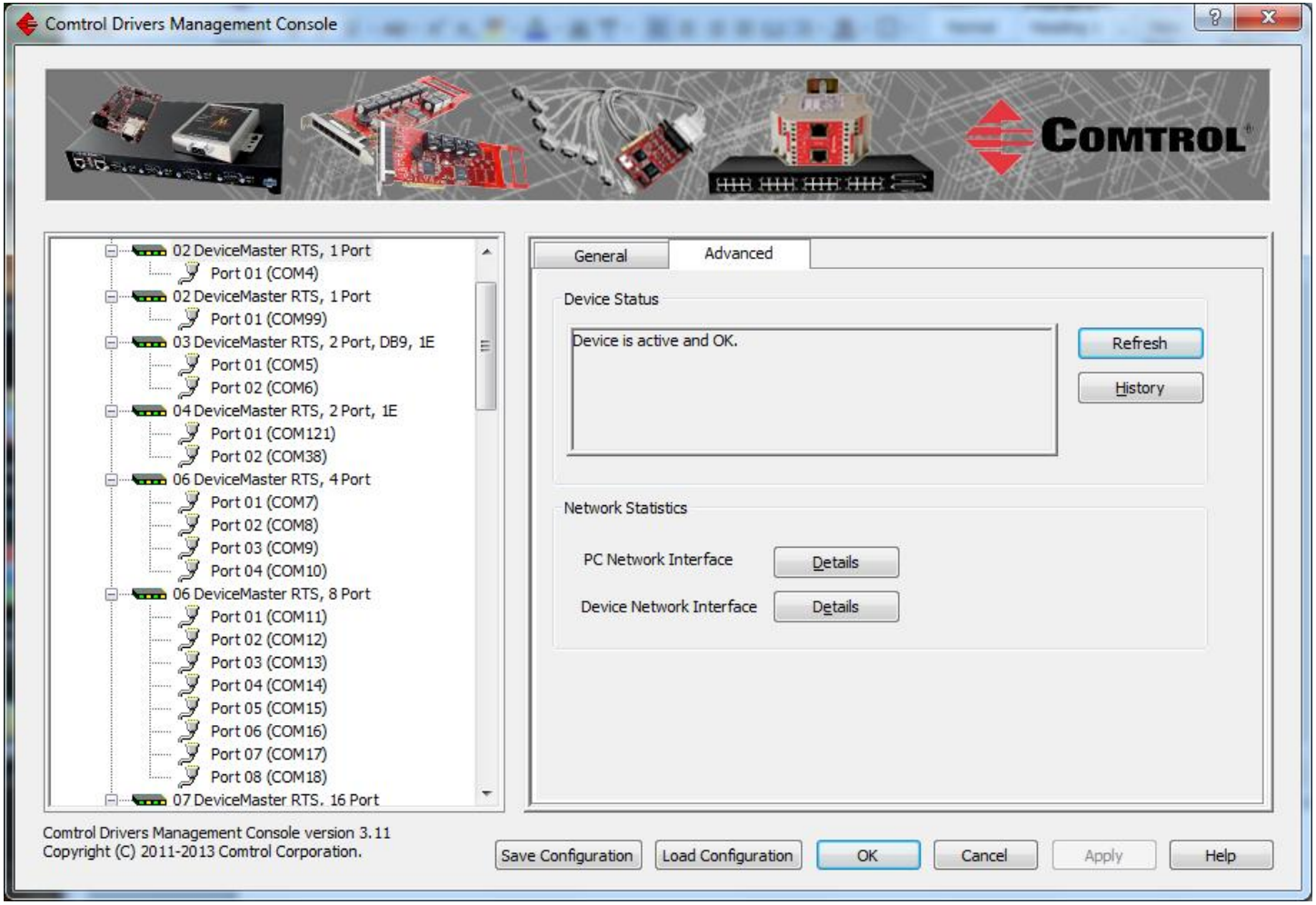
With Required [ ]



NS-Link Driver



NS-Link Device Status



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+