How the Internet works

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European Parliament - Brussels, Belgium
10 November 2016
Practicalities

• Questions at the end, please!
• Red pointers indicate policy aspects

• Questions later? alex@centr.org or peter@centr.org
The association for exchange, dialogue and innovation of country code domain registries in Europe

CENTR community
- 53 full members (ccTLDs), 9 associate members and 12 observers
- 50% of country code domain name registrations worldwide
- More than 70 million registrations

Member services
- Dialogue platform via working groups, general assemblies, mailing lists
- Best practice and knowledge sharing
- Policy, news, statistics and industry analysis
- A voice for ccTLDs in the region and the wider Internet community
What will you learn today?

• What the Internet really looks like (it’s not a cloud)
• What IP addresses are
• How they connect to each other
• How networks work
• How the domain name system (DNS) works
• Why the root is important and why IANA matters
• Who does what in the technical layers of the Internet
• Why this all matters for the Internet Governance discussions
Lately in the news

Google down: Orange bloque et redirige par erreur ses internautes vers le ministère de l’Intérieur [MAJ]

Réseaux: Depuis ce matin, les abonnés de chez Orange qui souhaitent se rendre sur le site de Google, de Wikipedia ou encore d’OVH rencontrent des difficultés. Certains utilisateurs se sont même vu servir une page du ministère de l’Intérieur, signalant le blocage administratif d’un site. Une erreur de DNS est en cause.

Source: ZDNet.fr | Lundi 17 Octobre 2016
Lately in the news

21 Hacked Cameras, DVRs Powered Today’s Massive Internet Outage

A massive and sustained Internet attack that has caused outages and network congestion today for a large number of Web sites was launched with the help of hacked “Internet of Things” (IoT) devices, such as CCTV video cameras and digital video recorders, new data suggests.

Earlier today cyber criminals began training their attack cannons on Dyn, an Internet infrastructure company that provides critical technology services to some of the Internet’s top destinations. The attack began creating problems for Internet users reaching an array of sites, including Twitter, Amazon, Tumblr, Reddit, Spotify and Netflix.
The Internet is built with carrots
Every single device connected to the internet requires an IP address. Not always unique though...

- IANA manages the global pool of IP addresses
- IANA hands large blocks to each region
- RIPE NCC for Europe
- RIPE NCC gives them to its members
  - ISPs
  - Mobile operators
  - Research institutions
- IP addresses can be
  - Static
  - Dynamic (consumers)
## IP addresses - IPv4 vs. IPv6

<table>
<thead>
<tr>
<th></th>
<th>IPv4</th>
<th>IPv6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Format</td>
<td>91.198.174.2</td>
<td>3ffe:6a88:85a3:08d3:1319:8a2e:0370:7344</td>
</tr>
<tr>
<td>Benefits</td>
<td>All equipment compatible</td>
<td>More secure</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Better routing – more stability IPv4 is running out due to enormous</td>
</tr>
<tr>
<td></td>
<td></td>
<td>increase in IP address consumption</td>
</tr>
<tr>
<td>Range</td>
<td>$4 \times 10^9$</td>
<td>$3.4 \times 10^{38}$</td>
</tr>
</tbody>
</table>
The association for exchange, dialogue and innovation of country code domain registries in Europe

SEE OUR MEMBERS

Highlights

CENTR Report on ICANN56

About CENTR

CENTR is the association of European country code top-level domain name registries. CENTR's main purpose is to provide its members with a forum for exchange of information.
Tip 1

IP addresses of websites can be found by using the NSLOOKUP command

![Image of command prompt window]
C:\Users\Peter Van Roste>nslookup www.centr.org
Server:   roes01.dnsresv6.prd.telenet-ops.be
Address:  2a02:1800:100::45:1

Non-authoritative answer:
Name:      www.centr.org
Addresses: 2a02:d08:1002:321:370:7216:3083:1
            37.72.163.83

C:\Users\Peter Van Roste>
Linksys WRT54GL

IP address: 192.168.1.1

Name: www.centr.org
Addresses: 2a02:d08:1002:321:370:7216:3083:1
37.72.163.83
<table>
<thead>
<tr>
<th>Region</th>
<th>IANA Registry</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America (ARIN)</td>
<td></td>
</tr>
<tr>
<td>Europe (RIPE)</td>
<td></td>
</tr>
<tr>
<td>Latin America (LACNIC)</td>
<td></td>
</tr>
<tr>
<td>Asia Pacific (APNIC)</td>
<td></td>
</tr>
<tr>
<td>Africa (AFRINIC)</td>
<td></td>
</tr>
</tbody>
</table>

“Backbone” (highly connected networks)
Tip 2

To see a potential route between your pc and the device you want to reach, use the *TRACERT* command in command prompt.
C:\Users\Peter Van Roste>tracert www.centr.org

Tracing route to www.centr.org [37.72.163.83]
over a maximum of 30 hops:

    1    5 ms    2 ms    3 ms  192.168.254.1
    2    5 ms    3 ms    3 ms  192.168.250.1
    3  110 ms   22 ms   150 ms 172.22.194.73
    4  19 ms   18 ms   18 ms  71.246-183-91.adsl-static.isp.belgacom.be [91.183.246.71]
    5  24 ms   30 ms   20 ms  70.246-183-91.adsl-static.isp.belgacom.be [91.183.246.70]
    6  22 ms   21 ms   20 ms  ae-21-1000.ibrstr6.isp.belgacom.be [91.183.246.106]
    7  22 ms   19 ms   26 ms  telenet3.bnix.net [194.53.172.64]
    8  27 ms   22 ms   24 ms  dD5E0FA70.access.telenet.be [213.224.250.112]
    9  23 ms   23 ms   23 ms  dD5E0F6F5.access.telenet.be [213.224.246.245]
   10  24 ms   23 ms   23 ms  dD5E0FDAA.access.telenet.be [213.224.253.170]
   11  23 ms   22 ms   23 ms  dD5E0301A.access.telenet.be [213.224.48.26]
   12  25 ms   23 ms   23 ms  ve300.cs1.dcg.as30961.net [88.151.241.250]
   13  31 ms   29 ms   22 ms  web-003.karakas.openminds.be [37.72.163.83]

Trace complete.

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    5   24 ms   30 ms   20 ms 70.246-183-91.adsl-static.isp.belgacom.be [91.183.246.70]
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6   22 ms 21 ms 20 ms  ae-21-1000.ibrstr6.isp.belgacom.be [91.183.246.106]
7   22 ms 19 ms 26 ms  telegen3.bnlx.net [194.53.172.64]
8   27 ms 22 ms 24 ms  dD5E0FA70.access.telenet.be [213.224.250.112]
9   23 ms 23 ms 23 ms  dD5E0F6F5.access.telenet.be [213.224.246.245]
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  5  24 ms  30 ms  20 ms 70.246-183-91.adsl-static.isp.belgacom.be [91.183.246.70]
  6  22 ms  21 ms  20 ms 1de-21-1000.10sr10.isp.belgacom.be [91.183.246.106]
  7  22 ms  19 ms  26 ms  telenet3.bnix.net [194.53.172.64]
  8  27 ms  22 ms  24 ms  jpff0a7z2.access.telenet.be [213.224.250.112]
  9  23 ms  23 ms  23 ms  dD5E0F6F5.access.telenet.be [213.224.246.245]
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5 24 ms 30 ms 20 ms  70.246-183-91.adsl-static.isp.belgacom.be [91.183.246.70]
6 22 ms 21 ms 20 ms  ae-21-1000.ibrstr6.isp.belgacom.be [91.183.246.106]
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8 27 ms 22 ms 24 ms  dD5E0FA70.access.telenet.be [213.224.250.112]
9 23 ms 23 ms 23 ms  dD5E0F6F5.access.telenet.be [213.224.246.245]
10 24 ms 23 ms 23 ms  dD5E0FDAA.access.telenet.be [213.224.253.170]
11 23 ms 22 ms 23 ms  dDEF6847.access.telenet.be [213.224.49.26]
12 25 ms 23 ms 23 ms  ve300.cs1.dcg.as30961.net [88.151.241.250]
13 31 ms 29 ms 22 ms  web-003.karakas.openminds.be [37.72.163.83]

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   11  23 ms   22 ms  23 ms  dD5E02014.access.telenet.be [213.224.48.26]
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Trace complete.

C:\Users\Peter Van Roste>
Let’s add the domain name system (DNS)

• Why do we need the DNS?
• How does it work?
• The Root
• The top-level domain
Why do we need the DNS?

There are three main reasons:

- Remembering addresses
- Flexibility (the underlying IP address/servers can change without any impact on the users)
- Security (Requests can be diverted to avoid server overload)

(And a fourth one)

- (Internet of Things [e.g. flood early warning system])
The Need for Domain Names

Smart cities
The DNS explained

https://www.youtube.com/watch?v=vZ007Vi5HIM
CENTR on YouTube: CENTRDNSS
The Root

The top-level domain (TLD) nameserver

.brussels .EU .COM .EE

europa.eu eurid.eu euractiv.eu
curia.europa.eu ec.europa.eu smtp.europa.eu

The second-level Domain

The domain server
ROOTZONE
- Rootzone Maintainer (IANA)

TLD ZONEFILE
- TLD Registry (EURid)

DOMAIN
- Domain Admin (Commission)
1. The Root
1. The Root

- IANA manages the root zone database
  - The root zone file is extracted from the root zone database

- The root zone file is hosted on 13 identical root servers, managed by different organisations (2 by EU orgs: RIPE & NetNod)

- Each of those 13 has many copies around the globe

- 4 of those copies are hosted in Brussels

- The US government (NTIA) no longer oversees the IANA function (transition occurred on 1 October 2016)
1. The Root - root zone file (root servers)

eu. 172800 IN NS x.dns.eu.
eu. 172800 IN NS y.dns.eu.
eu. 172800 IN NS cz.dns.eu.
eu. 172800 IN NS nl.dns.eu.
eu. 172800 IN NS si.dns.eu.
eu. 172800 IN NS uk.dns.eu.
EU. 86400 IN DS 61179 7 1 87E2B3544884B45F36A0DA72DADCB0239C4D73D4
EU. 86400 IN DS 61179 7 2 3B526BBC354AE085AD9984C9BE73D271411023EFF421EF184BCE41ACE3DE9F8B
EU. 86400 IN RRSIG DS 8 1 86400 20150411170000 20150401160000 48613 .
bCTz3iYxp7pTGQI7hG3jjZIsuQSp3mkDbOl1QPRoejWtSnp9caiovgl9Z49MN1bc8nWpbN6cVjB0HaswkHSOcj0VMD6ZsXIIIMNGtHPnWcBujyiGG2EdEaavBbUu
xH39zJcb1R73qZtzocbVAizuYRVIQEvTz6rg7RgXl/nE=
cz.dns.eu. 172800 IN A 93.190.128.138
nl.dns.eu. 172800 IN A 91.200.16.100
si.dns.eu. 172800 IN A 193.2.221.60
si.dns.eu. 172800 IN AAAA 2001:1470:8000:100:0:0:0:1
uk.dns.eu. 172800 IN A 195.66.241.178
x.dns.eu. 172800 IN A 194.0.1.19
x.dns.eu. 172800 IN AAAA 2001:678:4:0:0:0:0:13
y.dns.eu. 172800 IN A 194.146.106.90
y.dns.eu. 172800 IN AAAA 2001:67c:1010:23:0:0:0:53
ns6.nominum.eu. 172800 IN A 81.200.69.35
eu. 86400 IN NSEC eurovision. NS DS RRSIG NSEC
eu. 86400 IN RRSIG NSEC 8 1 86400 20150411170000 20150401160000 48613 .
Y2+jPipksunTS5NSn9BGs6XUpDNfFX8w1YwZug1+Hh4xr3f+YzoHAMtm3maHqN/A2QwB+tWKxbQhLx9blR4vFaJ2H8fEGOFS+P6e3X2lRRxYOcEkubx+v9QweLpSq
Syp5uA6OVpOUQ/phShZLDVVfCTbLOxBacFeXTQFSLZjQ=
## 2. The top-level domains

- There are (currently) 1,532 top-level domains

<table>
<thead>
<tr>
<th>ccTLDs</th>
<th>gTLDs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Country</strong>&lt;br&gt;254 ASCII ccTLDs – 44 IDN ccTLDs</td>
<td><strong>Generic top level domain</strong>&lt;br&gt;1200-ish gTLDs</td>
</tr>
<tr>
<td>ISO 3166 – 1 alpha 2 list Delegated based on IETF standard RFC 1591</td>
<td>Unrestricted but costly long ICANN process</td>
</tr>
<tr>
<td>Managed locally – serving the local internet community – funded by registration fees</td>
<td>Managed by independent operator under contract with ICANN – operator pays ICANN</td>
</tr>
</tbody>
</table>

**Cyrillic .eyJ & Greek .EU**

**.wine / .vin**
2. .eu WHOIS record for europa.eu


<table>
<thead>
<tr>
<th>NAME SERVERS</th>
<th>IP Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>ns1bru.europa.eu</td>
<td>158.168.131.22</td>
</tr>
<tr>
<td>ns2eu.bt.net</td>
<td>2a01:7080:14:101::2</td>
</tr>
<tr>
<td>ns3bru.europa.eu</td>
<td>2a01:7080:14:101::2</td>
</tr>
<tr>
<td>ns2lux.europa.eu</td>
<td>158.169.9.30</td>
</tr>
<tr>
<td>ns1lux.europa.eu</td>
<td>158.169.9.11</td>
</tr>
<tr>
<td>ns2bru.europa.eu</td>
<td>158.169.131.32</td>
</tr>
<tr>
<td>ns1.be.colt.net</td>
<td></td>
</tr>
<tr>
<td>ns1.bt.net</td>
<td></td>
</tr>
<tr>
<td>ns3lux.europa.eu</td>
<td>2a01:7080:24:101::2</td>
</tr>
</tbody>
</table>
1. User types domain name into browser

www.example.eu
1. User types domain name into browser

www.example.eu
2. Browser asks Access Provider for IP address of www.example.eu

What’s the IP address for www.example.eu?

Access Provider

DNS Resolver
3. DNS Resolver asks Root Name Server for IP of a DNS server for .eu

Where’s the .eu registry DNS server?
3. DNS Resolver asks Root Name Server for IP of a DNS server for .eu

It’s at IP address: 198.51.100.56
4. DNS Resolver asks .eu DNS server for IP of the DNS server for example.eu

Where’s the DNS server for example.eu?
4. DNS Resolver asks .eu DNS server for IP of the DNS server for example.eu

It’s at IP address: 203.0.113.185
5. DNS Resolver asks for the IP address for www.example.eu ...
5. DNS Resolver asks for the IP address for www.example.eu ...

It's at IP address: 192.0.2.12
6. ... and passes the IP address back to the browser

The IP address for www.example.eu is: 192.0.2.12
7. ... which contacts the website host using the IP address

Contacting 192.0.2.12

www.example.eu
8. HTTP traffic begins
How DNS Blocking Works
How DNS blocking works

What’s the IP address for www.example.eu?
How DNS blocking works

No such domain.
How DNS blocking works

Or...
How DNS blocking works

What’s the IP address for www.example.eu?
How DNS blocking works

It’s at (cough) IP: 203.0.113.234 (cough)
How DNS blocking works

Access Provider

DNS Resolver

www.example.eu

Police controlled server

203.0.113.234
You have been redirected to this stop page because the website you are trying to visit offers content that is considered illegal according to Belgian legislation.

If you are the owner or administrator of this website and you consider to be wrongly redirected, you can report this by fax at +32(0)2/733.56.16.
Lately in the news

Google down: Orange bloque et redirige par erreur ses internautes vers le ministère de l'Intérieur [MAJ]

Réseaux: Depuis ce matin, les abonnés de chez Orange qui souhaitaient se rendre sur le site de Google, de Wikipedia ou encore d'OVH rencontrent des difficultés. Certains utilisateurs se sont même vu servir une page du ministère de l'Intérieur, signalant le blocage administratif d'un site. Une erreur de DNS est en cause.
How DNS blocking works

Or..
4. DNS Resolver asks .eu DNS server for IP of the DNS server for example.eu

(cough) Never heard of it (cough)
Conclusions

• “DNS blocking” is a technical term
  – It describes a technical procedure, not an outcome
  – It is not synonymous with “preventing access using DNS”
  – It is unlikely to prevent users from reaching content they are actively seeking

• There is a big difference between seeking to protect users from content they wish to avoid, and seeking to obstruct users from reaching content they seek
  – In the first case, you can enlist the support of users and the software and services they use
  – In the latter, there is always a way around any impediment, and these ways can and will be made easy for anyone to use
Time to wrap-up
What did we learn today?

The internet is built with carrots
What did we learn today?
What did we learn today?

- www.europa.eu
- www.hyves.nl
- www.bbc.co.uk
- info@standaard.be
What did we learn today?
What did we learn today?

Technical flaws in DNS blocking
One more thing...

Some corners were cut in the making of this presentation.
Thanks to Malcolm Hutty (Linx) for the fancy slides on blocking!
Thank you

alex@centr.org