Automating BGP peerings in the dn42 environment

Hyacinthe Cartiaux

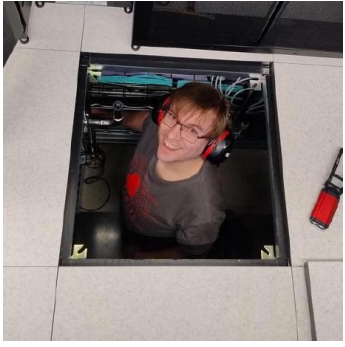
hyacinthe@cartiaux.net

January 31, 2026

FOSDEM 2026 - Brussels, Belgium

$ whoami

Hyacinthe Cartiaux



First time presenting at FOSDEM!

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?

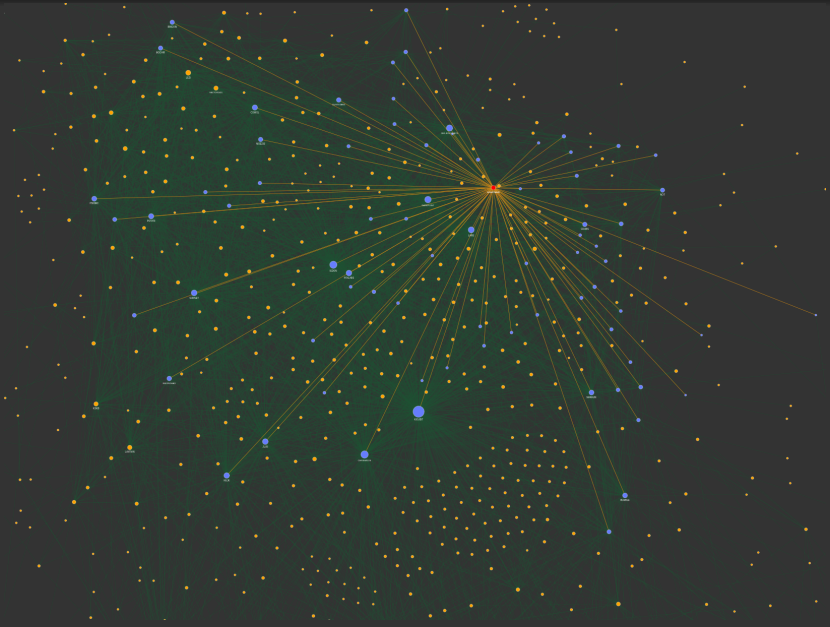
- **Community-driven**
- **Overlay network**
- **Large scale**
- **Technology-agnostic**

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



FOSDEM

dn42 ecosystem

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`

FlipFlap network: architecture

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`

Connectivity

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

Follow my guide:
`https://hcartiaux.github.io/tags/dn42/`

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 AAAAC3NzaC11ZDI1NTE5AAA
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
```

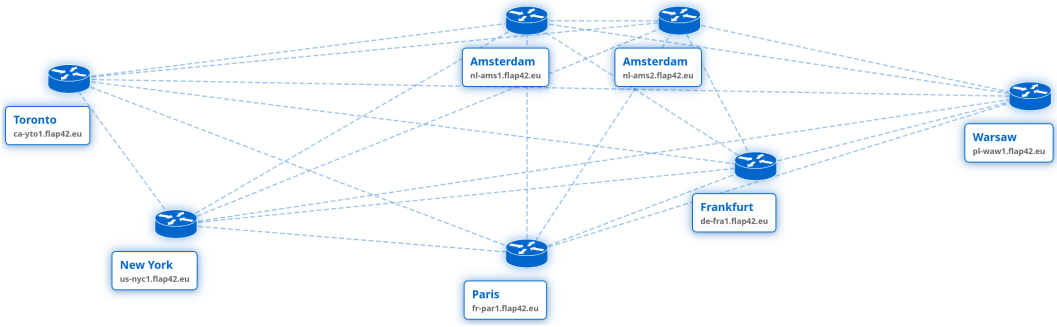
data/route/172.22.144.160_27

```
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



FlipFlap network: routing protocols

- **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!

dn42-sshd-autopeer

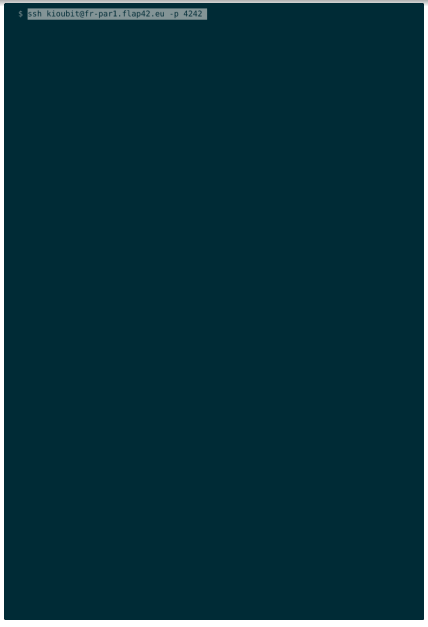
What is it?

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

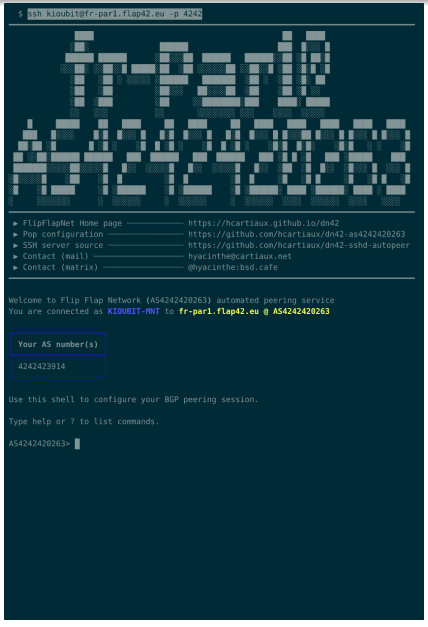
- **KISS:** One instance per PoP
- **Features:**
  - Authenticate against the dn42 registry (MAINTAINER objects)
  - Custom SSH daemon using Paramiko
  - Custom CLI (based on Python Cmd class)
  - Generation of WireGuard tunnel and Bird2 BGP peering configuration
- **MIT Licensed**

`https://github.com/hcartiaux/dn42-sshd-autopeer`

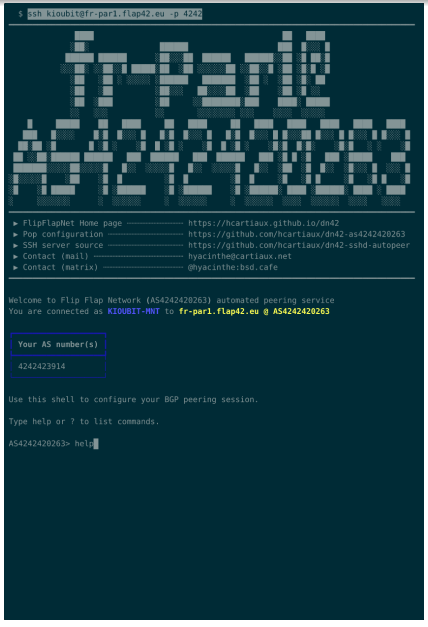
dn42-sshd-autopeer: demo time



dn42-sshd-autopeer: demo time



dn42-sshd-autopeer: demo time

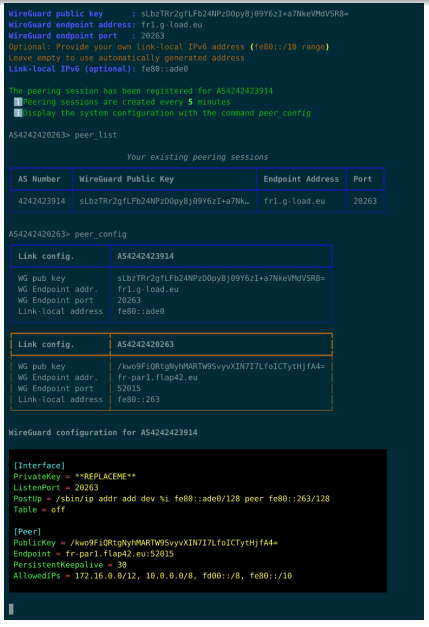


dn42-sshd-autopeer: demo time

```
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     : sLbzTRr2gfLFb24NPzDOpy8j09Y6zI+a7NkeVMdVSR8=
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 | sLbzTRr2gfLFb24NPzDOpy8j09Y6zI+a7Nk… | fr1.g-load.eu    | 20263


AS4242420263>
```

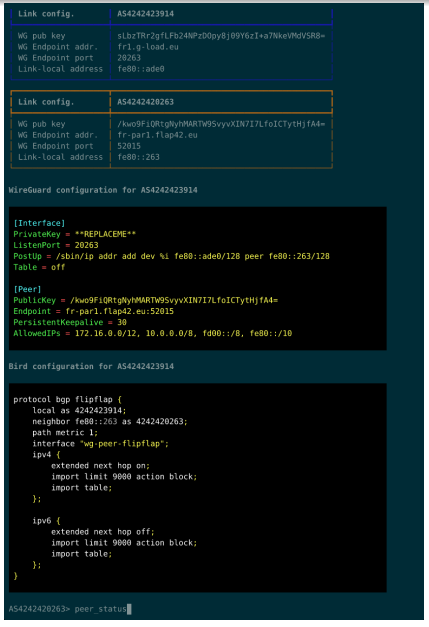
FOSDEM

dn42-sshd-autopeer: demo time



FOSDEM

dn42-sshd-autopeer: demo time



FOSDEM

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 = /kwo9FiQRtgNyhMARTW0SvyvXIN7I7LfoICTytHjfA4=
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>

FOSDEM

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 = /kwo9FiQRtgNyhMARTW0SvyvXIN7I7LfoICTytHjfA4=
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

FOSDEM

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: /kwo9FiQRtgNyhMARTW9SvyvXIN7I7LfoICTytHjfA4=
  private key: (hidden)
  listening port: 52015

peer: sLbzTRr2gfLFb24NPzDOpy8j09Y6zI+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::ade0%wg-as4242423914
    Neighbor AS:      4242423914
    Local AS:         4242420263
    Neighbor ID:      172.20.53.102
```

FOSDEM

dn42-sshd-autopeer: demo time

```
  public key: /kwo9FiQRtgNyhMARTW95vyvXIN7I7LfoICTytHjfA4=
  private key: (hidden)
  listening port: 52015

peer: sLbzTRr2gfLFb24NPzDOpy8j09Y6zI+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::ade0%wg-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:       202.538/240
    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
```

FOSDEM

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

A5424242063> bye
See You, Space Cowboy!
Shared connection to fr-par1.flap42.eu closed.
```

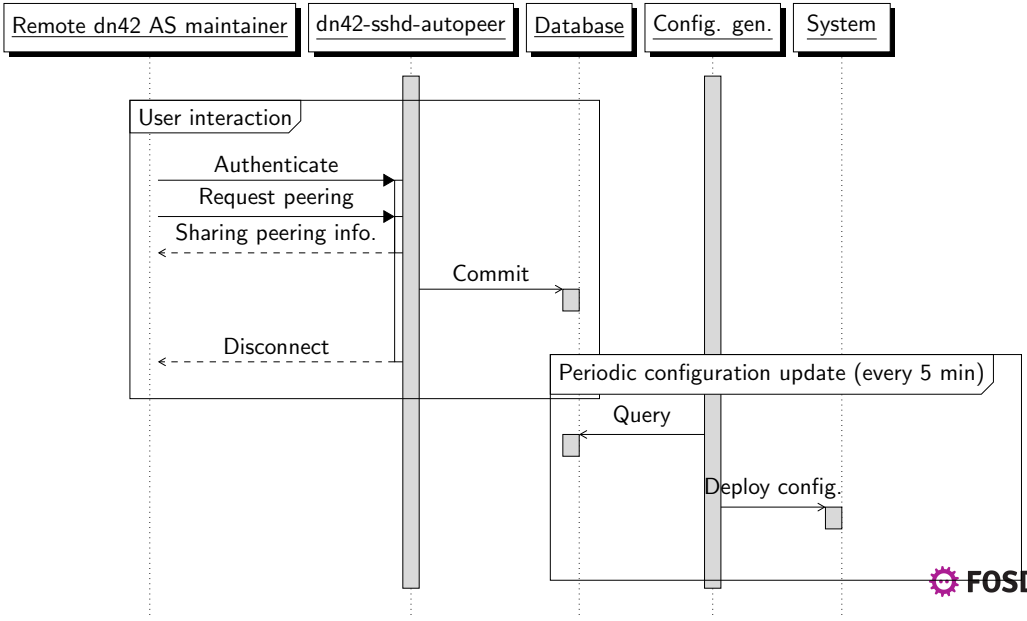
FOSDEM

dn42-sshd-autopeer: command line interface

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?

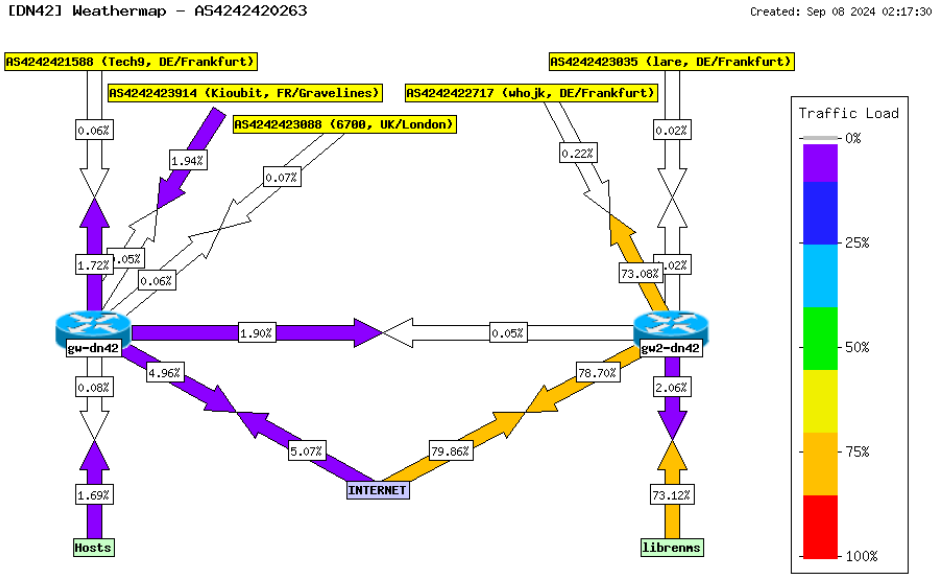
- **Step 0:** Prepare at least one host with a public IP
- **Step 1:** Submit a Pull Request to the git-based registry
- **Step 2:** Connect with others via manual or automatic peering
- **Step 3:** Set up your BGP router (`BIRD2`, `FRR`, etc.)

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



Tips: hosting strategy

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`

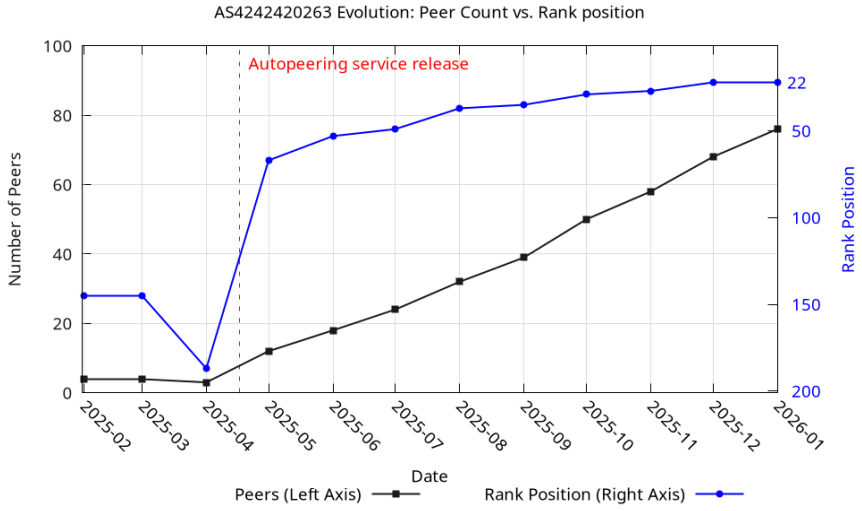
`https://github.com/hcartiaux/ansible`

Tips: hosting options for dn42 networks

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



Centrality index calculation: `https://github.com/iedon/dn42_map/blob/main/centrality.md`
Ranking: `https://api.iedon.com/dn42/ranking`

Conclusion: next steps

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

Future work:

- Improved configuration generation & deployment process
- Non-interactive usage/API
- 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?

flap42.eu
AS4242420263

FOSDEM

dn42