BIRD Internet Routing Daemon

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BIRD overview

- BIRD Internet Routing Daemon
- Routing protocols BGP, OSPF, RIP and BFD
- IPv4 and IPv6 support
- Linux and BSD kernel support
- Free and open source software (GPL)

BIRD features

- Programmable filters
- Clear and structured config files
- Multiple protocol instances
- Multiple routing tables
- Automatic reconfiguration on the fly
- Extensive documentation

Typical applications

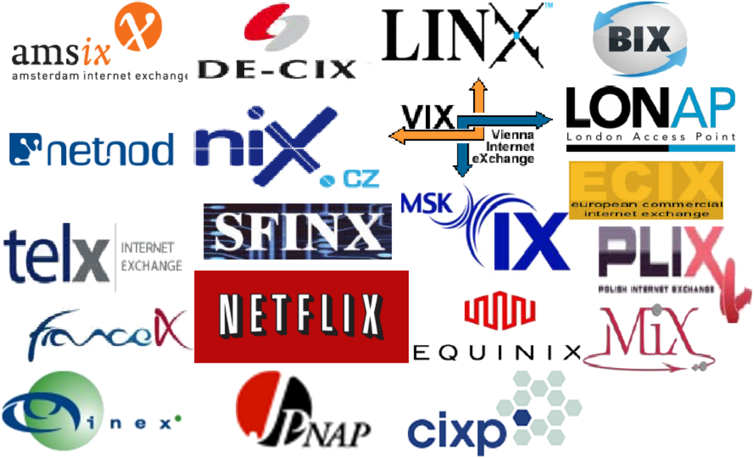
- OSPF routers in enterprise or small ISP networks
- BGP for external routing or route reflectors
- Route servers in internet exchange points

BGP Route server:

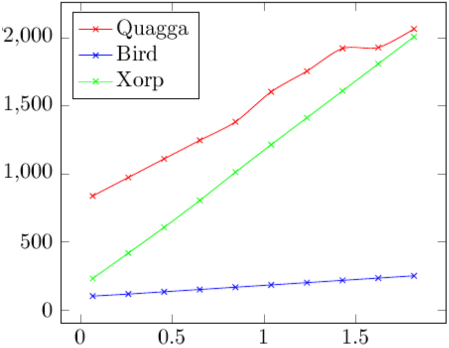
- Brokering of routing information in IXPs
- Only distribution of routing information
- Task not suited for dedicated hardware routers
- Requirements for many tables and flexible filtering

BIRD deployments

Euro-IX 2013: BIRD most popular route server in IXPs



Memory usage comparison

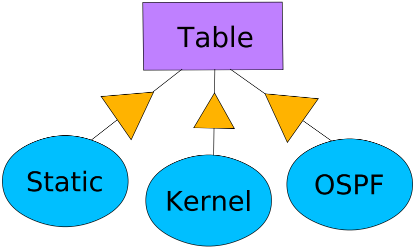


Memory usage [MB] / number of paths in RIB [millions].

Results and the graph taken from independent comparison at http://wh.cs.vsb.cz/sps/images/b/ba/BGP_route_servery.pdf

BIRD Concepts

- Routes
- Protocols
- Tables
- Filters



Protocols

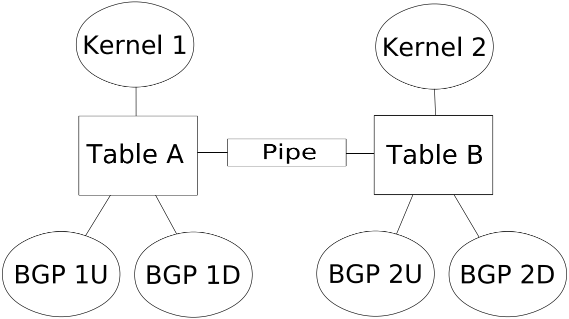
- Represent routing protocols (BGP, OSPF, RIP)
- Or other route sources (static, kernel, direct)
- Generate and receive routes
- Are connected to routing tables
- Protocols may have more instances

Tables

- Import and accumulate routes from protocols
- Preferred route is selected for each destination
- Then exported to attached protocols
- BIRD supports any number of tables
- Two tables can be connected through pipe

More routing tables

- Usually just one routing table
- Linux kernel supports more tables
- Can be used for e.g. policy routing
- Also for route servers



Filters

- Stand between protocol and table
- May modify, reject or accept routes
- Scripting language for route filtering
- Filter may access all route attributes
- Also for filtering of listings of routing tables

Filters – example

```
define martians = [ 10.0.0.0/8+, 172.16.0.0/12+
    192.168.0.0/16+, 169.254.0.0/16+, 224.0.0.0/4+,
    240.0.0.0/4+, 0.0.0.0/32-, 0.0.0.0/0{25,32} ];

filter bgp_in
{
    if net ~ martians then reject;
    if bgp_path.first != 1234 then reject;
    if bgp_path.len > 64 then reject;

    if net ~ [120.10.0.0/16+, 120.20.0.0/16+]
    then bgp_local_pref = 500;
    else bgp_local_pref = 100;

    bgp_med = 0;
    accept;
}
```

Essentials

- Separation of IPv4 and IPv6
- Config file and reconfiguration
- Control socket, birdc shell and commands
- Logging

- show route [all]
- show protocols [all]
- show interfaces
- show ospf ...

Basic configuration

```
router id 192.168.1.1;
log syslog all;

protocol device {
}

protocol static {
    import all;
    route 192.168.10.0/24 via 192.168.1.2;
    route 192.168.20.0/24 unreachable;
}

protocol kernel {
    export all;
    scan time 10;
}
```

Commands – examples

- show route 192.168.1.0/24
- show route for 192.168.1.10
- show route protocol ospf1
- show route where gw ~ 192.168.0.0/16
- show route where net.len ~ [16..24, 32]
- show route where bgp_path.len > 4
- show route where proto ~ "bpg*"
- show route where ifname = "eth0"
- show route filter myfilter

- show protocols
- enable | disable | restart ospf1
- configure [timeout | undo | confirm]
- down

OSPF – Open Shortest Path First

- Popular protocol for internal routing
- OSPFv2 for IPv4 (RFC 2328)
- OSPFv3 for IPv6 (RFC 5340)
- Router monitors reachability of its neighbors
- Local network topology is distributed to neighbors (LSA - Link State Advertisement)
- Every router gets complete map of network
- And computes shortest paths to all destinations

OSPF configuration

```
protocol ospf {
    import all;
    export filter {
        ospf_metric1 = 1000;
        if source = RTS_STATIC then accept; else reject;
    };

    area 0 {
        interface "eth0" {
            cost 5; hello 5; wait 10; dead 60;
        };
        interface "eth*" {
            cost 100; type pointopoint;
        };
    };
}
```

BGP – Border Gateway Protocol

- Standard protocol for internet routing
- BGPv4 (RFC 4271)
- Router receives routes from its neighbors
- Chooses preferred routes by local policy
- Preferred routes are used for forwarding
- And possibly propagated to other neighbors
- Forwarded routes contain many additional route attributes

BIRD as BGP router

```
protocol static {
    import all;

    route 10.10.0.0/16 reject;
    route 10.20.0.0/16 reject;
}

protocol bgp {
    import all;
    export where source = RTS_STATIC;

    local 192.168.1.1 as 65100;
    neighbor 192.168.1.2 as 65200;
}
```

BFD – Bidirectional Forwarding Detection

- Protocol for neighbor reachability and liveness testing
- Supplementary protocol to OSPF, BGP, . . .
- Reaction time in tens to hundreds of ms
- Command `show bfd sessions`

BFD – Bidirectional Forwarding Detection

```
protocol bfd {
    interface "eth*" {
        interval 50 ms;
        multiplier 4;
    };
}

protocol bgp {
    . . .

    local 192.168.1.1 as 65100;
    neighbor 192.168.1.2 as 65200;
    bfd;
}
```

IPv6 router advertisements

- For IPv6 stateless address autoconfiguration
- Easy way to generate IPv6 RAs from BIRD
- Support of RDNSS a DNSSL in RAs
- Dynamic IPv6 router advertisements

```
protocol radv {
    interface "eth*";
    rdnss 2001:0DB8:1234::10;
    dnssl "domain.cz";
    trigger 2000::/3;
}
```

Future plans

- Integrated multiprotocol design
- MPLS/VPN support
- Ethernet AF / bridge FDB support
- IS-IS protocol

Pitfalls

Sockets API

- Nice for simple TCP sockets
- Not so nice for raw or multicast sockets
- Sending packets with specified src addr and iface
- bind() overloaded / useless for multicast
- On Linux, at least we have SO_BINDTOIFACE
- IP_PKTINFO vs IP_SENDSRCADDR vs IP_HDRINCL
- For IPv6, IPV6_PKTINFO works well

Pitfalls

Ephemeral Source Port Selection

- IANA, RFC 6335 – range 49152–65535 should be used
- Linux – by default 32768–61000
- Tunable by net.ipv4.ip_local_port_range
- FreeBSD – by default 10000–65535, also tunable
- In FreeBSD, we have IP_PORTRANGE_HIGH cmsg
- Some BFD implmnttns reject packets with $sport < 49152$

Pitfalls

FIB, Netlink

- Multipath routes in IPv4 and IPv6
- Missing RTM_DELROUTE notifications for removed routes due to iface down
- IPv6 kernel device routes did not use RTPROT_KERNEL
- IPv6 routes did not support RTN_BLACKHOLE, RTN_PROHIBIT
- net.ipv6.route.max_size limit

Questions?

http://labs.nic.cz/
http://bird.network.cz/