Pyroute2: a transactional approach to the network setup

http://pyroute2.org/rtnl.pdf
http://docs.pyroute2.org/
https://github.com/svinota/pyroute2

network-related API towards the kernel:

* ioctl — ifconfig
* setsockopt, getsockopt — iptables
* file operations — sysfs, procfs
* AF_KEY — ipsec-tools
* AF_NETLINK — iproute2, …
* …

netlink families:

* NETLINK_XFRM — ipsec
* NETLINK_NFLOG — netfilter/iptables ULOG
* NETLINK_ISCSI
* NETLINK_GENERIC — nl80211, taskstats, events, …
* NETLINK_ROUTE — RTNL
* …

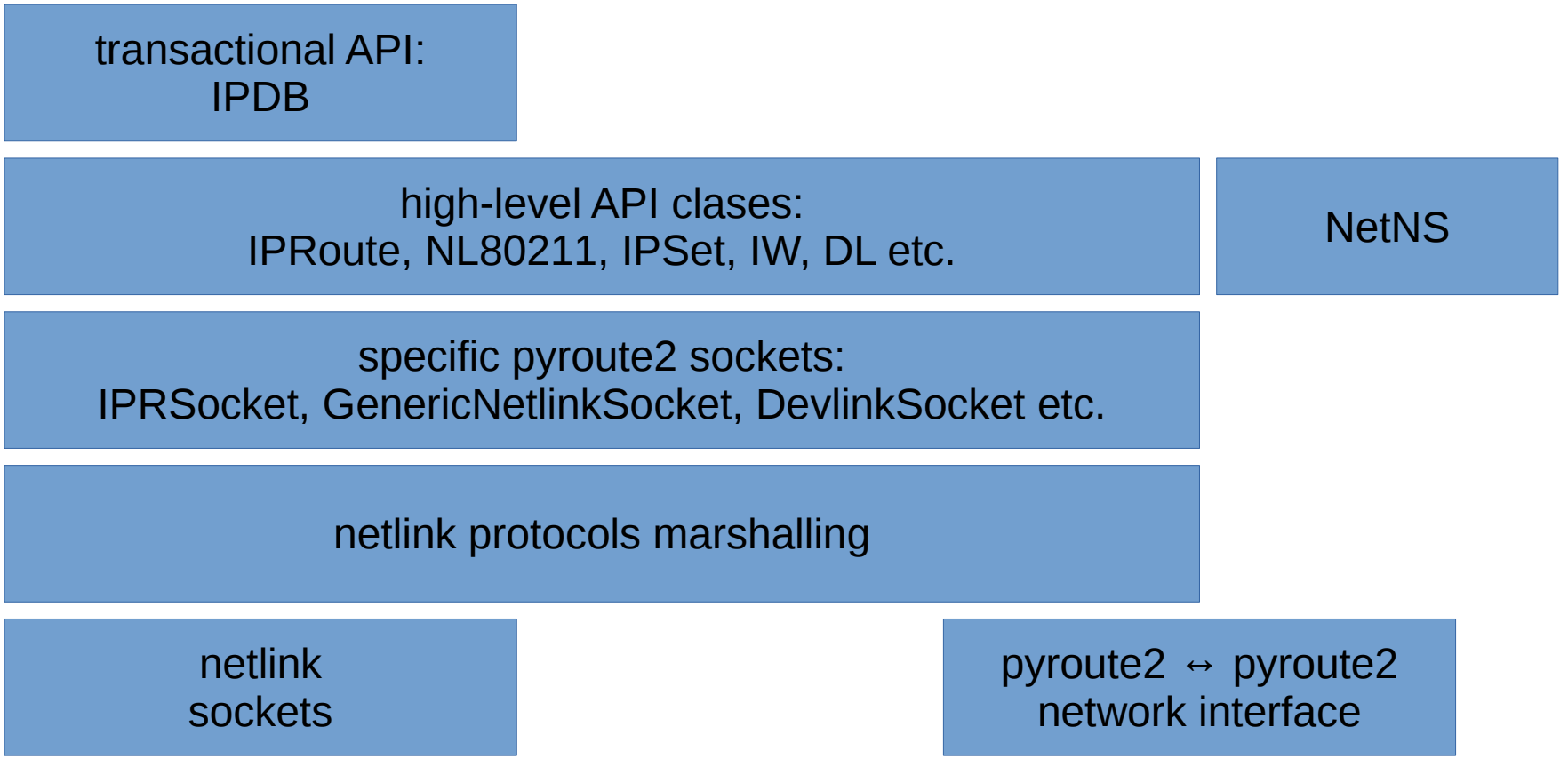
API

```
s = socket(AF_NETLINK, SOCK_DGRAM, NETLINK_ROUTE, …)
s.bind(…)  # optional, only to receive notifications

s.send(…)

s.recv(…)
```

the library architecture



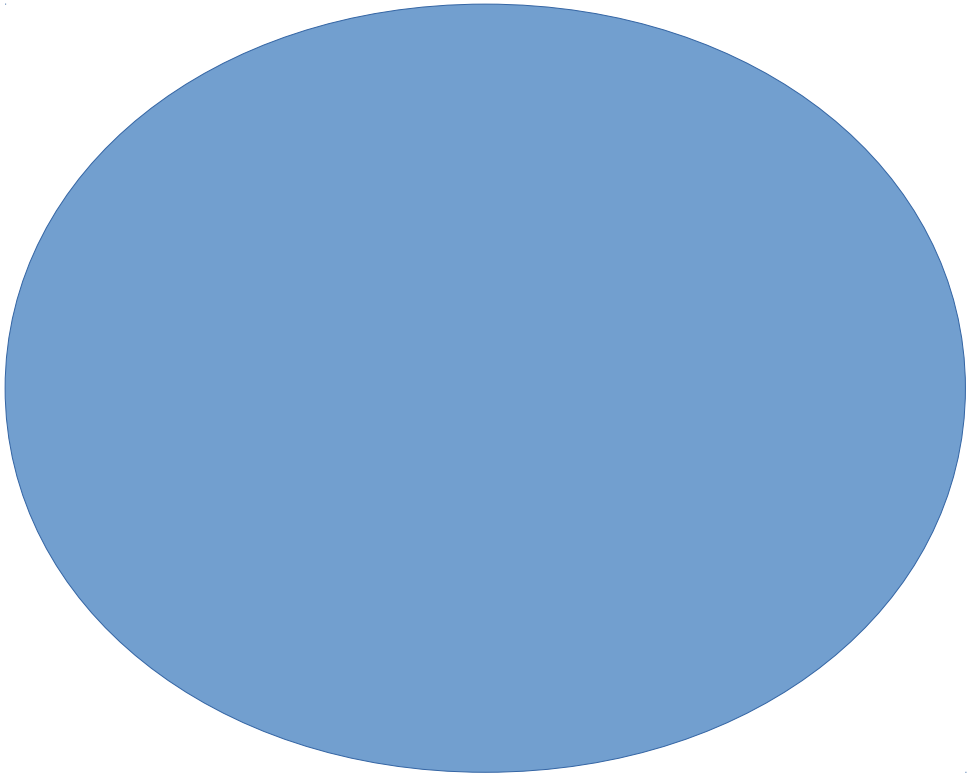
netlink packet representation

```
 {'header': {'error': None,
             'flags': 2,
             'length': 1260,
             'pid': 9479,                 # event initiator’s pid
             'sequence_number': 256,      # answer to packet id 256
             'type': 16},                 # event type RTM_NEWLINK
  'change': 0,
  'family': 0,
# …
  'index': 2,
  'attrs': [('IFLA_IFNAME', 'enp0s31f6'),
            ('IFLA_TXQLEN', 1000),
            ('IFLA_OPERSTATE', 'UP'),
            ('IFLA_MTU', 1500),
            ('IFLA_GROUP', 0),
# …
            ('IFLA_ADDRESS', 'c8:5b:67:58:a1:b7'),
            ('IFLA_BROADCAST', 'ff:ff:ff:ff:ff:ff')]}
```

IPDB object representation

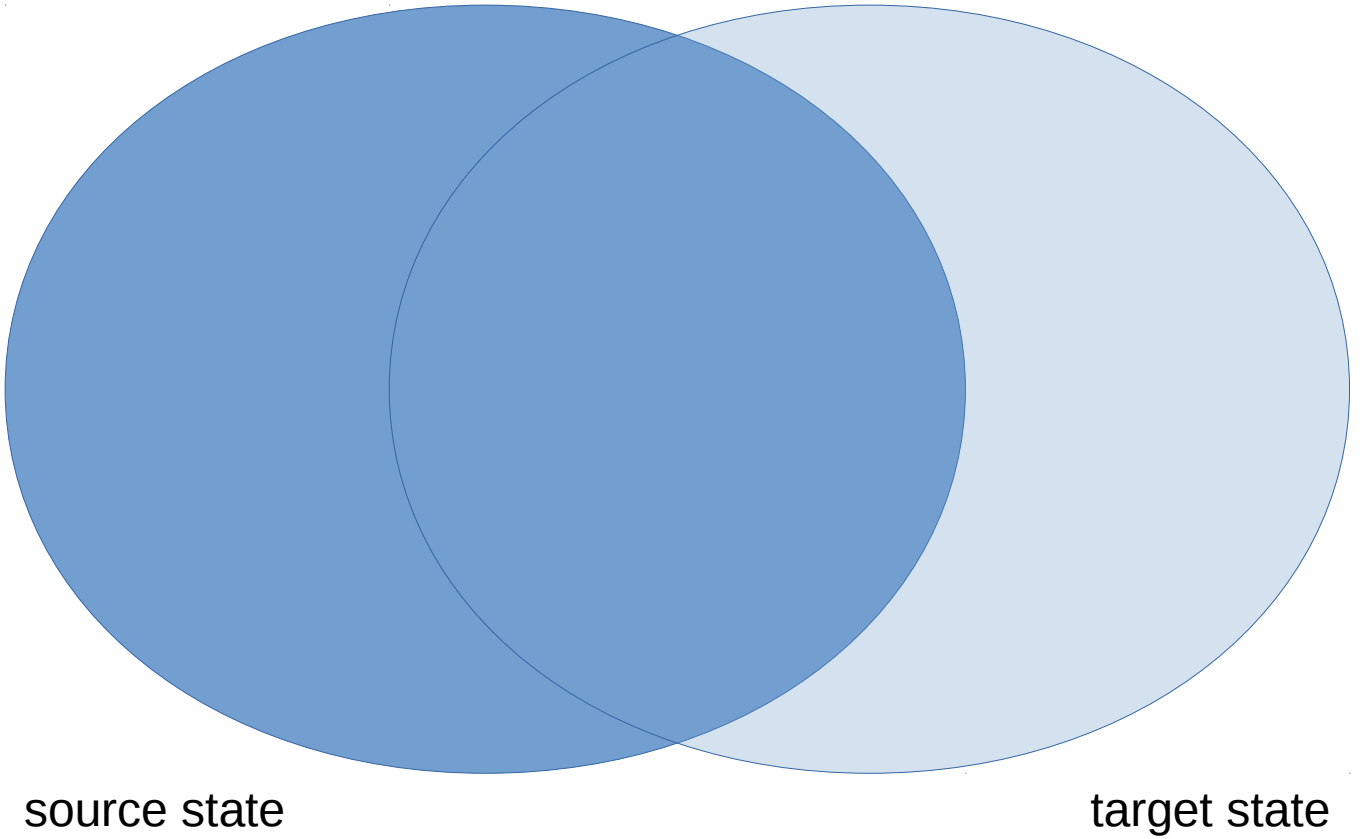
```
{'index': 4,
 'ipaddr': (('172.16.254.105', 24),
            ('10.0.1.12', 24),
            ('10.0.1.13', 24),
            ('fe80::7552:c31a:60c6:a427', 64)),
 'ifname': 'eth0',
 'broadcast': 'ff:ff:ff:ff:ff:ff',
 'address': 'c8:5b:76:c8:ff:6e',
 'mtu': 1500,
 'flags': 4099}
```

State transition as set operations

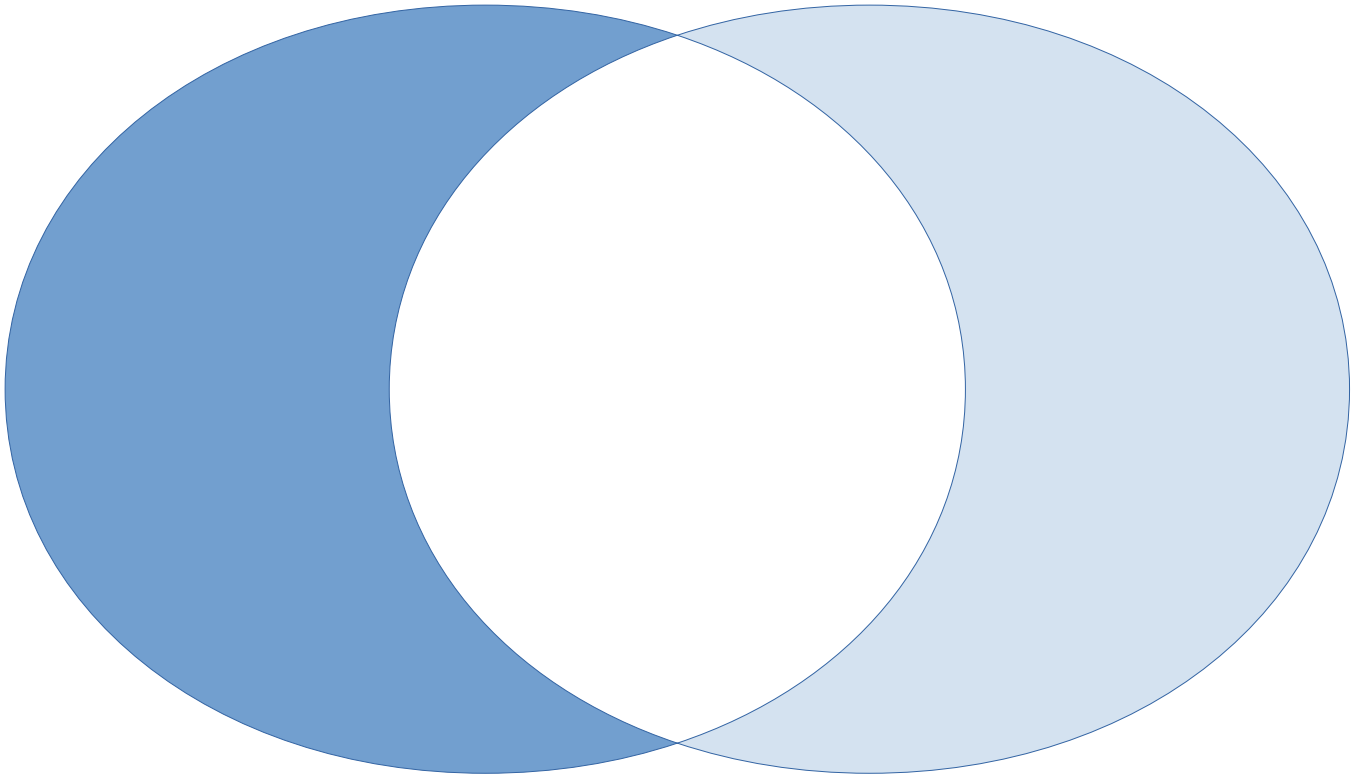


source state

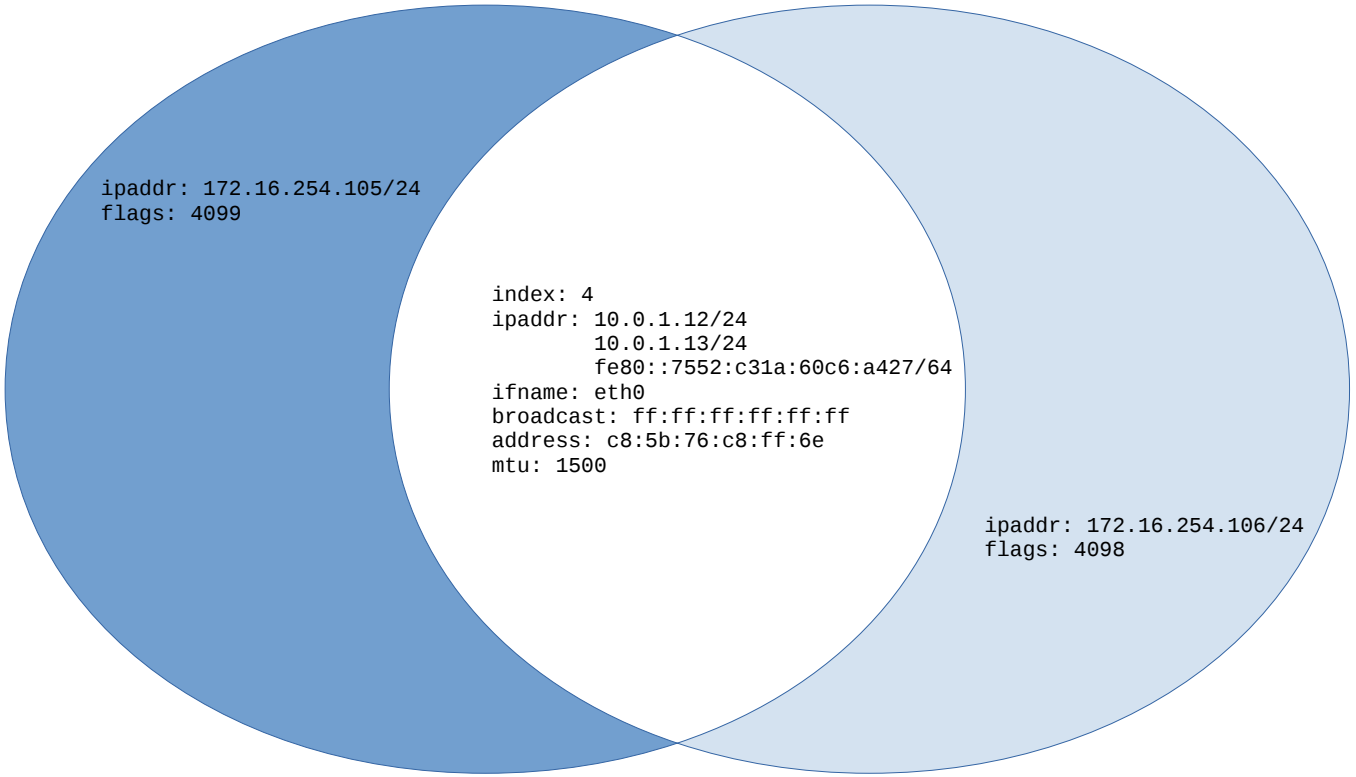
State transition as set operations



State transition as set operations



State transition as set operations



IPDB transaction

initial state

```
{'index': 4,
 'ipaddr': (('172.16.254.105', 24),
            ('10.0.1.12', 24),
            ('10.0.1.13', 24),
            ('fe80::7552:c31a:60c6:a427', 64)),
 'ifname': 'eth0',
 'broadcast': 'ff:ff:ff:ff:ff:ff',
 'address': 'c8:5b:76:c8:ff:6e',
 'mtu': 1500,
 'flags': 4099}
```

target state

```
{'index': 4,
 'ipaddr': (('172.16.254.106', 24),
            ('10.0.1.12', 24),
            ('10.0.1.13', 24),
            ('fe80::7552:c31a:60c6:a427', 64)),
 'ifname': 'eth0',
 'broadcast': 'ff:ff:ff:ff:ff:ff',
 'address': 'c8:5b:76:c8:ff:6e',
 'mtu': 1500,
 'flags': 4098}
```

added values

```
{'ipaddr': (('172.16.254.106', 24), ),
 'flags': 4098}
```

removed values

```
{'ipaddr': (('172.16.254.105', 24), ),
 'flags': 4099}
```

RTNL issues

* **events order**: e.g., one can get RTM_NEWLINK after the bridge removal
* **notifications**: dummy interfaces in the DOWN state send IPv6 addr notifications, while bridges don't
* **no notifications**: there is no notifications for traffic controls, like queues, classes etc.
* **structure declarations**: dynamic type resolution in the kernel via union
* **compatibility**: there is a lot of the legacy code in the kernel netlink code, e.g. HTB / TBF speed map
* …

pyroute2 is fixing things

IPDB level

* IPv4 vs. IPv6 notifications workarounds
* fuzzy logic in the transaction target matching
* retry some changes until completed
* context-dependent message handling
* object dependencies

socket level

* automatically use sysfs to manage bridge and bonds on the old kernels
* manage tuntap interfaces via ioctl

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