

Automating BGP peerings in the dn42 environment

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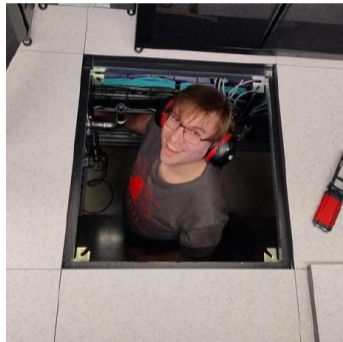
FOSDEM



Hyacinthe Cartiaux



First time presenting at FOSDEM!



What is dn42?

- **Decentralized Network**
- **Educational playground!**
- **Safe environment**
- **Real-World-like**
- **Interconnecting communities**
- **Home Lab**

Ideal for testing

BGP, Anycast, ROA & RPKI, complex BGP communities and route preferences, internal routing protocols (Babel/OSPF), etc

What is dn42?

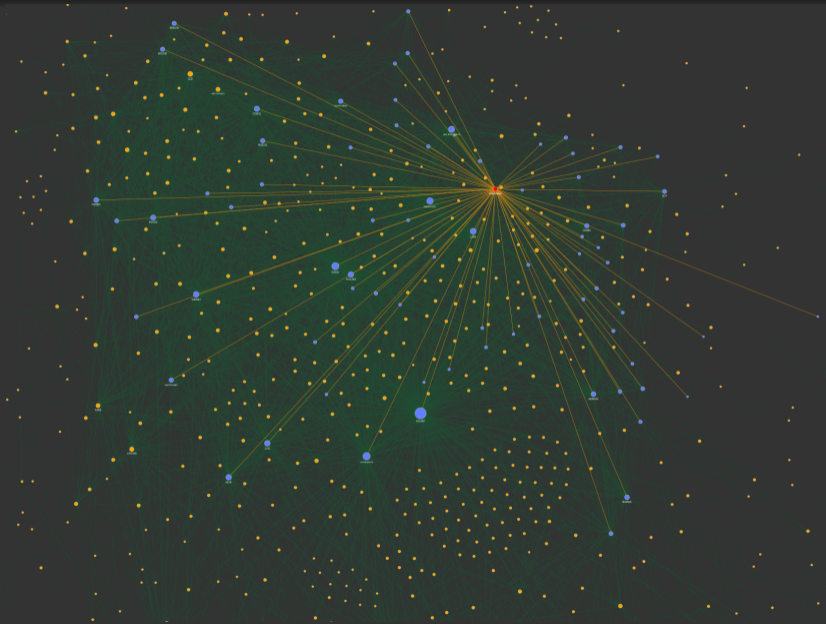
- **Community-driven**
- **Overlay network**
- **Large scale**
- **Technology-agnostic**

Private address space

- **IPv4:** 172.20.0.0/14
- **IPv6:** fd00::/8 (ULA range)
- **ASN:** Private 32-bit AS numbers (4242420000 to 4242429999)

Many mirrors: dn42.eu • dn42.dev • wiki.dn42.us

iEdon's map.dn42 visualization



Core services

- **Source of truth:** Registry
- **Identity:** Whois & CA
- **DNS:** Recursive/Auth for .dn42
- **Routing:** ROA/RPKI

Community services

- Looking glasses
- IRC & Boards
- Real-time maps
- Shells & Web pages
- Radio & Gaming

Explore!

Access the full list of community-hosted services:

<https://dn42.dev/internal/Internal-Services>

AS4242420263

fd28:7515:7d51::/48

172.22.144.160/27

172.22.145.160/27

My own dn42 network

Infrastructure

- Based on VPS in many geographic areas
- OS: Debian 13

Follow my guide:

<https://hcartiaux.github.io/tags/dn42/>

Connectivity

- Multi-home & Multi-PoP
- WireGuard Tunnels
- Full-Mesh Topology

My system configs:

<https://github.com/hcartiaux/dn42-as4242420263>

FlipFlap network: dn42 registry objects

data/inet6num/fd28:7515:7d51::48

```
inet6num:    fd28:7515:7d51:0000:0000:0000:0000:
cidr:        fd28:7515:7d51::/48
netname:     FLIPFLAP-NETWORK
descr:       Flip Flap Network IPv6 block
country:     FR
admin-c:     HCARTIAUX-DN42
tech-c:      HCARTIAUX-DN42
mnt-by:      HCARTIAUX-MNT
status:      ASSIGNED
nserver:     ns1.hcartiaux.dn42
nserver:     ns2.hcartiaux.dn42
```

data/route6/fd28:7515:7d51::48

```
route6:      fd28:7515:7d51::/48
origin:      AS4242420263
max-length:  48
mnt-by:      HCARTIAUX-MNT
source:      DN42
```

data/dns/hcartiaux.dn42

```
domain:      hcartiaux.dn42
admin-c:     HCARTIAUX-DN42
tech-c:      HCARTIAUX-DN42
mnt-by:      HCARTIAUX-MNT
nserver:     ns1.hcartiaux.dn42 172.22.144.161
nserver:     ns1.hcartiaux.dn42 fd28:7515:7d51:a:
nserver:     ns2.hcartiaux.dn42 172.22.144.177
nserver:     ns2.hcartiaux.dn42 fd28:7515:7d51:c::1
source:      DN42
```

data/mntner/HCARTIAUX-MNT

```
mntner:      HCARTIAUX-MNT
mnt-by:      HCARTIAUX-MNT
admin-c:     HCARTIAUX-DN42
tech-c:      HCARTIAUX-DN42
auth:        pgp-fingerprint 62C5D78FE715CF7CA97
auth:        ssh-ed25519 AAAAC3NzaC1lZDI1NTE5AAE=
source:      DN42
```

data/aut-num/AS4242420263

```
aut-num:     AS4242420263
as-name:     AS-FLIPFLAP-DN42
remarks:     -----
remarks:     More info and peering policy:
remarks:     https://hcartiaux.github.io/dn42/
remarks:     -----
admin-c:     HCARTIAUX-DN42
tech-c:      HCARTIAUX-DN42
mnt-by:      HCARTIAUX-MNT
source:      DN42
```

data/inetnum/172.22.144.160_27

```
inetnum:     172.22.144.160 - 172.22.144.191
cidr:        172.22.144.160/27
netname:     FLIPFLAP-NETWORK
descr:       Flip Flap Network IPv4 block
country:     FR
admin-c:     HCARTIAUX-DN42
tech-c:      HCARTIAUX-DN42
mnt-by:      HCARTIAUX-MNT
status:      ASSIGNED
nserver:     ns1.hcartiaux.dn42
nserver:     ns2.hcartiaux.dn42
source:      DN42
```

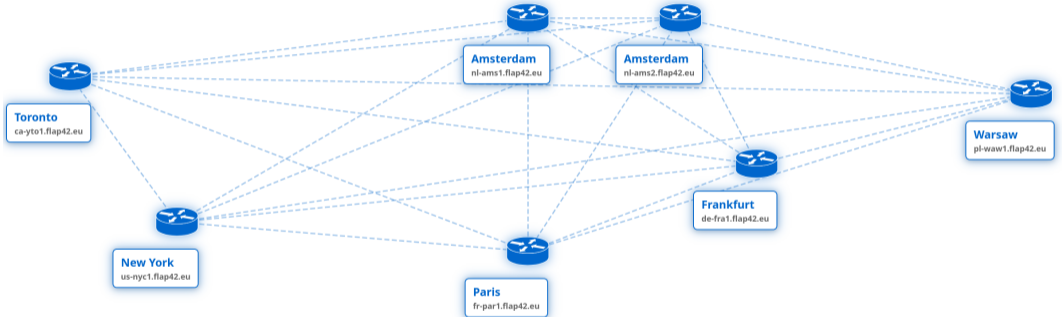
data/route/172.22.144.160_27

```
route:       172.22.144.160/27
origin:      AS4242420263
max-length:  27
mnt-by:      HCARTIAUX-MNT
source:      DN42
```

data/person/HCARTIAUX-DN42

```
person:      Hyacinthe Cartiaux
e-mail:      hyacinthe.cartiaux@gmail.com
nic-hdl:     HCARTIAUX-DN42
mnt-by:      HCARTIAUX-MNT
source:      DN42
```

FlipFlap network: map



- **BGP**
 - External: inter-AS routing
 - Path-vector routing protocol
 - Routing based on AS-Path length and local preferences

- **Babel** - RFC8966
 - Internal: intra-AS routing
 - Distance-vector routing protocol
 - Babel-RTT (Round Trip Time) extension - RFC9616
 - Routing based on cost to reach destination
 - Ideal above an overlay network and unstable links

Problem

Zero Traffic :(

Limitation

Not enough peers

Solution

Scale up! Provide an automatic peering service!

What is it?

Self-service CLI over SSH to request and set-up BGP peering sessions.

- **KISS:** One instance per PoP
- **Features:**
 - Authenticate against the dn42 registry (MAINTAINER objects)
 - Custom SSH daemon using Paramiko
 - Custom CLI (based on Python Cmd class)
 - Generation of WireGuard tunnel and Bird2 BGP peering configuration
- **MIT Licensed**

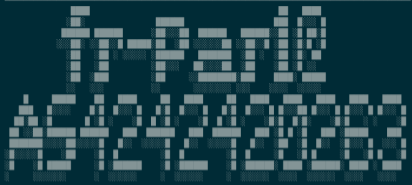
<https://github.com/hcartiaux/dn42-sshd-autopeer>

dn42-sshd-autopeer: demo time

```
s ssh kioubit@fr-par1.flap42.eu -p 4242
```

dn42-sshd-autopeer: demo time

```
$ ssh kioubit@fr-par1.flap42.eu -p 4242
```



```
┌── FlipFlaplet Home page ──────────── https://hcartiaux.github.io/dn42
┌── Pop configuration ───────────────── https://github.com/hcartiaux/dn42-as4242420263
┌── SSH server source ───────────────── https://github.com/hcartiaux/dn42-sshd-autopeer
┌── Contact (mail) ──────────────────── hyacinthe@cartiaux.net
┌── Contact (matrix) ────────────────── @hyacinthe:bsd.cafe
```

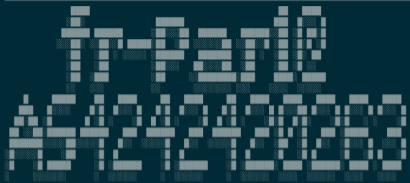
```
Welcome to Flip Flap Network (AS4242420263) automated peering service
You are connected as KIOUBIT-MNT to fr-par1.flap42.eu @ AS4242420263
```

Your AS number(s)

```
Use this shell to configure your BGP peering session.
Type help or ? to list commands.
AS4242420263> █
```

dn42-sshd-autopeer: demo time

```
$ ssh kioubit@fr-par1.flap42.eu -p 4242
```



```
┌── FlipFlaplet Home page ──────────── https://hcartiaux.github.io/dn42
┌── Pop configuration ───────────────── https://github.com/hcartiaux/dn42-as4242420263
┌── SSH server source ───────────────── https://github.com/hcartiaux/dn42-sshd-autopeer
┌── Contact (mail) ──────────────────── hyacinthe@cartiaux.net
┌── Contact (matrix) ─────────────────── @hyacinthe:bsd.cafe
```

```
Welcome to Flip Flap Network (AS4242420263) automated peering service
You are connected as KIOUBIT-MNT to fr-par1.flap42.eu @ AS4242420263
```

Your AS number(s)

4242423914

```
Use this shell to configure your BGP peering session.
Type help or ? to list commands.
AS4242420263> help
```

dn42-sshd-autopeer: demo time

```
Welcome to Flip Flap Network (AS4242420263) automated peering service
You are connected as KIOUBIT-MNT to fr-par1.flap42.eu @ AS4242420263

Your AS number(s)
4242423914

Use this shell to configure your BGP peering session.
Type help or ? to list commands.

AS4242420263> help

Documented commands (type help <topic>):
-----
bye help intro peer_config peer_create peer_list peer_remove peer_status

AS4242420263> peer_list

Your existing peering sessions



| AS Number | WireGuard Public Key | Endpoint Address | Port |
|-----------|----------------------|------------------|------|
|           |                      |                  |      |



AS4242420263> help peer_create
Interactive process to create a new peering session.

AS4242420263> peer_create
AS Number : 4242423914
WireGuard public key : sLbzTRr2gfLFb24NPz00py8j09Y6zI+a7NkeVhdVSRB=
WireGuard endpoint address: fr1.g-load.eu
WireGuard endpoint port : 20263
Optional: Provide your own link-local IPv6 address (fe80::/10 range)
Leave empty to use automatically generated address
Link-local IPv6 (optional): fe80::ade0

The peering session has been registered for AS4242423914
[ ] Peering sessions are created every 5 minutes
[ ] Display the system configuration with the command peer_config

AS4242420263> peer_list

Your existing peering sessions



| AS Number  | WireGuard Public Key                   | Endpoint Address | Port  |
|------------|----------------------------------------|------------------|-------|
| 4242423914 | sLbzTRr2gfLFb24NPz00py8j09Y6zI+a7Nk... | fr1.g-load.eu    | 20263 |



AS4242420263> |
```

dn42-sshd-autopeer: demo time

```
WireGuard public key   : sLbzTRr2gfLFb24NPzD0py8j09Y6zI+a7NkeVMdVSRB=  
WireGuard endpoint address: fr1.g-load.eu  
WireGuard endpoint port   : 20263  
Optional: Provide your own link-local IPv6 address (fe80::/10 range)  
Leave empty to use automatically generated address  
Link-local IPv6 (optional): fe80::ade0
```

```
The peering session has been registered for AS4242423914  
■ Peering sessions are created every 5 minutes  
■ Display the system configuration with the command peer_config
```

```
AS4242420263> peer_list
```

Your existing peering sessions

AS Number	WireGuard Public Key	Endpoint Address	Port
4242423914	sLbzTRr2gfLFb24NPzD0py8j09Y6zI+a7Nk...	fr1.g-load.eu	20263

```
AS4242420263> peer_config
```

Link config.	AS4242423914
WG pub key	sLbzTRr2gfLFb24NPzD0py8j09Y6zI+a7NkeVMdVSRB=
WG Endpoint addr.	fr1.g-load.eu
WG Endpoint port	20263
Link-local address	fe80::ade0

Link config.	AS4242420263
WG pub key	/kwo9F1QRtglyhMARTw9SvyvXIN7I7LfoICTyHjFA4=
WG Endpoint addr.	fr-par1.flap42.eu
WG Endpoint port	52015
Link-local address	fe80::263

```
WireGuard configuration for AS4242423914
```

```
[Interface]  
PrivateKey = **REPLACEME**  
ListenPort = 20263  
PostUp = /sbin/ip addr add dev %i fe80::ade0/128 peer fe80::263/128  
Table = off  
  
[Peer]  
PublicKey = /kwo9F1QRtglyhMARTw9SvyvXIN7I7LfoICTyHjFA4=  
Endpoint = fr-par1.flap42.eu:52015  
PersistentKeepalive = 30  
AllowedIPs = 172.16.0.0/12, 10.0.0.0/8, fd00::/8, fe80::/10
```

dn42-sshd-autopeer: demo time

Link config.	AS4242423914
WG pub key	sLbzTRr2gfLFb24NPzD0py8j09Y6zI+a7NkeVMdVSR8=
WG Endpoint addr.	fr1.g-load.eu
WG Endpoint port	20263
Link-local address	fe80::ade0

Link config.	AS4242420263
WG pub key	/kwo9F1QRtgNyhMARTW9SvyyXIN7I7LfoICTyHjFA4=
WG Endpoint addr.	fr-par1.flap42.eu
WG Endpoint port	52015
Link-local address	fe80::263

WireGuard configuration for AS4242423914

```
[Interface]
PrivateKey = **REPLACEME**
ListenPort = 20263
PostUp = /sbin/ip addr add dev %i fe80::ade0/128 peer fe80::263/128
Table = off

[Peer]
PublicKey = /kwo9F1QRtgNyhMARTW9SvyyXIN7I7LfoICTyHjFA4=
Endpoint = fr-par1.flap42.eu:52015
PersistentKeepalive = 30
AllowedIPs = 172.16.0.0/12, 10.0.0.0/8, fd00::/8, fe80::/10
```

Bird configuration for AS4242423914

```
protocol bgp flapflap {
    local as 4242423914;
    neighbor fe80::263 as 4242420263;
    path metric 1;
    interface "wg-peer-flipflap";
    ipv4 {
        extended next hop on;
        import limit 9000 action block;
        import table;
    };
    ipv6 {
        extended next hop off;
        import limit 9000 action block;
        import table;
    };
}
```

AS4242420263> peer_status

dn42-sshd-autopeer: demo time

```
ListenPort = 20263
PostUp = /sbin/ip addr add dev %i fe80::ade0/128 peer fe80::263/128
Table = off

[Peer]
PublicKey = /kwp9FiQRtgNyhMARTW9SvyyvXIN7I7LfoICTyHjfa4=
Endpoint = fr-par1.flap42.eu:52015
PersistentKeepalive = 30
AllowedIPs = 172.16.0.0/12, 10.0.0.0/8, fd00::/8, fe80::/10
```

Bird configuration for AS4242423914

```
protocol bgp flipflap {
    local as 4242423914;
    neighbor fe80::263 as 4242420263;
    path metric 1;
    interface "wg-peer-flipflap";
    ipv4 {
        extended next hop on;
        import limit 9000 action block;
        import table;
    };
    ipv6 {
        extended next hop off;
        import limit 9000 action block;
        import table;
    };
};
```

AS4242420263> peer_status

```
$ # Configuration generator timer
$ systemctl list-timers dn42-genconfig
NEXT                                LEFT LAST                                PASSED
UNIT                                ACTIVATES
Thu 2026-01-15 15:33:18 CET 4min 52s Thu 2026-01-15 15:24:09 CET 4min 16s ago
dn42-genconfig.timer dn42-genconfig.service

1 timers listed.
Pass --all to see loaded but inactive timers, too.

$ # Wireguard interface
$ wg show wg-as4242423914

$ # Bird BGP session
$ birdc show protocols all ebgp_as4242423914_v6
BIRD 2.17.1 ready.
syntax error, unexpected CF_SYM_UNDEFINED, expecting END or CF_SYM_KNOWN or TE
```

AS4242420263> █

dn42-sshd-autopeer: demo time

```
ListenPort = 20263
PostUp = /sbin/ip addr add dev %i fe80::ade0/128 peer fe80::263/128
Table = off

[Peer]
PublicKey = /kwp9FiQRtgNyhMARTW9SvyvXIN7I7LfoICTyHjFA4=
Endpoint = fr-par1.flap42.eu:52015
PersistentKeepalive = 30
AllowedIPs = 172.16.0.0/12, 10.0.0.0/8, fd00::/8, fe80::/10

Bird configuration for AS4242423914

protocol bgp flipflap {
    local as 4242423914;
    neighbor fe80::263 as 4242420263;
    path metric 1;
    interface "wg-peer-flipflap";
    ipv4 {
        extended next hop on;
        import limit 9000 action block;
        import table;
    };
    ipv6 {
        extended next hop off;
        import limit 9000 action block;
        import table;
    };
};
}

AS4242420263> peer_status

$ # Configuration generator timer
$ systemctl list-timers dn42-genconfig
NEXT                                LEFT LAST                                PASSED
UNIT                                ACTIVATES
Thu 2026-01-15 15:33:18 CET 4min 52s Thu 2026-01-15 15:24:09 CET 4min 16s ago
dn42-genconfig.timer dn42-genconfig.service

1 timers listed.
Pass --all to see loaded but inactive timers, too.

$ # Wireguard interface
$ wg show wg-as4242423914

$ # Bird BGP session
$ birdc show protocols all ebgp_as4242423914_v6
BIRD 2.17.1 ready.
syntax error, unexpected CF_SYM_UNDEFINED, expecting END or CF_SYM_KNOWN or TE

AS4242420263> peer_status
```

dn42-sshd-autopeer: demo time

```
$ # Configuration generator timer
$ systemctl list-timers dn42-genconfig
NEXT                LEFT LAST                PASSED
UNIT                ACTIVATES
Thu 2026-01-15 15:33:18 CET 4min 52s Thu 2026-01-15 15:24:09 CET 4min 16s ago
dn42-genconfig.timer dn42-genconfig.service

1 timers listed.
Pass --all to see loaded but inactive timers, too.

$ # Wireguard interface
$ wg show wg-as4242423914

$ # Bird BGP session
$ birdc show protocols all ebgp_as4242423914_v6
BIRD 2.17.1 ready.
syntax error, unexpected CF_SYM_UNDEFINED, expecting END or CF_SYM_KNOWN or TE
```

AS4242420263> peer status

```
$ # Configuration generator timer
$ systemctl list-timers dn42-genconfig
NEXT                LEFT LAST                PASSED UNIT
ACTIVATES
Thu 2026-01-15 15:33:18 CET 3min 35s Thu 2026-01-15 15:24:09 CET 5min ago
dn42-genconfig.timer dn42-genconfig.service

1 timers listed.
Pass --all to see loaded but inactive timers, too.

$ # Wireguard interface
$ wg show wg-as4242423914
interface: wg-as4242423914
public key: /kwo9fjQRtgNyhMARTW9SvyyXIN7I7LfoICTyHjfa4=
private key: (hidden)
listening port: 52015

peer: sLbzTRr2gflFb24NPzD0py8j09Y6zI+a7NkeVMdVSR8=
endpoint: [2001:41d0:203:4576::1]:20263
allowed ips: 172.16.0.0/12, 10.0.0.0/8, fd00::/8, fe80::/10
latest handshake: 20 seconds ago
transfer: 272.57 KiB received, 268.01 KiB sent
persistent keepalive: every 30 seconds

$ # Bird BGP session
$ birdc show protocols all ebgp_as4242423914_v6
BIRD 2.17.1 ready.

```

Name	Proto	Table	State	Since	Info
ebgp_as4242423914_v6	BGP	---	up	15:29:27.994	Established

```
BGP state: Established
Neighbor address: fe80::ade@wg-as4242423914
Neighbor AS: 4242423914
Local AS: 4242420263
Neighbor ID: 172.20.53.102
```

dn42-sshd-autopeer: demo time

```
public key: /kwo9F1ORtgNyhMARTW9SvvyXIN7I7LfoICTyHjFA4=
private key: (hidden)
listening port: 52015

peer: sLbzTRr2gfLFb24NPzD0py8j09Y6zI+a7NkeVMdVSR8=
endpoint: [2001:41d0:203:4576::1]:20263
allowed ips: 172.16.0.0/12, 10.0.0.0/8, fd00::/8, fe80::/10
latest handshake: 20 seconds ago
transfer: 272.57 KiB received, 268.01 KiB sent
persistent keepalive: every 30 seconds

$ # Bird BGP session
$ birdc show protocols all ebgp_as4242423914_v6
BIRD 2.17.1 ready.
Name      Proto  Table  State Since      Info
ebgp_as4242423914_v6 BGP    ---    up      15:29:27.994 Established
BGP state:
  Established
Neighbor address: fe80::ade0twg-as4242423914
Neighbor AS:      4242423914
Local AS:         4242420263
Neighbor ID:      172.20.53.102
Local capabilities
  Multiprotocol
    AF announced: ipv4 ipv6
    Route refresh
    Extended next hop
    IPv6 nexthop: ipv4
    Graceful restart
    4-octet AS numbers
    Enhanced refresh
    Long-lived graceful restart
Neighbor capabilities
  Multiprotocol
    AF announced: ipv4 ipv6
    Route refresh
    Extended next hop
    IPv6 nexthop: ipv4
    Extended message
    Graceful restart
    4-octet AS numbers
    Enhanced refresh
    Long-lived graceful restart
  Hostname: fr1
Session:          external AS4
Source address:   fe80::263
Hold timer:       202.530/240
Keepalive timer: 51.612/80
Send hold timer: 413.132/480
Channel ipv4
  State:          UP
  Table:          master4
  Preference:     100
  Input filter:   (unnamed)
  Output filter:  (unnamed)
  Import limit:   9000
```

dn42-sshd-autopeer: demo time

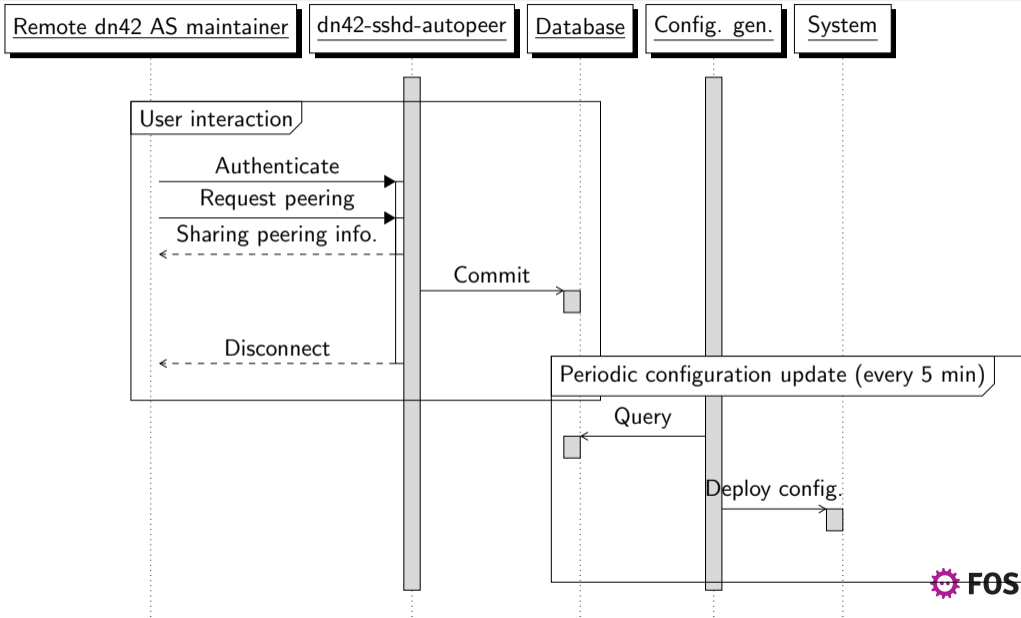
```
Enhanced refresh
Long-lived graceful restart
Neighbor capabilities
Multiprotocol
  AF announced: ipv4 ipv6
Route refresh
Extended next hop
  IPv6 nexthop: ipv4
Extended message
Graceful restart
4-octet AS numbers
Enhanced refresh
Long-lived graceful restart
Hostname: fr1
Session:          external AS4
Source address:  fe80::263
Hold timer:      202.538/240
Keepalive timer: 51.612/80
Send hold timer: 413.132/480
Channel ipv4
State:          UP
Table:         master4
Preference:    100
Input filter:  (unnamed)
Output filter: (unnamed)
Import limit:  9000
Action:        block
Routes:        940 imported, 667 exported, 306 preferred
Route change stats:  received  rejected  filtered  ignored  accept
Import updates:    949          0          4          0          9
Import withdraws:  13          0         ---         10
Export updates:    1286        306          7         ---         9
Export withdraws:  0          ---         ---         ---         3
BGP Next hop:    :: fe80::263
Channel ipv6
State:          UP
Table:         master6
Preference:    100
Input filter:  (unnamed)
Output filter: (unnamed)
Import limit:  9000
Action:        block
Routes:        980 imported, 704 exported, 309 preferred
Route change stats:  received  rejected  filtered  ignored  accept
Import updates:    990          0          6          0          9
Import withdraws:  15          0         ---         14
Export updates:    1333        309          7         ---         10
Export withdraws:  0          ---         ---         ---         3
BGP Next hop:    :: fe80::263
```

```
AS4242420263> bye
See You, Space Cowboy!
Shared connection to fr-par1.flap42.eu closed.
```

PoP	SSH Command
nl-ams2.flap42.eu	ssh <mntner>@nl-ams2.flap42.eu -p 4242
fr-par1.flap42.eu	ssh <mntner>@fr-par1.flap42.eu -p 4242
pl-waw1.flap42.eu	ssh <mntner>@pl-waw1.flap42.eu -p 4242
us-nyc1.flap42.eu	ssh <mntner>@us-nyc1.flap42.eu -p 4242
de-fra1.flap42.eu	ssh <mntner>@de-fra1.flap42.eu -p 4242
ca-yto1.flap42.eu	ssh <mntner>@ca-yto1.flap42.eu -p 4242

Command	Description
peer_create	Interactive process to create a new peering session
peer_config	Show the configuration for an existing peering session
peer_list	List your existing peering sessions
peer_remove	Remove an existing peering session
peer_status	Print the current status of a peering session

dn42-sshd-autopeer: workflow



Tips: how to join the party?

- **Step 0:** Prepare at least one host with a public IP
- **Step 1:** Submit a Pull Request to the git-based registry
- **Step 2:** Connect with others via manual or automatic peering
- **Step 3:** Set up your BGP router (BIRD2, FRR, etc.)

Socialize!

Join **#dn42@hackint**, **#dn42-peering@hackint** and **the mailing list**.

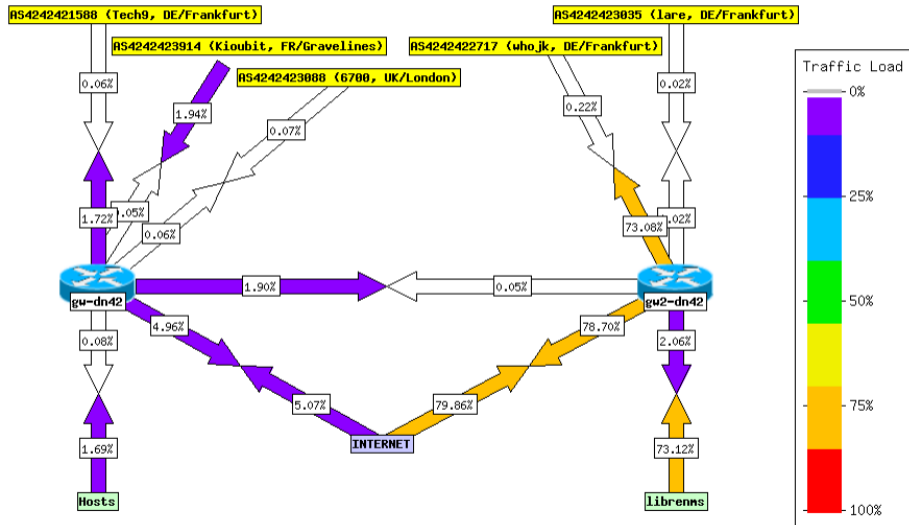
For saying hello, troubleshooting, manual peering requests, and community news.

Getting Started guide: <https://dn42.dev/howto/Getting-Started>

Tips: start small

[DN42] Weathermap - AS4242420263

Created: Sep 08 2024 02:17:30



Avoid Bare-Metal

- **Murphy's Law:** Hardware fails exactly when you are busy

Delegate the hardware and automate

- **Infrastructure:** Use Cloud/VPS instances + **Terraform** / **OpenTofu**
- **Configuration:** Automated PoP deployment using **Ansible**
- **Goal:** Restoring a PoP should be a low-effort task

<https://github.com/hcartiaux/terraform>

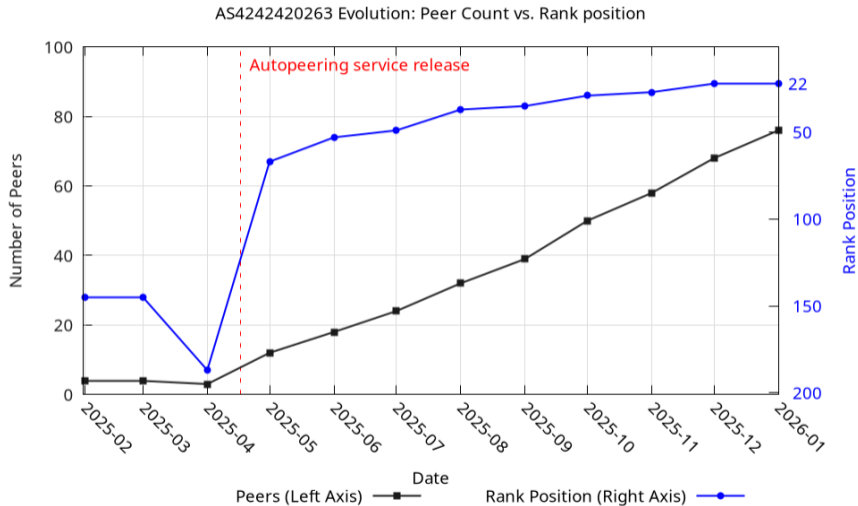
<https://github.com/hcartiaux/ansible>

How to host a low-cost dn42 network?

- Residential hosting
- Public clouds
- Low-cost dedicated servers
- Community providers
 - BoxyBSD.com provides free *BSD VPS instances for educational purposes (Thanks Gyptazy!)



Conclusion: AS4242420263 progression



dn42-sshd-autopeer simplifies peering in dn42 by automating configuration exchange through SSH.

Future work:

- Improved configuration generation & deployment process
- GPG-based authentication support
- Adoption by other AS maintainers

Broader vision:

- Create more peerings within dn42
- Encourage wider adoption of automatic peering services
- Reduce centralization to better mirror the real Internet

Download the slides!



Thank you for your attention!

Questions?

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FOSDEM

