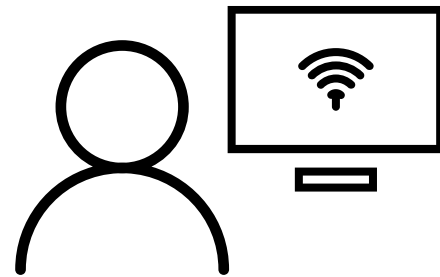


What's in a name?

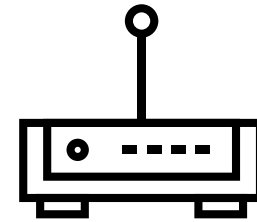
A Gentle Introduction to DNS

Why do we need DNS?



User

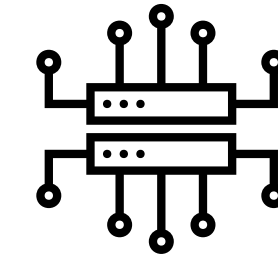
I'd like to visit
enthusiasticon.de



Router

I need an IP address

Cool, lets make an
HTTP request



DNS Resolver

I can help!

The IPs are:
- 104.27.138.91
- 104.27.139.91



We can look at how this works!


```
$ dig enthusiasticon.de
```



```
> dig enthusiasticon.de
```

```
; <<>> DiG 9.10.6 <<>> enthusiasticon.de
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 13171
;; flags: qr rd ra; QUERY: 1, ANSWER: 2, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags;; udp: 4096
;; QUESTION SECTION:
;enthusiasticon.de.      IN  A

;; ANSWER SECTION:
enthusiasticon.de.  258 IN  A    104.27.139.91
enthusiasticon.de.  258 IN  A    104.27.138.91

;; Query time: 0 msec
;; SERVER: 192.168.12.1#53(192.168.12.1)
;; WHEN: Mon May 18 10:30:20 CEST 2020
;; MSG SIZE  rcvd: 78
```



```
> dig enthusiasticon.de
```

```
; <<>> DiG 9.10.6 <<>> enthusiasticon.de
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 13171
;; flags: qr rd ra; QUERY: 1, ANSWER: 2, AUTHORITY: 0, ADDITIONAL: 1
```

```
;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags;; udp: 4096
```

```
;; QUESTION SECTION:
;enthusiasticon.de.      IN  A
```

```
;; ANSWER SECTION:
enthusiasticon.de.  258 IN  A    104.27.139.91
enthusiasticon.de.  258 IN  A    104.27.138.91
```

```
;; Query time: 0 msec
;; SERVER: 192.168.12.1#53(192.168.12.1)
;; WHEN: Mon May 18 10:30:20 CEST 2020
;; MSG SIZE rcvd: 78
```


» dig enthusiasticon.de

```
; <<>> DiG 9.10.6 <<>> enthusiasticon.de
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 13171
;; flags: qr rd ra; QUERY: 1, ANSWER: 2, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags;; udp: 4096
;; QUESTION SECTION:
;enthusiasticon.de.      IN  A

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enthusiasticon.de.  258 IN  A    104.27.139.91
enthusiasticon.de.  258 IN  A    104.27.138.91

;; Query time: 0 msec
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;; WHEN: Mon May 18 10:30:20 CEST 2020
;; MSG SIZE rcvd: 78
```



```
> dig enthusiasticon.de
```

```
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;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 13171
;; flags: qr rd ra; QUERY: 1, ANSWER: 2, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags;; udp: 4096
;; QUESTION SECTION:
;enthusiasticon.de.      IN  A

;; ANSWER SECTION:
enthusiasticon.de.  258 IN  A    104.27.139.91
enthusiasticon.de.  258 IN  A    104.27.138.91

;; Query time: 0 msec
;; SERVER: 192.168.12.1#53(192.168.12.1)
;; WHEN: Mon May 18 10:30:20 CEST 2020
;; MSG SIZE  rcvd: 78
```

So how does the router know?


```
$ dig +trace enthusiasticon.de
```



```
; <<>> DiG 9.10.6 <<>> A +trace enthusiasticon.de
```

```
;; global options: +cmd
```

```
.      79301    IN  NS  c.root-servers.net.  
.      79301    IN  NS  f.root-servers.net.  
.      79301    IN  NS  h.root-servers.net.
```

```
[.....]
```

```
.      79301    IN  NS  j.root-servers.net.
```

```
;; Received 239 bytes from 192.168.12.1#53(192.168.12.1) in 0 ms
```

```
de.    172800   IN  NS  a.nic.de.  
de.    172800   IN  NS  f.nic.de.
```

```
[.....]
```

```
de.    172800   IN  NS  z.nic.de.
```

```
;; Received 751 bytes from 193.0.14.129#53(k.root-servers.net) in 34 ms
```

```
enthusiasticon.de. 86400   IN  NS  noel.ns.cloudflare.com.  
enthusiasticon.de. 86400   IN  NS  maria.ns.cloudflare.com.
```

```
;; Received 601 bytes from 2001:678:2::53#53(a.nic.de) in 25 ms
```

```
enthusiasticon.de. 300 IN  A   104.27.138.91  
enthusiasticon.de. 300 IN  A   104.27.139.91
```

```
;; Received 78 bytes from 173.245.59.216#53(noel.ns.cloudflare.com) in 22 ms
```



Hierarchies!

enthusiasticon.de.<root>

Who knows
about "."?

local router

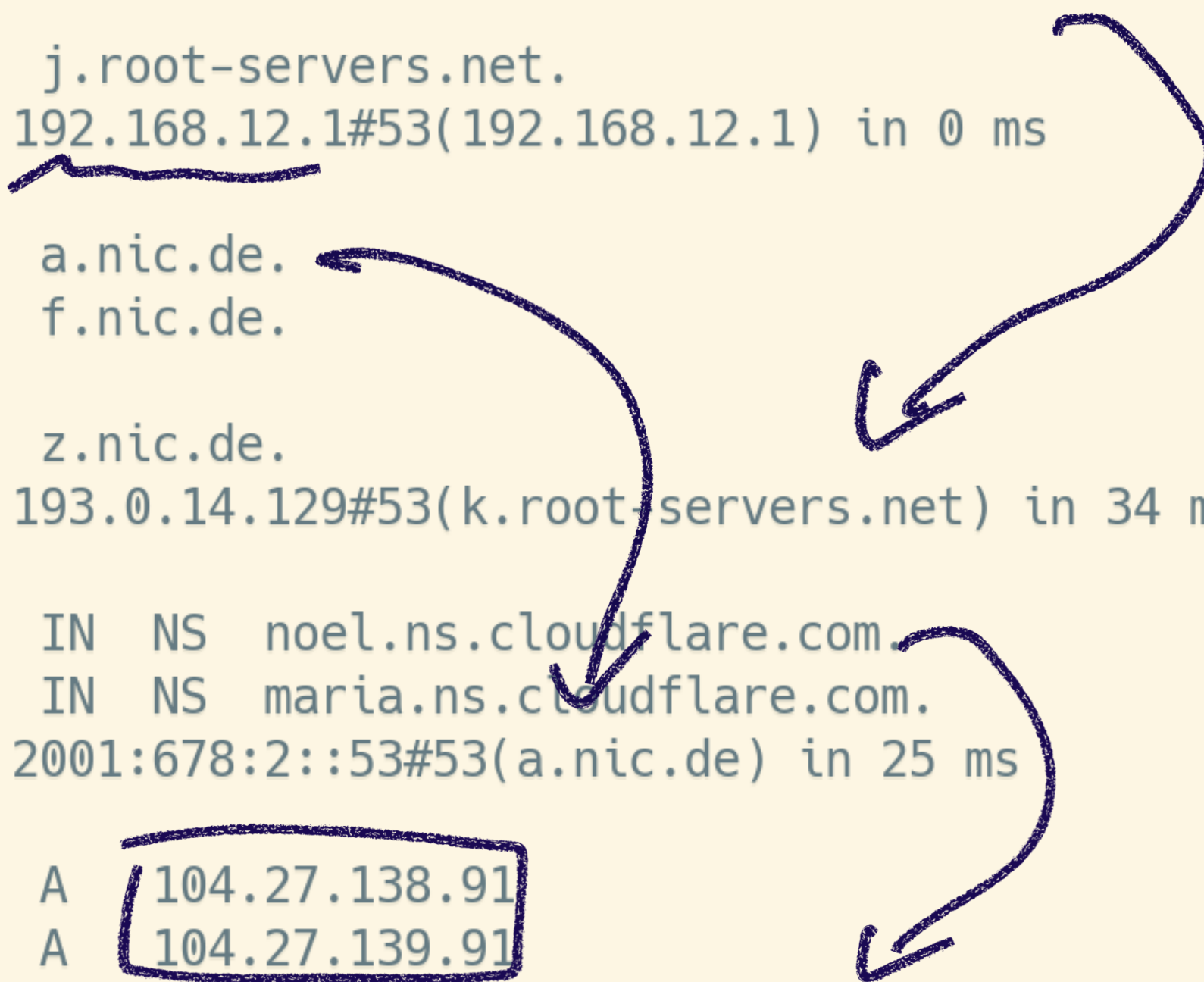
```
; <<>> DiG 9.10.6 <<>> A +trace enthusiasticon.de
;; global options: +cmd
.          79301    IN    NS    c.root-servers.net.
.          79301    IN    NS    f.root-servers.net.
.          79301    IN    NS    h.root-servers.net.
[.....]
.          79301    IN    NS    j.root-servers.net.
;; Received 239 bytes from 192.168.12.1#53(192.168.12.1) in 0 ms

de.        172800   IN    NS    a.nic.de.
de.        172800   IN    NS    f.nic.de.
[.....]
de.        172800   IN    NS    z.nic.de.
;; Received 751 bytes from 193.0.14.129#53(k.root-servers.net) in 34 ms

enthusiasticon.de. 86400   IN    NS    noel.ns.cloudflare.com.
enthusiasticon.de. 86400   IN    NS    maria.ns.cloudflare.com.
;; Received 601 bytes from 2001:678:2::53#53(a.nic.de) in 25 ms

enthusiasticon.de. 300    IN    A     104.27.138.91
enthusiasticon.de. 300    IN    A     104.27.139.91
;; Received 78 bytes from 173.245.59.216#53(noel.ns.cloudflare.com) in 22 ms
```

these servers know





```
; <<>> DiG 9.10.6 <<>> A +trace enthusiasticon.de
;; global options: +cmd
.          79301    IN    NS    c.root-servers.net.
.          79301    IN    NS    f.root-servers.net.
.          79301    IN    NS    h.root-servers.net.
[.....]
.          79301    IN    NS    j.root-servers.net.
;; Received 239 bytes from 192.168.12.1#53(192.168.12.1) in 0 ms

de.        172800   IN    NS    a.nic.de.
de.        172800   IN    NS    f.nic.de.
[.....]
de.        172800   IN    NS    z.nic.de.
;; Received 751 bytes from 193.0.14.129#53(k.root-servers.net) in 34 ms

enthusiasticon.de. 86400   IN    NS    noel.ns.cloudflare.com.
enthusiasticon.de. 86400   IN    NS    maria.ns.cloudflare.com.
;; Received 601 bytes from 2001:678:2::53#53(a.nic.de) in 25 ms

enthusiasticon.de. 300 IN    A    104.27.138.91
enthusiasticon.de. 300 IN    A    104.27.139.91
;; Received 78 bytes from 173.245.59.216#53(noel.ns.cloudflare.com) in 22 ms
```



Where are these root servers?

List of Root Servers

HOSTNAME	IP ADDRESSES	OPERATOR
a.root-servers.net	198.41.0.4, 2001:503:ba3e::2:30	Verisign, Inc.
b.root-servers.net	199.9.14.201, 2001:500:200::b	University of Southern California, Information Sciences Institute
c.root-servers.net	192.33.4.12, 2001:500:2::c	Cogent Communications
d.root-servers.net	199.7.91.13, 2001:500:2d::d	University of Maryland
e.root-servers.net	192.203.230.10, 2001:500:a8::e	NASA (Ames Research Center)
f.root-servers.net	192.5.5.241, 2001:500:2f::f	Internet Systems Consortium, Inc.
g.root-servers.net	192.112.36.4, 2001:500:12::d0d	US Department of Defense (NIC)
h.root-servers.net	198.97.190.53, 2001:500:1::53	US Army (Research Lab)
i.root-servers.net	192.36.148.17, 2001:7fe::53	Netnod
j.root-servers.net	192.58.128.30, 2001:503:c27::2:30	Verisign, Inc.
k.root-servers.net	193.0.14.129, 2001:7fd::1	RIPE NCC
l.root-servers.net	199.7.83.42, 2001:500:9f::42	ICANN
m.root-servers.net	202.12.27.33, 2001:dc3::35	WIDE Project

<https://www.iana.org/domains/root/servers>

news and publications [see all news and publication items](#)

2019-08-14 [Threat Mitigation For the Root Server System \(Document\)](#)

2019-03-28 [Operational Statement on the final step in the KSK Rollover](#)

2019-03-14 [Operational Statement on the Integrity of the Root Server System](#)

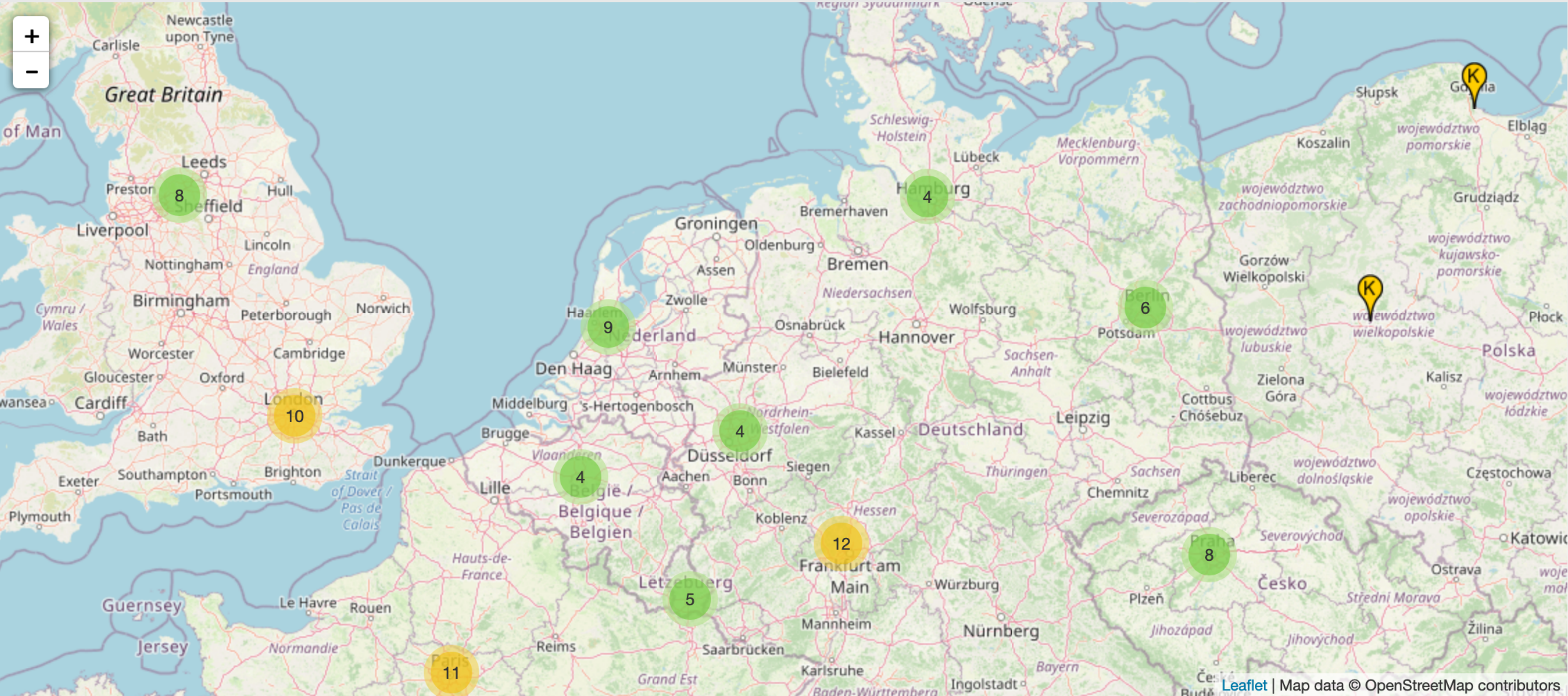
meeting agendas [see all agenda items](#)

2019-11-17 [IETF 106/Singapore \(PDF\)](#)

2019-07-21 [IETF 105/Montreal \(PDF\)](#)

2019-03-24 [IETF 104/Prague \(PDF\)](#)

2018-11-04 [IETF 103/Bangkok \(PDF\)](#)



As of 2020-05-22, the root server system consists of 1091 instances operated by the 12 independent root server operators.



```
; This file holds the information on root name servers needed to
; initialize cache of Internet domain name servers
; (e.g. reference this file in the "cache . <file>"
; configuration file of BIND domain name servers).
```

```
; This file is made available by InterNIC
; under anonymous FTP as
;     file                /domain/named.cache
;     on server           FTP.INTERNIC.NET
; -OR-                   RS.INTERNIC.NET
```

```
; last update:      April 29, 2020
; related version of root zone:      2020042901
```

```
; FORMERLY NS.INTERNIC.NET
```

```
.                3600000      NS      A.ROOT-SERVERS.NET.
A.ROOT-SERVERS.NET. 3600000      A       198.41.0.4
A.ROOT-SERVERS.NET. 3600000      AAAA    2001:503:ba3e::2:30
```

```
; FORMERLY NS1.ISI.EDU
```

```
.                3600000      NS      B.ROOT
```

<https://www.internic.net/domain/named.root>

.	3600000	NS	A.ROOT-SERVERS.NET.
A.ROOT-SERVERS.NET.	3600000	A	198.41.0.4
A.ROOT-SERVERS.NET.	3600000	AAAA	2001:503:ba3e::2:30



```
; <<>> DiG 9.10.6 <<>> A +trace enthusiasticon.de
;; global options: +cmd
.          79301    IN    NS    c.root-servers.net.
.          79301    IN    NS    f.root-servers.net.
.          79301    IN    NS    h.root-servers.net.
[.....]
.          79301    IN    NS    j.root-servers.net.
;; Received 239 bytes from 192.168.12.1#53(192.168.12.1) in 0 ms

de.        172800   IN    NS    a.nic.de.
de.        172800   IN    NS    f.nic.de.
[.....]
de.        172800   IN    NS    z.nic.de.
;; Received 751 bytes from 193.0.14.129#53(k.root-servers.net) in 34 ms

enthusiasticon.de. 86400    IN    NS    noel.ns.cloudflare.com.
enthusiasticon.de. 86400    IN    NS    maria.ns.cloudflare.com.
;; Received 601 bytes from 2001:678:2::53#53(a.nic.de) in 25 ms

enthusiasticon.de. 300 IN    A    104.27.138.91
enthusiasticon.de. 300 IN    A    104.27.139.91
;; Received 78 bytes from 173.245.59.216#53(noel.ns.cloudflare.com) in 22 ms
```



```
$ dig de. @k.root-servers.net
```



```
; <<>> DiG 9.10.6 <<>> NS de. @k.root-servers.net
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 21376
;; flags: qr rd; QUERY: 1, ANSWER: 0, AUTHORITY: 6, ADDITIONAL: 13
;; WARNING: recursion requested but not available

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 4096
;; QUESTION SECTION:
;de.                IN  NS

;; AUTHORITY SECTION:
de.                172800 IN  NS  a.nic.de.
[...]
de.                172800 IN  NS  z.nic.de.

;; ADDITIONAL SECTION:
a.nic.de.          172800 IN  AAAA  2001:678:2::53
[...]
z.nic.de.          172800 IN  AAAA  2a02:568:fe02::de
a.nic.de.          172800 IN  A     194.0.0.53
[...]
z.nic.de.          172800 IN  A     194.246.96.1

;; Query time: 23 msec
;; SERVER: 2001:7fd::1#53(2001:7fd::1)
;; WHEN: Sat May 23 12:20:54 CEST 2020
;; MSG SIZE rcvd: 401
```

```
; <<>> DiG 9.10.6 <<>> NS de. @k.root-servers.net
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 21376
;; flags: qr rd; QUERY: 1, ANSWER: 0, AUTHORITY: 6, ADDITIONAL: 13
;; WARNING: recursion requested but not available

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 4096
;; QUESTION SECTION:
;de.                IN  NS

;; AUTHORITY SECTION:
de.                172800 IN  NS  a.nic.de.
[...]
de.                172800 IN  NS  z.nic.de.

;; ADDITIONAL SECTION:
a.nic.de.          172800 IN  AAAA  2001:678:2::53
[...]
z.nic.de.          172800 IN  AAAA  2a02:568:fe02::de
a.nic.de.          172800 IN  A     194.0.0.53
[...]
z.nic.de.          172800 IN  A     194.246.96.1

;; Query time: 23 msec
;; SERVER: 2001:7fd::1#53(2001:7fd::1)
;; WHEN: Sat May 23 12:20:54 CEST 2020
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```




```
; <<>> DiG 9.10.6 <<>> A +trace enthusiasticon.de
;; global options: +cmd
.          79301    IN  NS   c.root-servers.net.
.          79301    IN  NS   f.root-servers.net.
.          79301    IN  NS   h.root-servers.net.
[.....]
.          79301    IN  NS   j.root-servers.net.
;; Received 239 bytes from 192.168.12.1#53(192.168.12.1) in 0 ms

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de.        172800   IN  NS   f.nic.de.
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enthusiasticon.de. 86400   IN  NS   noel.ns.cloudflare.com.
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```
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;; global options: +cmd
.          79301    IN    NS    c.root-servers.net.
.          79301    IN    NS    f.root-servers.net.
.          79301    IN    NS    h.root-servers.net.
[.....]
.          79301    IN    NS    j.root-servers.net.
;; Received 239 bytes from 192.168.12.1#53(192.168.12.1) in 0 ms

de.        172800   IN    NS    a.nic.de.
de.        172800   IN    NS    f.nic.de.
[.....]
de.        172800   IN    NS    z.nic.de.
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enthusiasticon.de. 300 IN    A     104.27.138.91
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;; Received 78 bytes from 173.245.59.216#53(noel.ns.cloudflare.com) in 22 ms
```





```
; <<>> DiG 9.10.6 <<>> A +trace enthusiasticon.de
```

```
;; global options: +cmd
```

```
.          79301    IN    NS    c.root-servers.net.
```

```
.          79301    IN    NS    f.root-servers.net.
```

```
.          79301    IN    NS    h.root-servers.net.
```

```
[.....]
```

```
.          79301    IN    NS    j.root-servers.net.
```

```
;; Received 239 bytes from 192.168.12.1#53(192.168.12.1) in 0 ms
```

```
de.        172800   IN    NS    a.nic.de.
```

```
de.        172800   IN    NS    f.nic.de.
```

```
[.....]
```

```
de.        172800   IN    NS    z.nic.de.
```

```
;; Received 751 bytes from 193.0.14.129#53(k.root-servers.net) in 34 ms
```

```
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```

```
enthusiasticon.de. 86400    IN    NS    maria.ns.cloudflare.com.
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```
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```

```
enthusiasticon.de. 300 IN    A    104.27.138.91
```

```
enthusiasticon.de. 300 IN    A    104.27.139.91
```

```
;; Received 78 bytes from 173.245.59.216#53(noel.ns.cloudflare.com) in 22 ms
```





be like dig

keep asking

Resources



- <https://howdns.works>
- <https://powerdns.org/hello-dns/basic.md.html>
- <https://blog.schenck.online/oversimplified-dns/>
- <https://ip.seveas.net/dnsgraph/>
- <https://www.zytrax.com/books/dns/>

Knut Hühne - k-nut.eu - @notknut