

# IPv6

CERN, 6th June 2012 - IPv6 day  
edoardo.martelli@cern.ch

# IPv6 day: 6th of June 2012



<http://www.worldipv6day.org/>

# IPv6 and IPv4

# Addresses

# IP addresses



## IPv4

32 bits

Written as 4 groups of 8 bits, decimal notation:

**137.138.10.16**

(correspond to: 89.8A.0A.10 Hex)

## IPv6

128 bits

Written as 8 groups of 16 bits, hexadecimal notation:

**2001:0db8:a137:b138:c000:d000:e000:f001**

# Subnets



## IPv4

Netmask (0s in the host part):

**137.138.10.0 255.255.255.0**

Prefix length (number of bits used for the network address):

**137.138.10.0/24**

## IPv6

Only prefix length:

**2001:0db8:a137:b138::/64**

Host part is omitted

Smallest network: /64 (recommendation)

# Network and Host parts



1	16	32	48	64	80	92	108	128	
1111:2222			:3333:4444		:5555:6666			:7777:8888/64	
Site prefix			Subnet		Host				

# Number of addresses



## IPv4

32 bits means  $2^{32} \sim 4$  billions

## IPv6

128 bits means  $2^{128} \sim$  infinite

A normal allocation for a site/company (/32) gives:

- **$2^{32}$  subnets** (the whole IPv4 space)
- **$2^{64}$  host addresses per subnet** (25000 hosts per square meter on earth, per subnet)



# IPv6 notation



## IPv6

Leading 0s can be omitted:

**2001:0db8:a100:0001:0020:0300:0000:4000**

can also be written:

**2001:db8:a100:1:20:300:0:4000**

Groups of four 0s can be omitted and replaced by :: (only once):

**2001:0db8:a137:0000:0000:abcd:0000:1234**

can also be written:

**2001:0db8:a137::abcd:0:1234**

# Special addresses



	IPv4	IPv6
Loopback	127.0.0.1	::1
Unspecified address		::
Link Local		FE80::/10
Unique Local	10.0.0.0/8 (RFC1918)	FC00::/7
Default route	0.0.0.0/0	::/0
Multicast	224.0.0.0/4	FF00::/8
Documentation		2001:DB8::/32

[<http://tools.ietf.org/html/rfc4291>]

# Broadcast vs Multicast



IPv4 uses broadcast to reach all the nodes on a subnet:

**255.255.255.255**

Broadcast addresses no longer exist in IPv6, but special multicast addresses for groups of hosts. Some examples:

All Nodes Addresses:

**FF02::1** (link-local)

All Routers Addresses:

**FF02::2** (link-local)

**FF05::2** (site-local)

All DHCPv6 servers:

**FF02::1:2** (link-local)

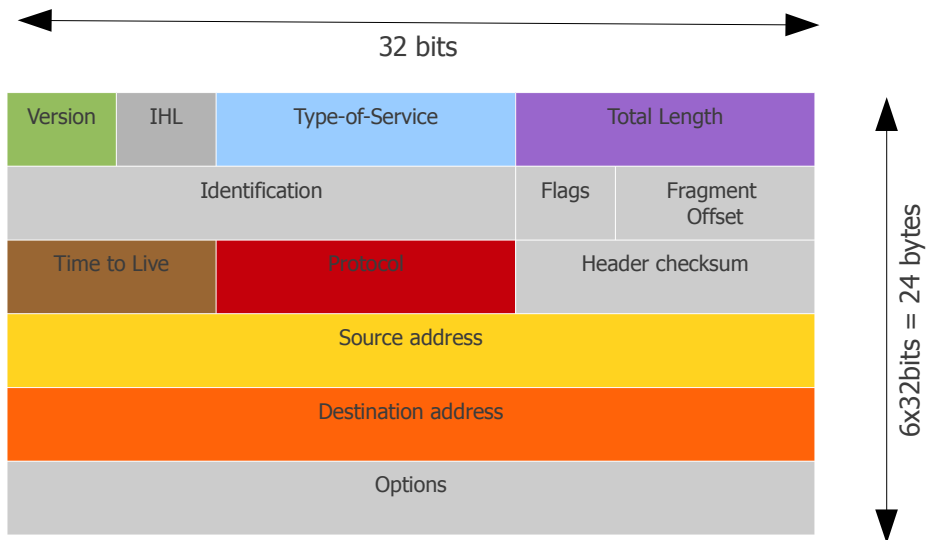
**FF05::1:3** (site-local)

# Packets

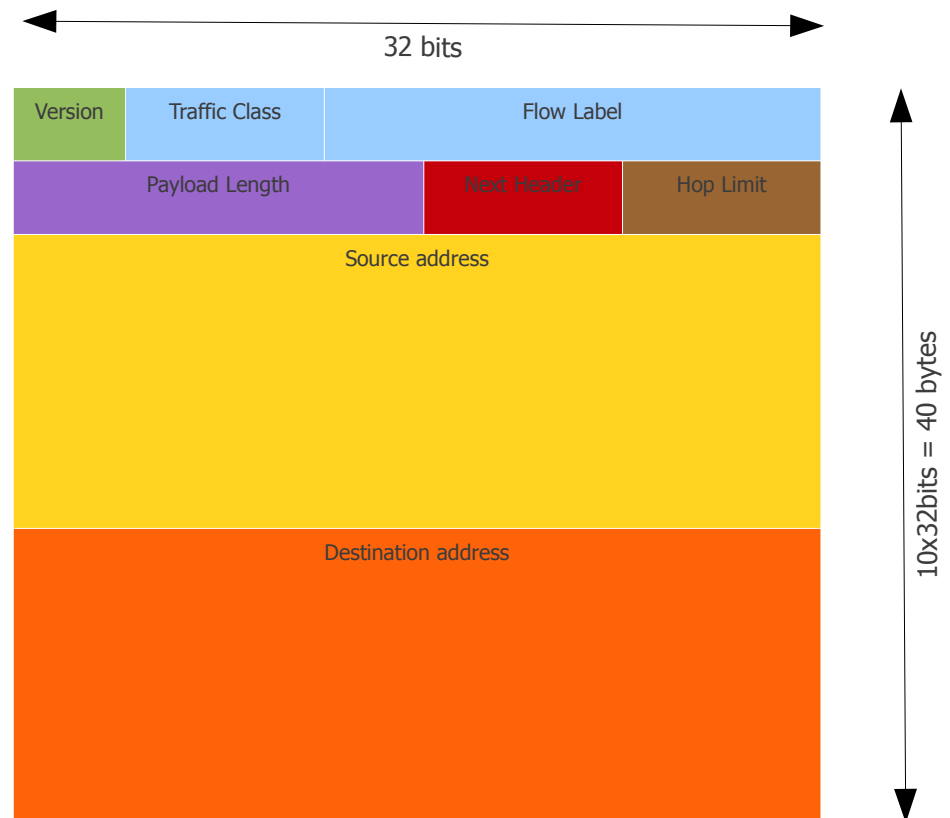
# IP headers



## IPv4 header



## IPv6 header



[<http://tools.ietf.org/html/rfc2460>]

# Fragmentation



**IPv4:** When a packet is too big for the next link over which it is to travel, it can be fragmented by the sender (host or router).

**IPv6:** Fragmentation can only occur at the source node, and reassembly is only done at the destination node.

IPv6 routers never fragment IPv6 packets. Packets exceeding the size of the maximum transmission unit of the destination link are dropped and this condition is signaled by a Packet too Big ICMPv6 type 2 message to the originating node, similarly to the IPv4 method when the Don't Fragment bit set.

End nodes in IPv6 are expected to perform path MTU discovery to determine the maximum size of packets to send, and the upper-layer protocol is expected to limit the payload size. However, if the upper-layer protocol is unable to do so, the sending host may use the Fragment extension header in order to perform end-to-end fragmentation of IPv6 packets.

[[http://en.wikipedia.org/wiki/IPv6\\_packet#Fragmentation](http://en.wikipedia.org/wiki/IPv6_packet#Fragmentation)]

## IPv4:

Minimum MTU = 576 Bytes

Maximum MTU = 65535 ( $2^{16} - 1$ ) Bytes

## IPv6:

Minimum MTU = 1280 Bytes

Maximum MTU = 4294967295 ( $2^{32} - 1$ ) Bytes

# Protocols



# Neighbor discovery



IPv4: **ARP** Address Resolution Protocol

IPv6: **NDP** Neighbor Discovery Protocol

**NDP** specifies 5 types of ICMP packets:

- **Router Advertisement (RA)**: periodic advertisement of the availability of a router
- **Router Solicitation (RS)**: the host needs RA immediately (at boot time)
- **Neighbor Solicitation (NS)**: to determine the link-layer address of a neighbor (equivalent to ARP request)
- **Neighbor Advertisement (NA)**: answer to a NS packet (equivalent to ARP reply)
- **Redirect**: Used by a router to inform a host of a better route to a given destination

[<http://tools.ietf.org/html/rfc4861>]

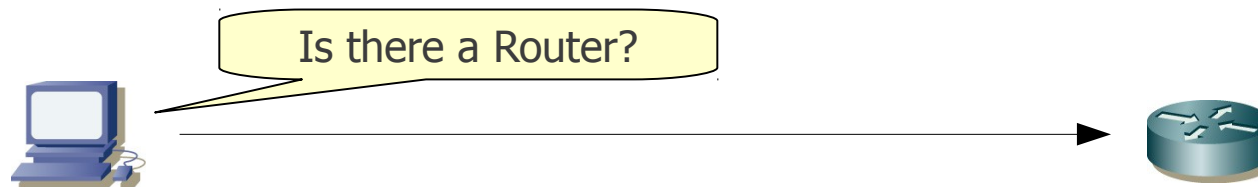
# Host Auto-configuration



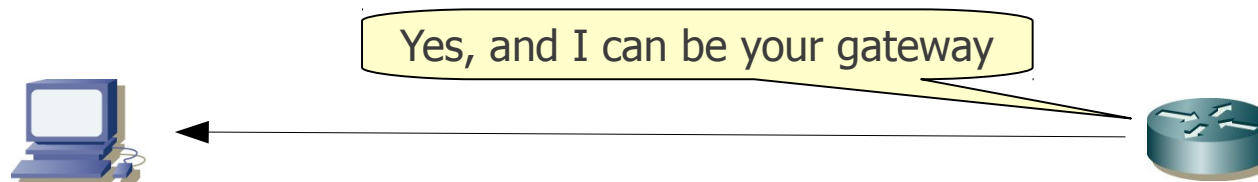
IPv4: **DHCP**

IPv6: **SLAAC** StateLess Address AutoConfiguration  
**DHCPv6**

IPv6 hosts can configure themselves automatically when connected to a routed IPv6 network using ICMPv6 router discovery (RD) messages and EUI-64 for their own unique address.



Routers respond to those requests with a router advertisement (RA) packet that contains network configuration parameters (subnet, default gateway).



[<http://tools.ietf.org/html/rfc2462>]

# EUI-64



EUI-64 is an identifier used to generate a unique host address from the MAC address

**MAC address:**



FFFE inserted:



Bit 7 is inverted:

0000 0000

0000 0010

**EUI-64 address:**



[<http://tools.ietf.org/html/rfc3513>]

# Routing



**RIP**(v2) IPv4 only

**RIPng** IPv6 only

**OSPF**(v2) IPv4 only

**OSPFv3** IPv6 only

**ISIS** IPv4 and IPv6

**Multiprotocol BGP** IPv4 and IPv6

# Deployment

# Change your mindset

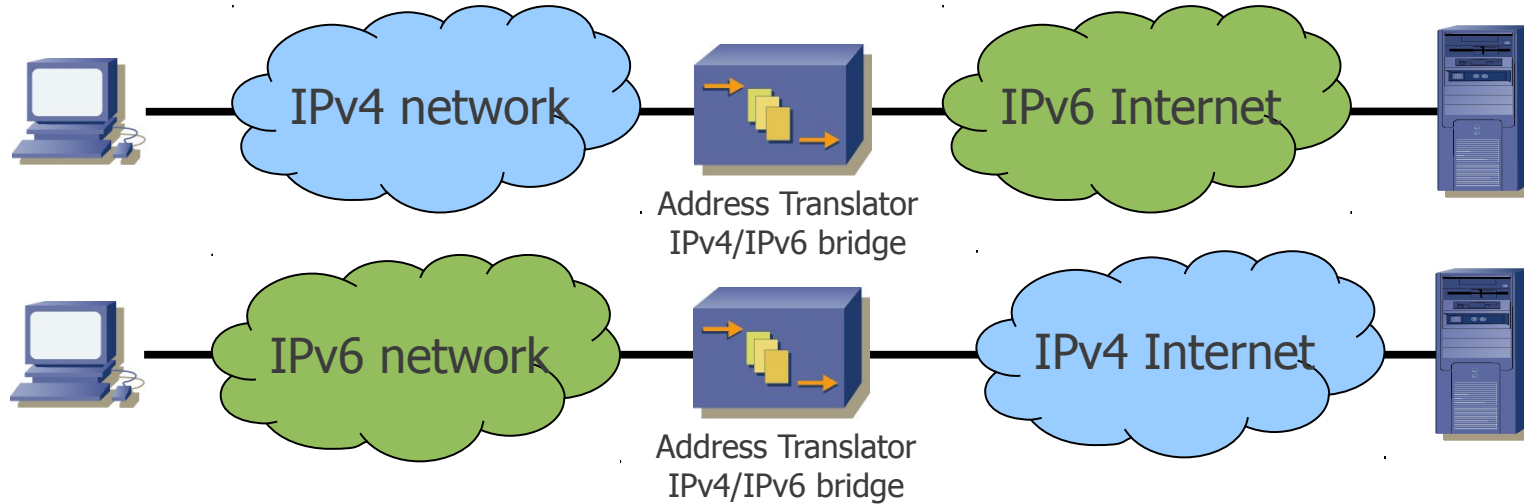


- No fear to waste
- Multiple addresses per interface, even in the same IPv6 subnet
- No NAT (not even designed)

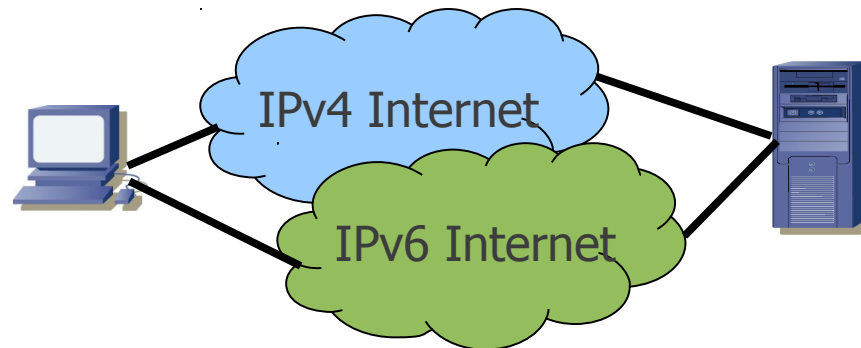


# Transition strategies

## Bridging:



## Dual Stack:



## Bridging

- doesn't scale
- no end-to-end connectivity
- all typical issues of NAT
- may be good for an easy start



## Dual-Stack

- The way to go!

# Hands-On

# Start IPv6: Linux

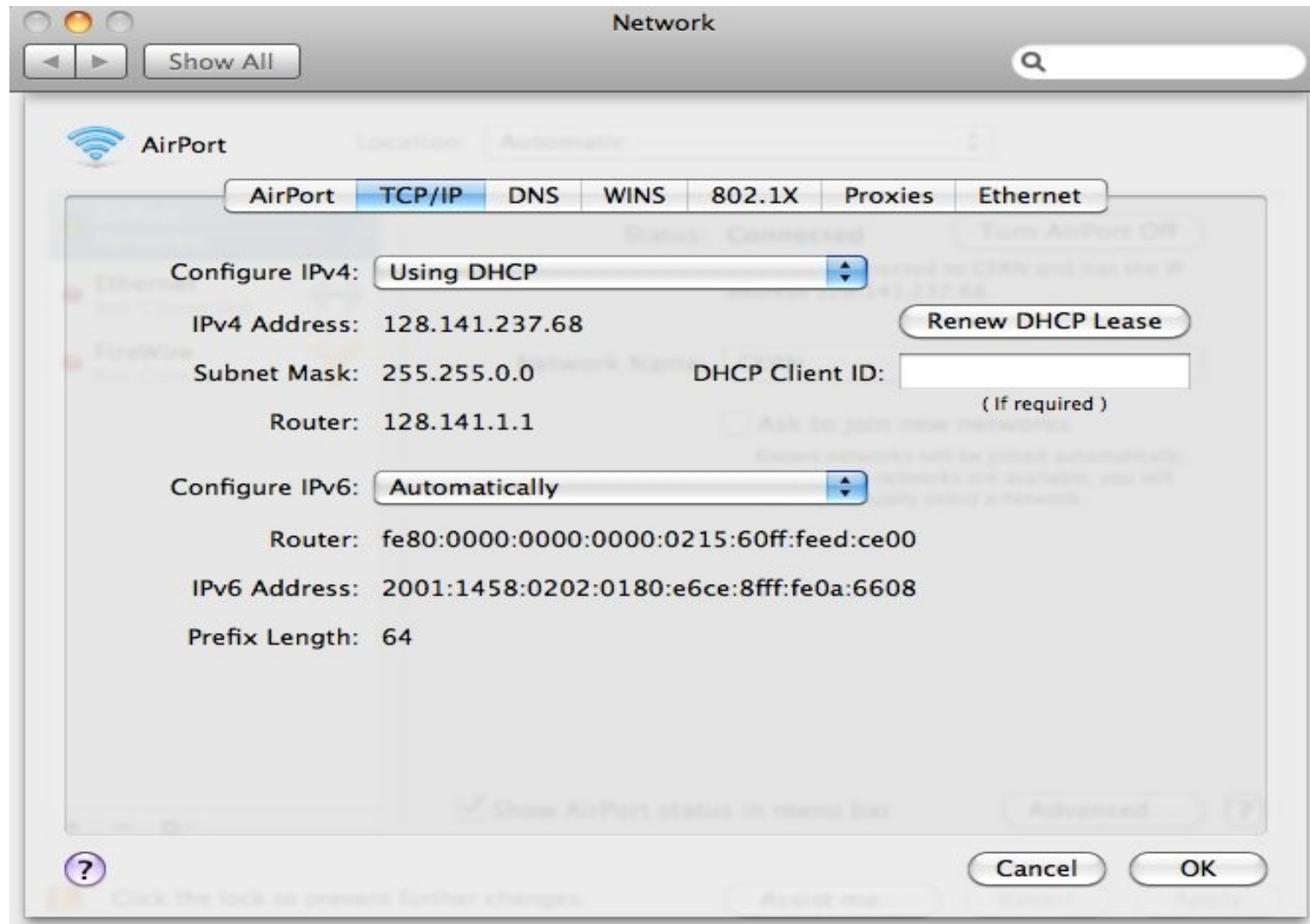


- **SLC5:** IPv6 may be disabled. Edit the file `/etc/modprobe.conf` and remove the lines disabling ipv6 (`#alias ipv6 off,`  
`#options ipv6 disable=1`); then reboot
- **Others:** on by default

# Start IPv6: MacOS X



Enable IPv6 in System Preference, Network:

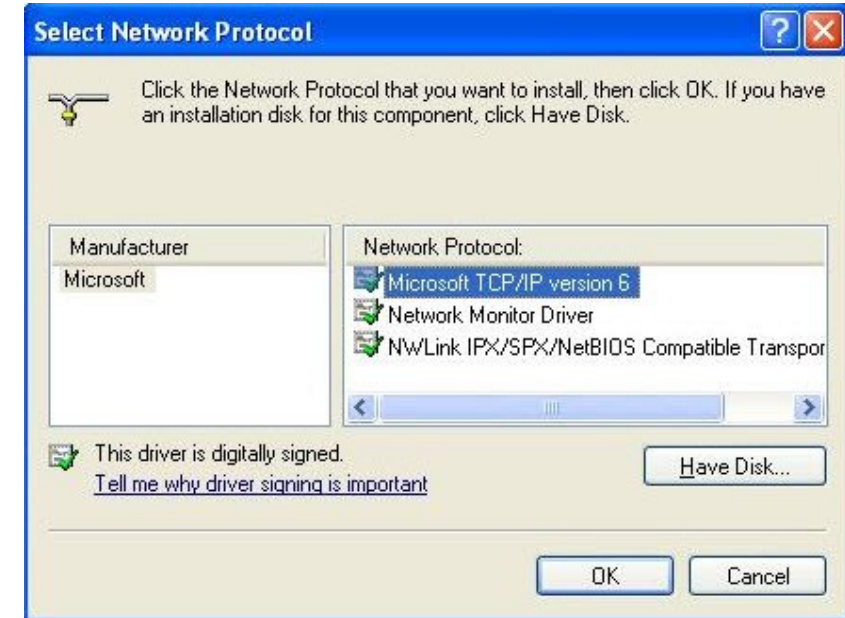


# Start IPv6: Windows



- **Windows 7:** on by default
- **Windows Vista:** on by default
- **Windows XP:**

1. Open Network Connections
2. Right-click any local area connection, and then click Properties.
3. Click Install.
4. In the Select Network Component Type dialog box, click Protocol, and then click Add.
5. In the Select Network Protocol dialog box, click Microsoft TCP/IP version 6, and then click OK.
6. Click Close to save changes to your network connection.



# Check IPv6: Linux



```
marit> ifconfig
```

```
wlan0      Link encap:Ethernet  HWaddr cc:af:78:b0:d5:f4
           inet addr:128.141.237.134  Bcast:128.141.255.255  Mask:255.255.0.0
           inet6 addr: 2001:1458:202:180:ad02:b668:dca8:5d0a/64  Scope:Global
           inet6 addr: 2001:1458:202:180:ceaf:78ff:feb0:d5f4/64  Scope:Global
           inet6 addr: fe80::ceaf:78ff:feb0:d5f4/64  Scope:Link
           UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
           RX packets:95074  errors:0  dropped:0  overruns:0  frame:0
           TX packets:27280  errors:0  dropped:0  overruns:0  carrier:0
           collisions:0  txqueuelen:1000
           RX bytes:58292242 (58.2 MB)  TX bytes:3596671 (3.5 MB)
```

```
marit> ip -6 route
```

```
2001:1458:201:b130::/64 dev wlan0  proto kernel  metric 256
fe80::/64 dev wlan0  proto kernel  metric 256
default via 2001:1458:202:180::1 dev wlan0  metric 1024
```

# Check IPv6: MacOS X



```
mac$ ifconfig
en1: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    ether e4:ce:8f:0a:66:08
    inet6 fe80::e6ce:8fff:fe0a:6608%en1 prefixlen 64 scopeid 0x6
    inet6 2001:1458:202:167:e6ce:8fff:fe0a:6608 prefixlen 64 autoconf
    inet 128.141.236.202 netmask 0xffff0000 broadcast 128.141.255.255
    media: autoselect
    status: active
```

```
mac$ netstat -rn
```

```
Routing tables
```

```
Internet6:
```

Destination	Gateway	Flags	Netif
<b>default</b>	<b>fe80::218:71ff:febb:6e00%en1</b>	UGc	en1
::1	::1	UH	lo0
2001:1458:202:167::/64	link#6	UC	en1
2001:1458:202:167::1	a:0:30:b0:20:c1	UHLW	en1



# Check IPv6: Windows 7



```
C:\>ipconfig
```

```
Wireless LAN adapter Wireless Network Connection:
```

```
IPv6 Address. . . . . : 2001:1458:202:180:b87d:a686:7f8f:cb3b
Temporary IPv6 Address. . . . . : 2001:1458:202:180:dc2d:e953:1553:2b2c
Link-local IPv6 Address . . . . . : fe80::b87d:a686:7f8f:cb3b%12
IPv4 Address. . . . . : 128.141.237.112
Subnet Mask . . . . . : 255.255.0.0
Default Gateway . . . . . : fe80::215:60ff:feed:ce00%12
                            128.141.1.1
```

```
C:>netstat -rn
```

```
=====
```

```
Interface List
```

```
12...00 1e 65 71 8b 0a .....Intel(R) WiFi Link 5100 AGNIPv6 Route Table
```

```
=====
```

```
Active Routes:
```

If	Metric	Network Destination	Gateway
12	281	::/0	fe80::215:60ff:feed:ce00
1	306	::1/128	On-link
12	33	2001:1458:202:180::/64	On-link
12	281	2001:1458:202:180:b87d:a686:7f8f:cb3b/128	On-link
12	281	2001:1458:202:180:dc2d:e953:1553:2b2c/128	On-link
12	281	fe80::/64	On-link
12	281	fe80::b87d:a686:7f8f:cb3b/128	

# Check IPv6: <http://ipv6-test.com>



IPv6 test - IPv6/4 connectivity and speed test - Mozilla Firefox

Firefox | WebHome < IPv6 < TWiki | Test your IPv6. | IPv6 test - IPv6/4 connectivity and ... | Add-ons Manager | entropy.me.uk - SixOrNot

ipv6-test.com

Recent | EM | NET | ITCS | CERN | NEWS

## ipv6 test

connection test | speed test | ping test | website test | statistics | api | forum <sup>NEW</sup>

IPv6-test.com is a free service that checks your IPv6 and IPv4 connectivity and speed. Diagnose connection problems, discover which address(es) you are currently using to browse the Internet, and what is your browser's protocol of choice when both v6 and v4 are available.

When both protocols are available, your browser uses

### IPv6

Your internet connection is **IPv6** capable

## 2001:1458:201:b130::191

**Cern**  
  
Address type is  
**Global Unicast / Native IPv6**

Your internet connection is **IPv4** capable

## 137.138.32.137

pcitcsem-malli.cern.ch  
**RIPE Network Coordination Centre**  


FR 46.105.61.149 (+1) OVH Sarl 16276 OVH

# Check IPv6: <http://test-ipv6.com>



Test your IPv6 - Mozilla Firefox

Firefox ▾ TEST-IPV6 Test your IPv6. ▾ TEST-IPV6 Test your IPv6. ▾ v6 IPv6 test-IPv6/4 connecti... ▾ Add-ons Manager ▾ entropy.me.uk - SixOrNot ▾ SixOrNot Online Docume... ▾ +

test-ipv6.com

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Test IPv6 | [FAQ](#) | [World IPv6 Launch](#) | [Local Times](#) | [Mirrors](#) | [Stats](#)

## Test your IPv6 connectivity.

[Summary](#) | [Tests Run](#) | [Technical Info](#) | [Share Results / Contact](#)

- Your IPv4 address on the public Internet appears to be 137.138.32.137
- Your IPv6 address on the public Internet appears to be 2001:1458:201:b130::191
- The [World IPv6 Launch](#) day is June 6th, 2012. **Good news!** Your current browser, on this computer and at this location, are expected to keep working after the Launch. [\[more info\]](#)
- ✓ Congratulations! You appear to have both IPv4 and IPv6 Internet working. If a publisher publishes to IPv6, your browser will connect using IPv6. Your browser prefers IPv6 over IPv4 when given the choice (this is the expected outcome).
- ✓ Your DNS server (possibly run by your ISP) appears to have no access to the IPv6 Internet, or is not configured to use it. This may in the future restrict your ability to reach IPv6-only sites. [\[more info\]](#)

**Your readiness scores**

**10/10** for your IPv4 stability and readiness, when publishers offer both IPv4 and IPv6

**9/10** for your IPv6 stability and readiness, when publishers are forced to go IPv6 only

Click to see [test data](#)

(Updated server side IPv6 readiness stats)

[Like](#) [Simon Leinen](#) and 13,382 others like this. [Tweet](#) 4,749

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Need something simpler? <http://omgipv6day.com> Spread the word!

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[Mirrors](#) | [Mission](#) | [Source](#) | [Email](#) - [Attributions](#) | [Debug](#)  
This is a mirror of test-ipv6.com. The views expressed here may or may not reflect the views of the mirror owner.

US 216.218.228.114 Hurricane Electric, Inc. 6939 HURRICANE

# Check IPv6: SixOrNot Firefox Add-on



The screenshot shows the Firefox Add-ons Manager interface. The browser tabs include 'WebHome < IPv6 < TWiki', 'Test your IPv6', 'IPv6 test - IPv6/4 connect...', 'Add-ons Manager', 'entropy.me.uk - SixOrNot', and 'SixOrNot Online Docume...'. The main content area displays the details for the 'SixOrNot 0.7.3' add-on by Timothy Baldock. The add-on is described as an 'IPv6 status indicator' that shows whether a website supports IPv6. It includes a description of its functionality, a list of settings (Automatic Updates, Last Updated, Homepage, Rating, Show addressbar icon, Greyscale mode), and a preview image of the add-on's interface.

## 6 SixOrNot 0.7.3

By [Timothy Baldock](#)

**We Believe in an Op**  
And we're dedicated to keeping it free, open and ac

### IPv6 status indicator

This extension allows you to see at a glance whether the site you are connecting to supports the current generation of the Internet Protocol (IPv6) and whether you are connecting using the same. A panel can be opened to provide more detailed information about the remote site's IP addresses, including information about all the domains contacted in order to load the page.

The icon can be shown either in the address bar or as a toolbar button, permitting positioning almost anywhere within the Firefox window.

This add-on does not consult with any external service to determine your own IP address, avoiding any privacy concerns arising from such behaviour. A major advantage this add-on has over similar IP address add-ons is that it tries to make use of platform-native methods for determining local IP addresses and resolving remote ones. This permits a more accurate assessment of your IPv4/IPv6 connectivity.

It also combines the connection-address-only approach of other add-ons with DNS resolution. This allows you to see when you are connecting via IPv4, but the remote site has the capability to be contacted via IPv6.

Automatic Updates	<input checked="" type="radio"/> Default <input type="radio"/> On <input type="radio"/> Off
Last Updated	02/17/2012
Homepage	<a href="http://entropy.me.uk/sixornot/">http://entropy.me.uk/sixornot/</a>
Rating	★★★★☆ <a href="#">10 reviews</a>
Show addressbar icon	<input checked="" type="checkbox"/>
Greyscale mode	<input type="checkbox"/>

# Server issue



A badly configured server may cause delays in the clients:

```
host> telnet v6test.ipv6.cern.ch 80
Trying 2001:1458:201:b130::191...
Trying 137.138.32.137...
Connected to v6test.ipv6.cern.ch.
Escape character is '^]'.
```

**More information:**

**<http://cern.ch/ipv6>**