Workshop on Scientific Applications for the Internet of Things (IoT)
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IPv6 in practice with RPi

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Contents

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Objectives

▸ Use IPv6 from RPi (with Ubuntu)

▸ Understand an IPv6 LAN: addresses, prefix, autoconfiguration, DNS

▸ Use real-world services over IPv6

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Lab Topology (I)

▸ Two type of devices on the same LAN: RPi & Laptops

▸ Will use autoconfiguration for all of them

192.168.88.0/24 (DHCPv4)
2001:760:2e0b:1728:::/64 (RA)

Router

INTERNET IPv6

RPi1

RPi2

Laptop1

RPi15

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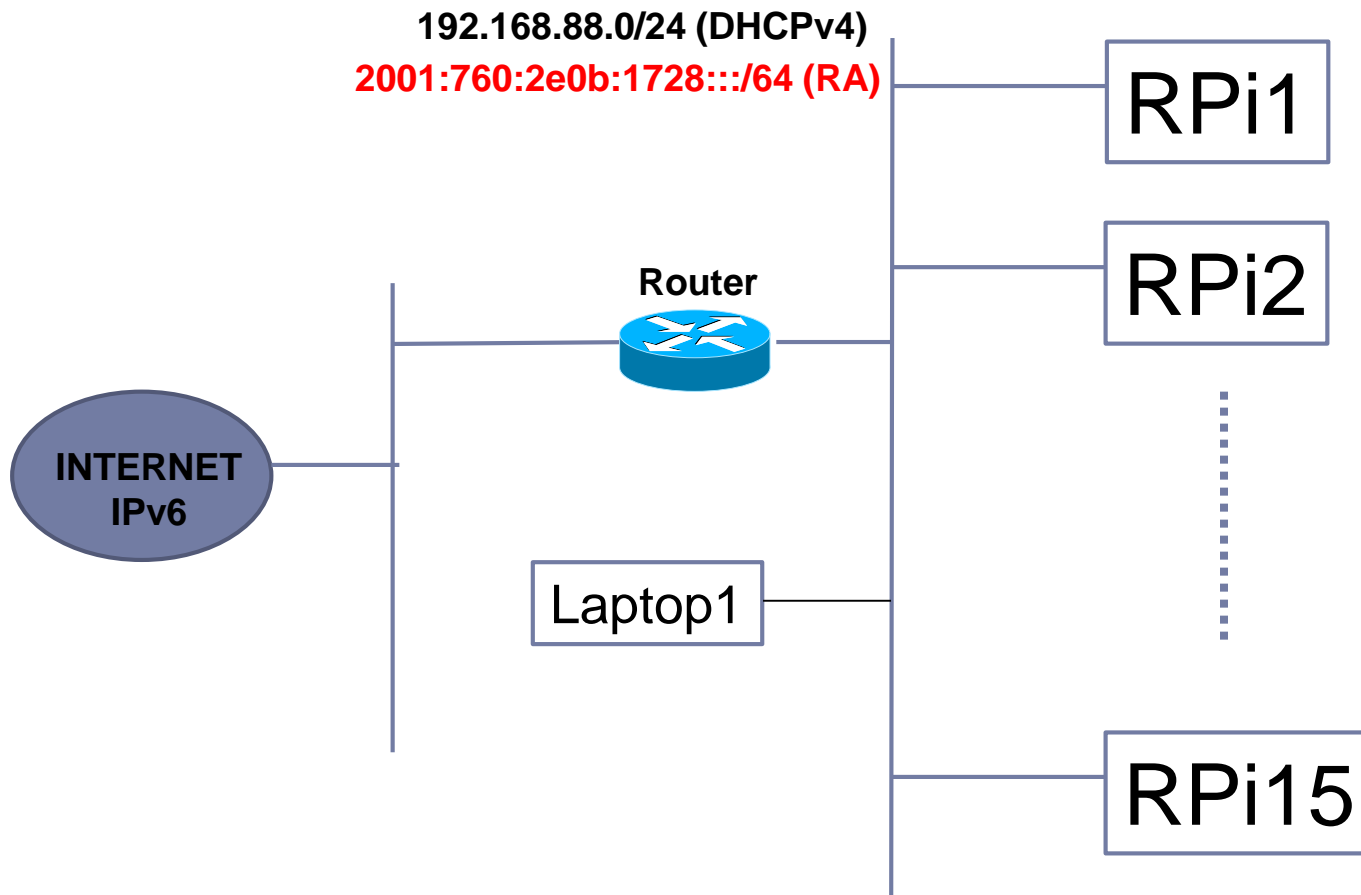
IPv6 Configuration (I)

▸ IPv6 in Linux: supported since kernel 2.4.x

▸ Now it's part of the kernel

▸ Enabled by default

▸ Useful commands:

  ▸ **ifconfig**: to check IPv6 configuration of network interfaces

  ▸ **ping6** <hostname-with-IPv6>|<IPv6-add>|[-I <interface>] <link-local-ipv6address>

  ▸ **traceroute6** -n < hostname-with-IPv6 >|< IPv6-add>

  ▸ **tracepath6** -n <hostname-with-IPv6 >|< IPv6-add>

  ▸ **tcpdump**: capture packets on an interface

▸ Two sets of tools to configure/check IPv6:

1. iptools (recommended)

2. ifconfig + route

Packages and Commands

▸ Check the package that owns a command:

`apt-cache search <command-name>`

▸ Install package:

`sudo apt-get install <package-name>`

▸ Examples of: commands -> packages:

  ▸ dig, nslookup, host -> dnsutils

  ▸ traceroute -> traceroute

  ▸ traceroute6 -> iputils-tracepath

  ▸ tcpdump -> tcpdump

IPv6 Configuration (II)

ifconfig

```
eth0    Link encap:Ethernet   HWaddr 00:E0:81:05:46:57
        inet addr:192.168.88.3  Bcast:192.168.88.255  Mask:255.255.255.0
        inet6 addr: fe80::2e0:81ff:fe05:4657/64 Scope:Link
        inet6 addr: 2001:760:2e0b:1728::3/64 Scope:Global
        UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
        RX packets:2010563 errors:0 dropped:0 overruns:0 frame:0
        TX packets:1700527 errors:0 dropped:0 overruns:2 carrier:0
        collisions:0 txqueuelen:100
        RX bytes:205094215 (195.5 Mb)  TX bytes:247063610 (235.6Mb)
        Interrupt:11 Base address:0xe000 Memory:f8201000-f8201038
lo      Link encap:Local Loopback
        inet addr:127.0.0.1  Mask:255.0.0.0
        inet6 addr: ::1/128 Scope:Host
        UP LOOPBACK RUNNING  MTU:16436  Metric:1
        RX packets:1675838 errors:0 dropped:0 overruns:0 frame:0
        TX packets:1675838 errors:0 dropped:0 overruns:0 carrier:0
        collisions:0 txqueuelen:0
        RX bytes:659846244 (629.2 Mb)  TX bytes:659846244 (629.2 Mb)
```

IPv6 Configuration (III)

▸ Ping examples:

```
# ping6 ::1
PING ::1(::1) 56 data bytes
64 bytes from ::1: icmp_seq=1 ttl=64 time=0.047 ms
64 bytes from ::1: icmp_seq=2 ttl=64 time=0.039 ms
64 bytes from ::1: icmp_seq=3 ttl=64 time=0.042 ms
64 bytes from ::1: icmp_seq=4 ttl=64 time=0.020 ms
--- ::1 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 2999ms
rtt min/avg/max/mdev = 0.020/0.037/0.047/0.010 ms


# ping6 -I eth0 fe80::2e0:81ff:fe05:4617
PING fe80::2e0:81ff:fe05:4617(fe80::2e0:81ff:fe05:4617) from ::1 eth0:
56 data bytes
64 bytes from fe80::2e0:81ff:fe05:4617: icmp_seq=1 ttl=64 time=0.056 ms
64 bytes from fe80::2e0:81ff:fe05:4617: icmp_seq=2 ttl=64 time=0.055 ms
64 bytes from fe80::2e0:81ff:fe05:4617: icmp_seq=3 ttl=64 time=0.048 ms
64 bytes from fe80::2e0:81ff:fe05:4617: icmp_seq=4 ttl=64 time=0.128 ms
--- fe80::2e0:81ff:fe05:4657 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 2997ms
rtt min/avg/max/mdev = 0.048/0.071/0.128/0.034 ms
```

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IPv6 Configuration (IV)

▸ ## Add IPv6 address

```
# /sbin/ip -6 addr add <ipv6address>/<prefixlength> dev <interface>
# /sbin/ifconfig <interface> inet6 add <ipv6address>/<prefixlength>
```

▸ ## Delete IPv6 address

```
# /sbin/ip -6 addr del <ipv6address>/<prefixlength> dev <interface>
# /sbin/ifconfig <interface> inet6 del <ipv6address>/<prefixlength>
```

▸ ## See neighbor cache

```
# ip -6 neigh show [dev <device>]
```

▸ ## Add an entry to the neighbor cache

```
# ip -6 neigh add <IPv6 address> lladdr <link-layer address> dev
  <device>
```

▸ ## Delete an entry in the neighbor cache

```
# ip -6 neigh del <IPv6 address> lladdr <link-layer address> dev
  <device>
```

IPv6 Configuration (V)

▸ ## Check IPv6 routes

```
#/sbin/ip -6 route show [dev <device>]

#/sbin/route -A inet6
```

▸ ## Add route through a gateway

```
#/sbin/ip -6 route add <ipv6network>/<prefixlength> via <ipv6address> [dev
    <device>]

#/sbin/route -A inet6 add <ipv6network>/<prefixlength> gw <ipv6address> [dev
    <device>]
```

▸ ## Delete route through a gateway

```
#/sbin/ip -6 route del <ipv6network>/<prefixlength> via <ipv6address> [dev
    <device>]

#/sbin/route -A inet6 del <network>/<prefixlength> [dev <device>]
```

▸ ## Add route through an interface

```
#/sbin/ip -6 route add <ipv6network>/<prefixlength> dev <device> metric 1

#/sbin/route -A inet6 add <network>/<prefixlength> dev <device>
```

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IPv6 Configuration (VI)

▸ ## Delete route through an interface

```
# /sbin/ip -6 route del <ipv6network>/<prefixlength> dev <device>

# /sbin/route -A inet6 del <network>/<prefixlength> dev <device>
```

▸ ## Default route is written as `default` or `::/0` or `2000::/3`

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IPv6 Configuration (VII)

▸ **Permanent configuration in Debian/Ubuntu:**

   ▸ Edit **/etc/network/interfaces** for network, IPv4 and IPv6:

```
iface eth0 inet6 static
        address 2001:db8:1:A::1
        netmask 64
        # gateway 2001:db8:1234:5::1
```

   ▸ Edit **/etc/resolv.conf** for DNS servers, IPv4 and IPv6 :

```
nameserver 2001:db8:1::53
nameserver 2001:db8:2::53
```

▸ **ADD the IPv6 configuration, leave the IPv4 one**

▸ **Reload network configuration:**

```
1.  sudo /etc/init.d/networking restart
2.  sudo ifdown eth0
    sudo ifup eth0
```

Use IPv6 (I)

▸ **Check IPv6 services running on your Linux:**

```
# netstat –tan
   Active Internet connections (servers and established)
   Proto Recv-Q Send-Q Local Address  Foreign Address      State
   ...
   tcp6   0      0      :::80         :::*            LISTEN
   ...


# netstat -uan
```

▸ **SSH to RPi**

    ▸ From Linux use the command line: ssh

    For user/password on host 2001:db8:1:2::A use

```
#ssh user@2001:db8:1:2::A
password
```

    ▸ From Windows: use putty

Use IPv6 (II)

- DNS resolution in Linux: **dig / host / nslookup**
- To resolve www.example.com on 2001:db8:1::53 server

```
# dig any www.example.com @2001:db8:1::53
# host -t ANY www.example.com 2001:db8:1::53
# host -t AAAA www.example.com 2001:db8:1::53
```

- You can use different parameters with dig:
  - **any/a/aaaa/mx/ns** to indicate any type of information related with the domain name or specific IPv4 (a), IPv6(aaaa), mail exchange (mx) or name server (ns) information
  - **+short** to have a short answer, not so verbose
  - **+trace** to see the resolution path through different servers
- You can use different parameters with host:
  - -t any/aaaa/a/mx/ns

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Exercises (I)

1. Write down the name of the interfaces where you have IPv6 enabled.
2. Write down the IPv6 address(es) of each one.
3. Identify the type of addresses.

4. Check your neighbor cache
5. Ask to other students about their link-local and global IPv6 addresses. Try to ping them.
6. Check again your neighbor cache, do you see any change on it?

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Exercises (II)

7. Check your IPv6 routes.

8. What's the default gateway for IPv6? Write it down. What kind of address is it? How do you think this has been configured?

9. What are your IPv6 DNS servers?

10. Configure the following public IPv6 DNS servers:

    ```
    nameserver 2001:4860:4860::8888
    nameserver 2001:4860:4860::8844
    ```

11. Use them to resolve (take note of the addresses):

    ▶ www.facebook.com

    ▶ www.google.com

    ▶ www.wikipedia.org

    ▶ www.youtube.com

    ▶ www.yahoo.com

    ▶ maps.google.com

    ▶ docs.google.com

Exercises (III)

12. Ping the IPv4 and IPv6 addresses of the sites mentioned before.

13. Traceroute the IPv4 and IPv6 addresses of the web sites mentioned before.

14. Check services running on your host:

   ▸ What IPv6 services do you see running on with TCP?

   ▸ What IPv6 services do you see running on with UDP?

Exercises (IV)

▸ Configure Static IPv6 Addresses

192.168.88.0/24 (DHCPv4)
2001:760:2e0b:1728:::/64 (RA)

.101
::101 RPi1

.102
::102 RPi2

Router

INTERNET IPv6

Laptop1 **::1**
.1

.115
::115 RPi15

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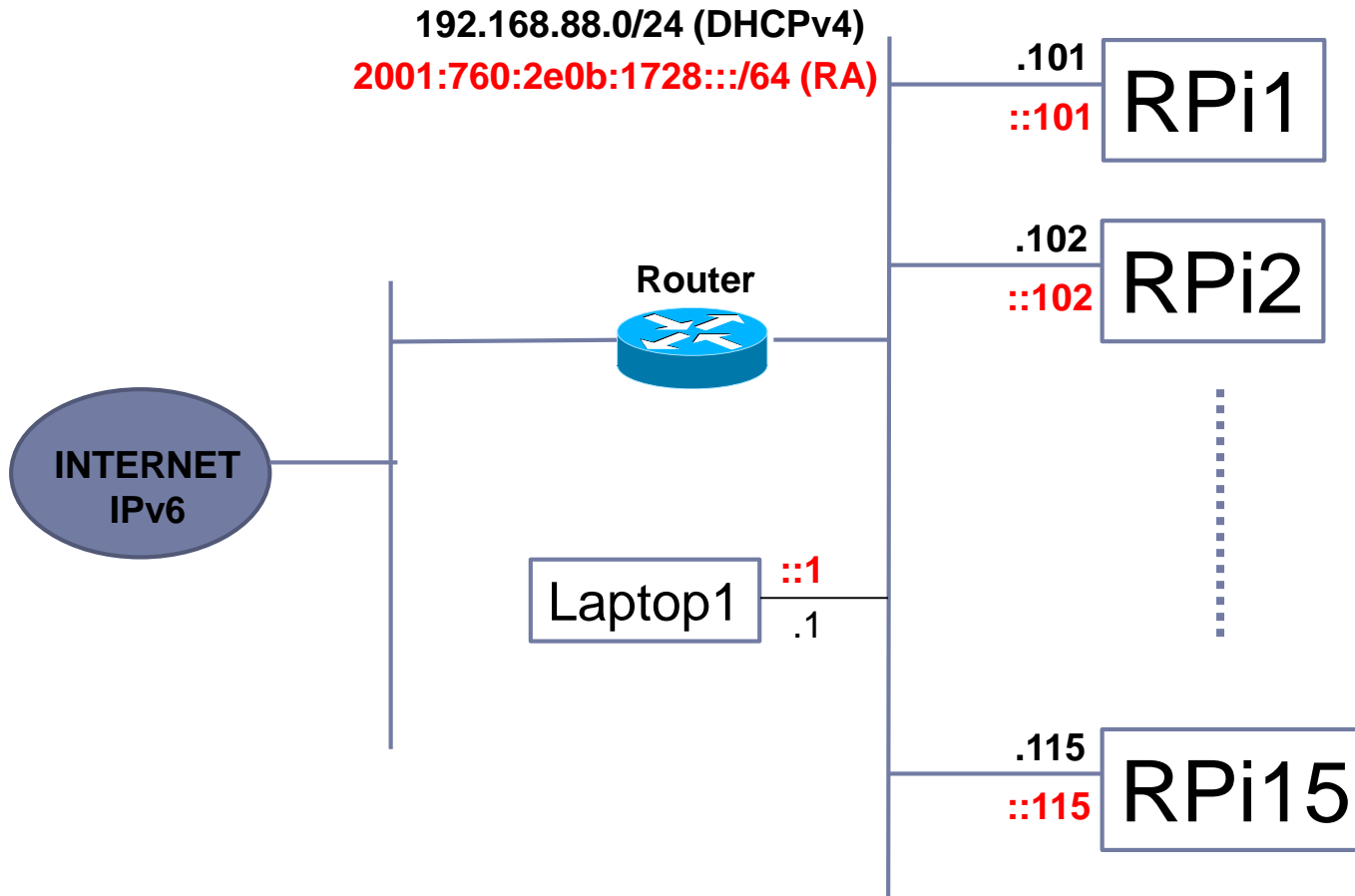
Thanks!

▸ # Questions?

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▸ http://about.me/alvarovives
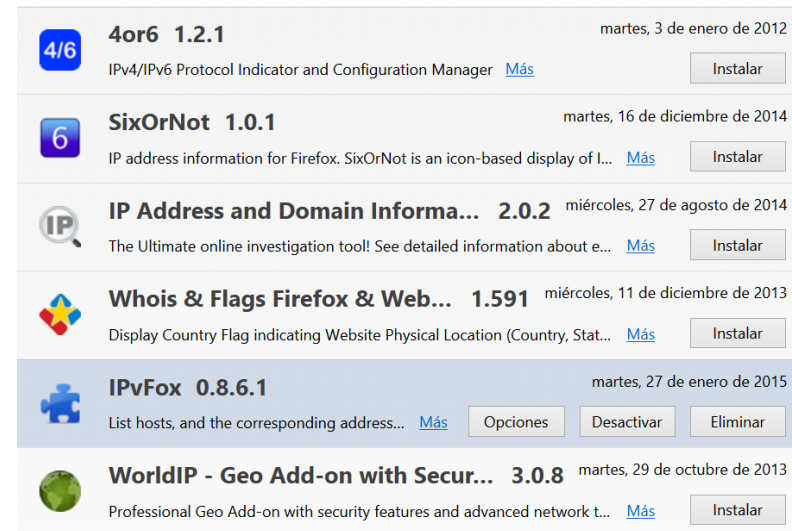
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IPv6 Plugins on Browsers: Firefox (I)

▶ There are a various Firefox plugins related with IPv6, in order of preference:

  ▶ **IPvFox** (0.8.6.1 from 6/1/2015)

  ▶ **SixOrNot** (1.0.1 from 16/12/2015)

  ▶ 4or6 (1.2.1 from 3/1/2012)

▶ To look for plugins in Firefox:

  ▶ Tools -> Plugins -> Search: ipv6

IPv6 Plugins on Browsers: Firefox (II)

▸ **IPvFox** could be directly installed clicking on 'Install'.

▸ From now on in the navigation bar there will be an indicator of the protocol version used to access the contents, for example, with IPvFox:

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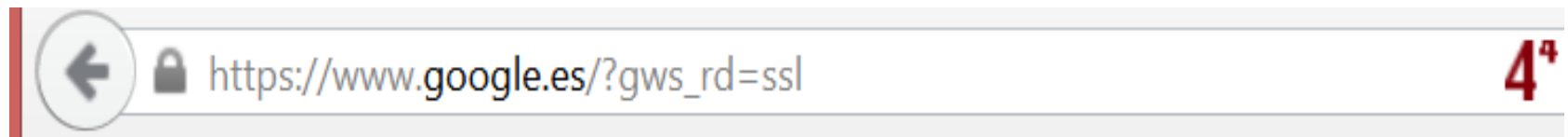
IPv6 Plugins on Browsers: Firefox (III)

▸ For **SixOrNot**, after installing it, you have to enter into Options:
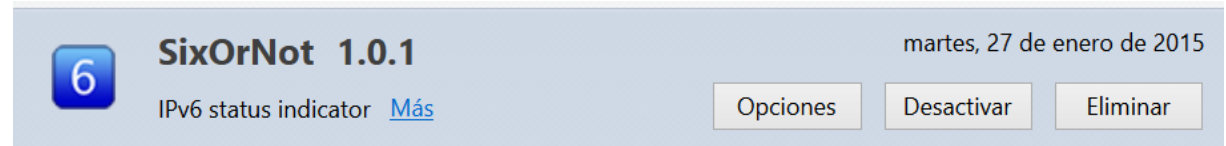
▸ And activate "Show Icon in the address bar":
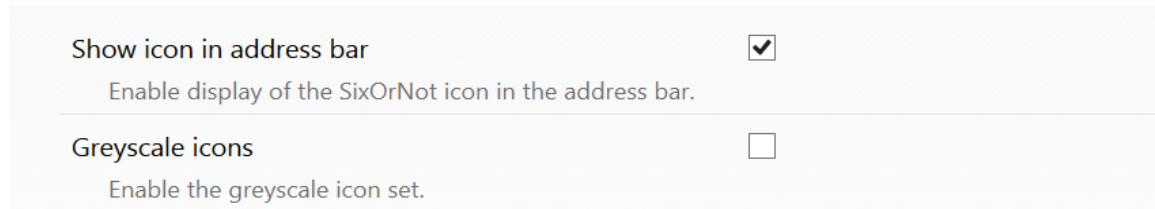
▸ Icon in navigation bar showing info about domain names (IPv4, IPv6 or both). Color indicate IPv4 (red) or IPv6 (green).

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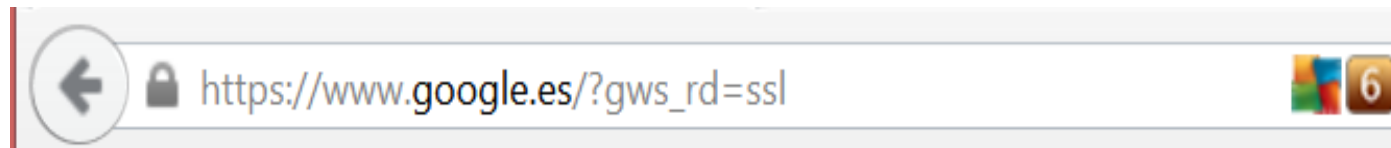
IPv6 Plugins on Browsers: Chrome (I)

▶ There are some extensions for Chrome related with IPv6, in order of preference::

  ▶ **IPvFoo** (version 1.31 from 18/1/2015)

  ▶ **IP Address and Domain Information** (version 3.33 from 26/8/2014)

  ▶ if ipv6 (version 1.2 from 10/9/2013)

▶ Look in the "Extensions" menu or write in the address bar "chrome://extensions/". Once there, click in "Obtain more extensions"
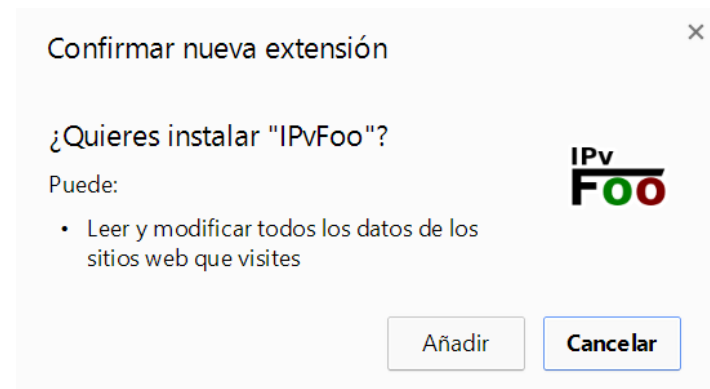
▶ Write ipv6 in the upper left search box and press ENTER

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IPv6 Plugins on Browsers: Chrome (II)

▸ Click the blue button "+ FREE" to install the extension

▸ It ask to confirm we want to give the required permissions, click in "Add":

IPv6 Plugins on Browsers: Chrome (III)

▸ **IPvFoo** icon in the address bar indicate if you can access to the contents of the web page using IPv4, IPv6 or both.
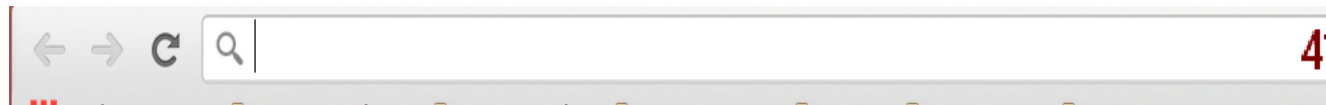
▸ Clicking the **IP Address and Domain Information** icon shows detailed information about the domain and the IPs: