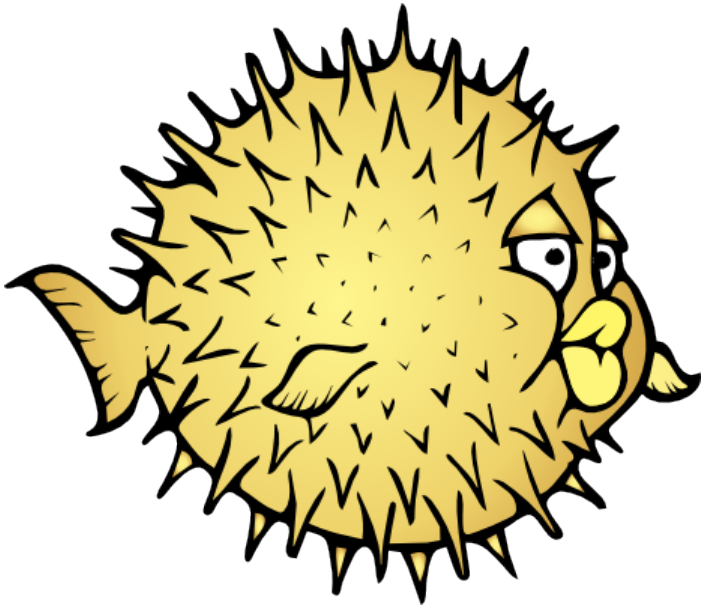
Embracing the BSD Routing Table



Martin Pieuchot
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EuroBSDcon, Belgrade

September 2016

Embracing the BSD Routing Table

How many *global data structures* do you need?

Agenda

BSD Routing Table

Refined Interface

New data structures

Conclusion

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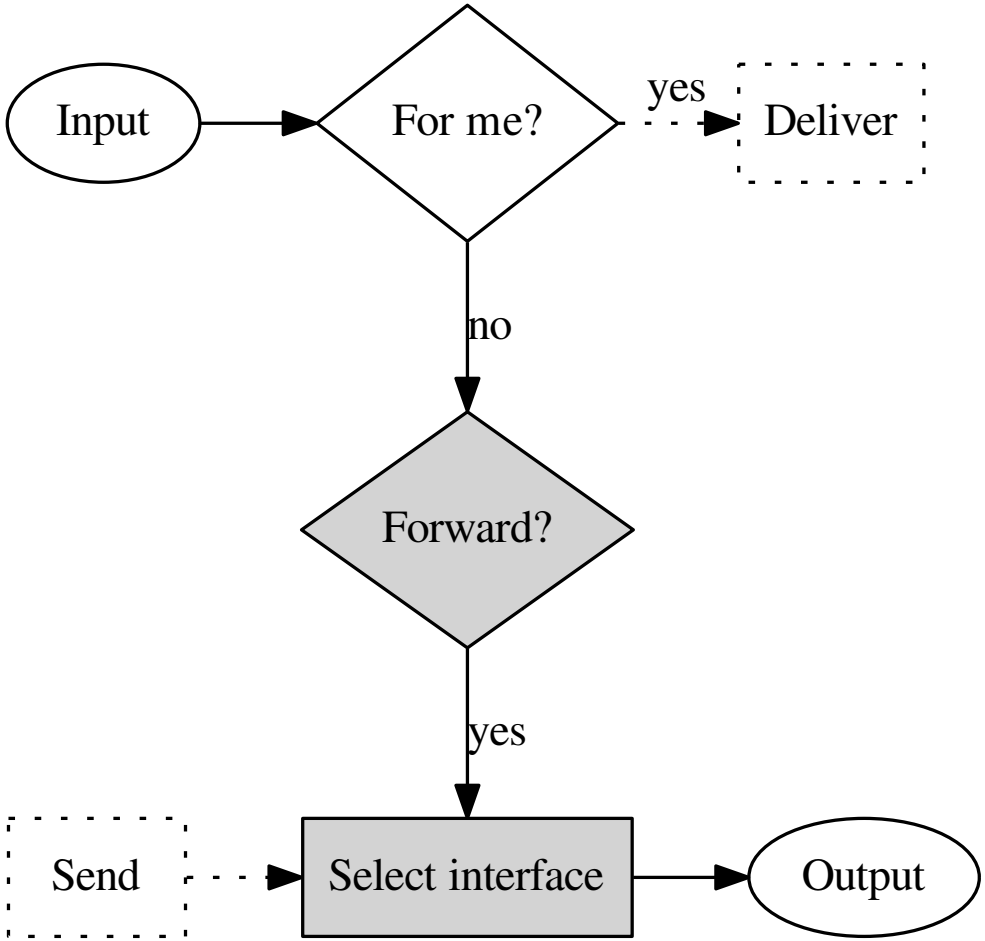
Forwarding table

sys/net/radix.c



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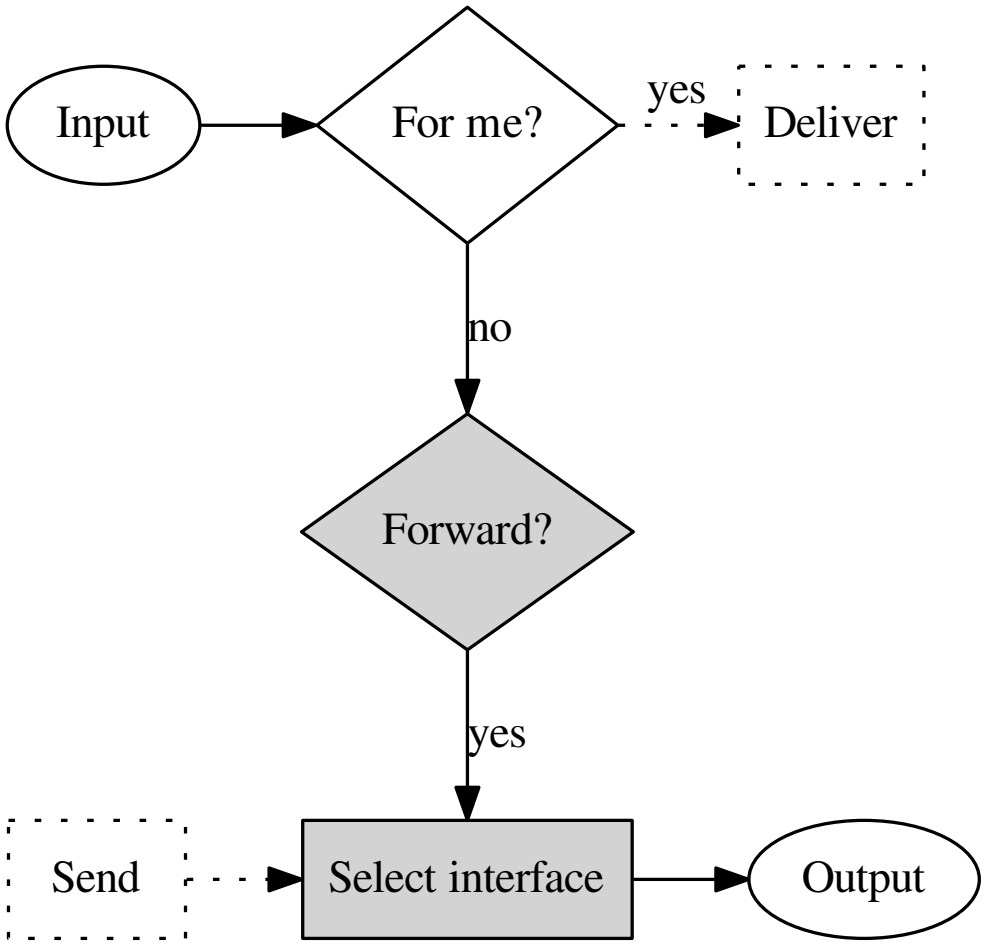


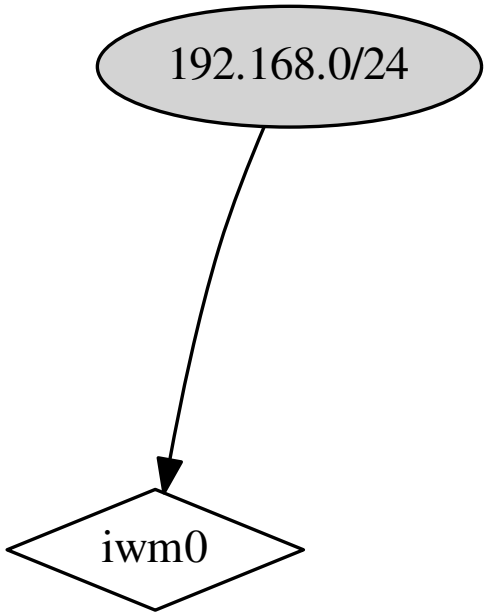
Since 4.3 Reno

- replace hash-based lookup
- PATRICIA trie
  - radix tree with $r = 2$

Link layer address translation

sys/net/if_ethersubr.c

RTF_CLONING: For each connected route



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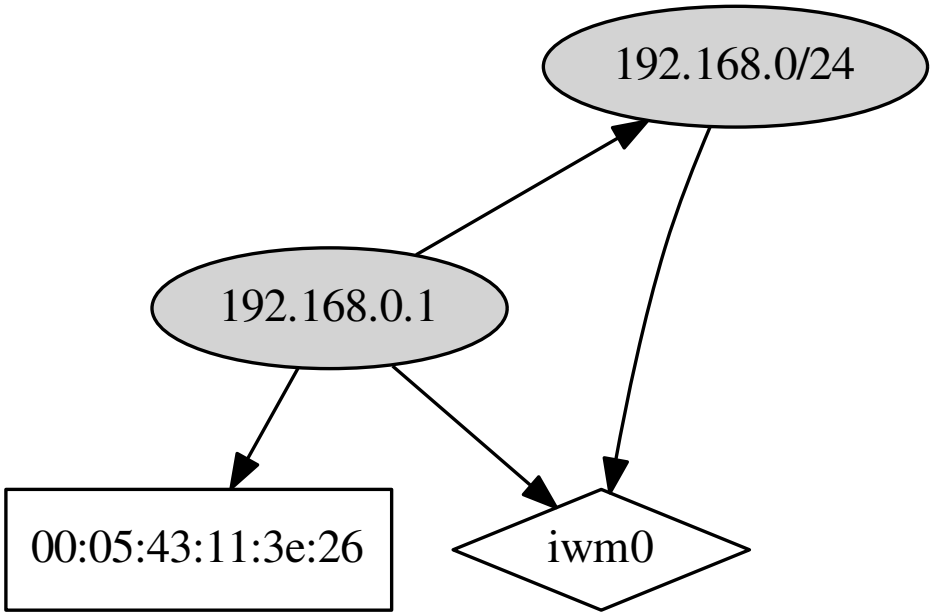

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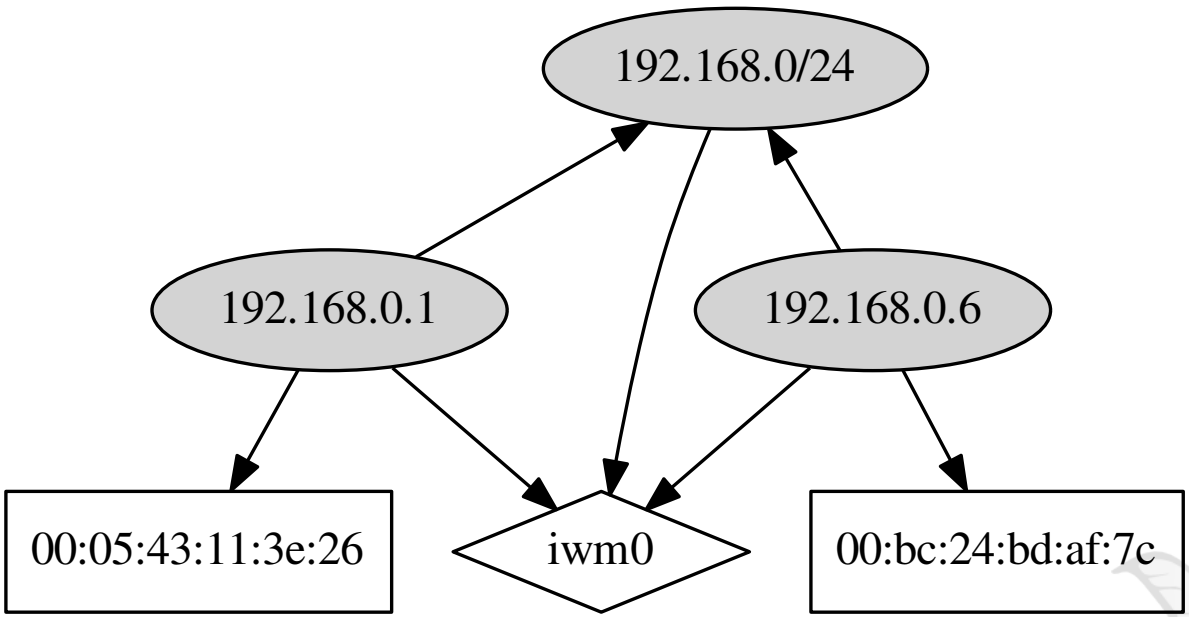

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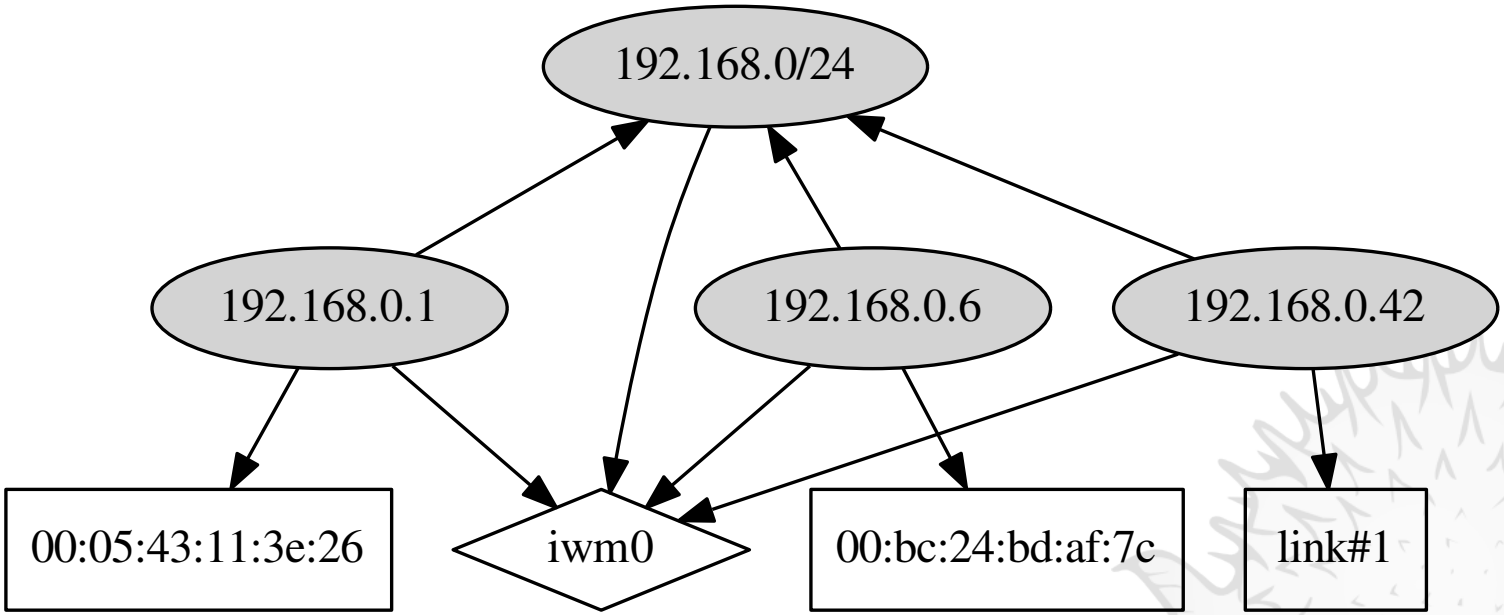


Message oriented IPC

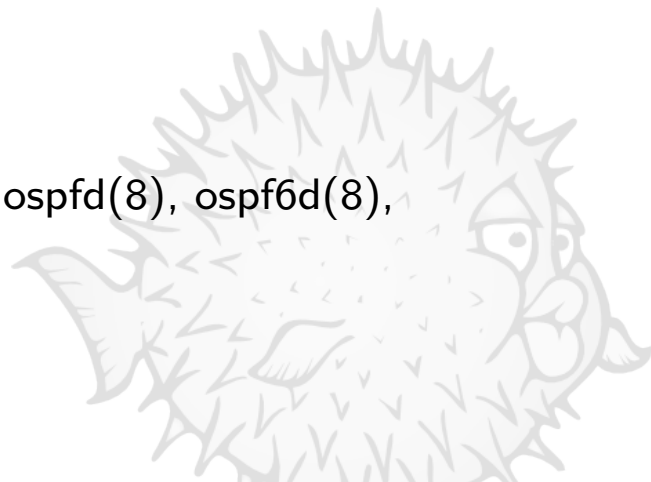
sys/net/rtsock.c

Routing messages

- RTM_ADD
- RTM_DELETE
- RTM_CHANGE
- RTM_GET
- RTM_NEWADDR
- RTM_DELADDR
- RTM_IFINFO
- ...

Native speakers

route(8), dhclient(8), bgpd(8), dvmrpd(8), eigrpd(8), ldpd(8), ospfd(8), ospf6d(8), ripd(8), snmpd(8), ...



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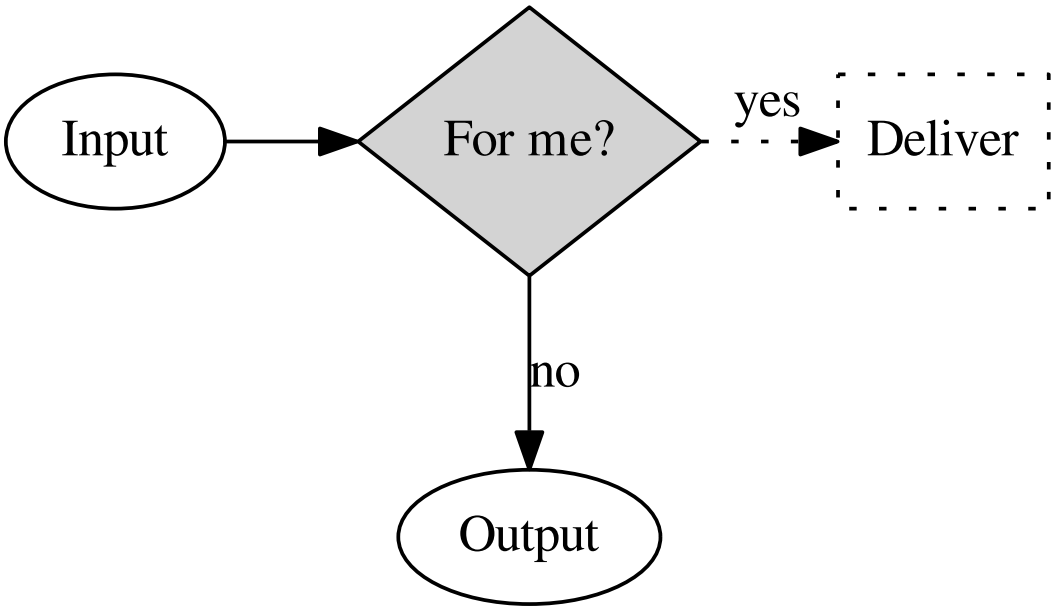
Single lookup

sys/netinet/ip_input.c



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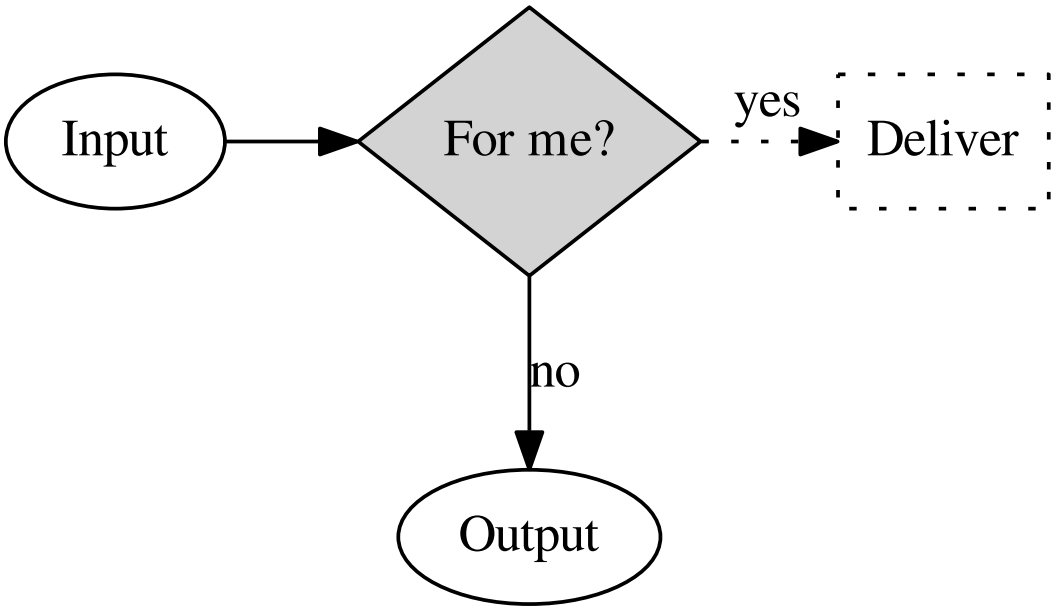


Forwarding?

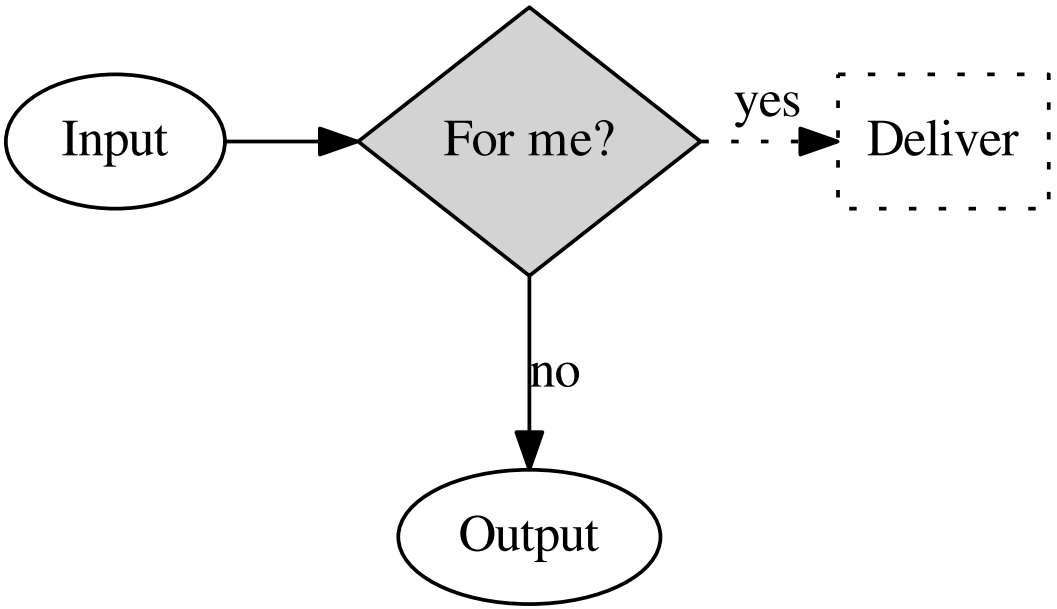
Where?

Which Source?

Link layer address?

Single lookup

sys/netinet/ip_input.c



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- RTF_BROADCAST

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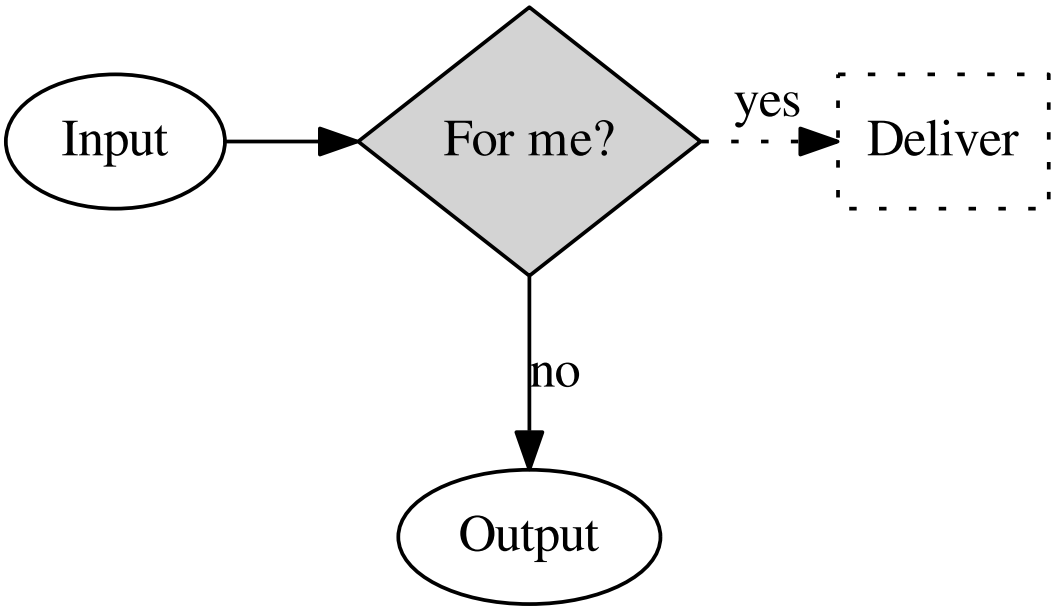

Forwarding?

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- RTF_BROADCAST

Where?

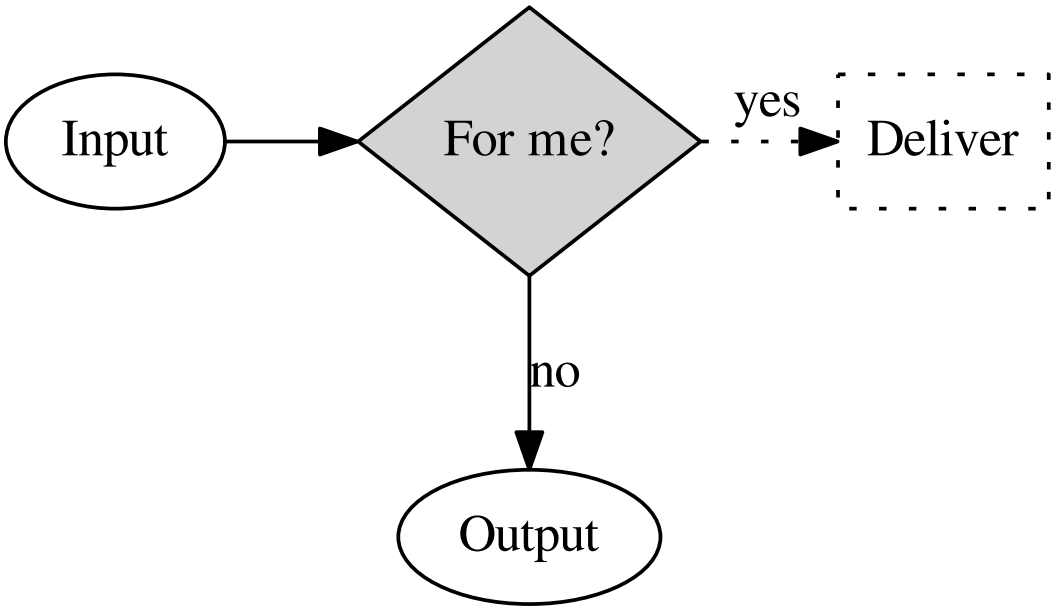
- rt_ifidx

Which Source?

Link layer address?

Single lookup

sys/netinet/ip_input.c



Forwarding?

- RTF_LOCAL
- RTF_BROADCAST

Where?

- rt_ifidx

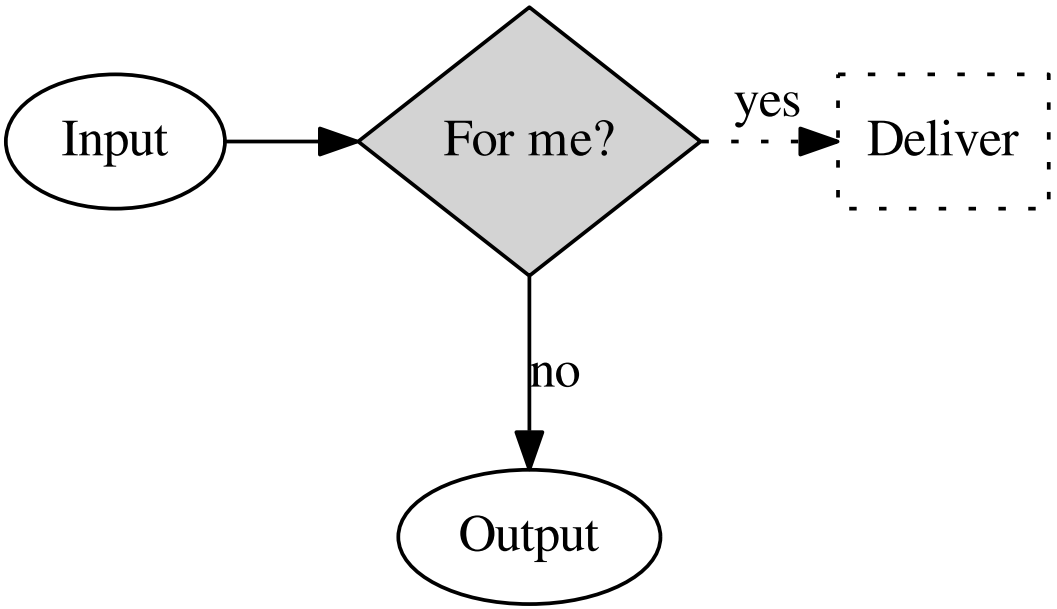
Which Source?

- rt_ifa

Link layer address?

Single lookup

sys/netinet/ip_input.c



Forwarding?

- RTF_LOCAL
- RTF_BROADCAST

Where?

- rt_ifidx

Which Source?

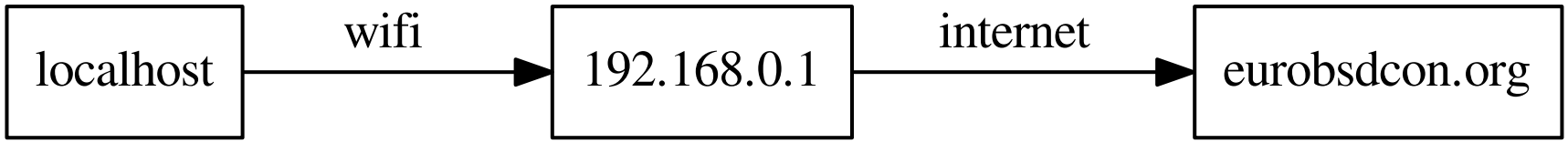
- rt_ifa

Link layer address?

- rt_gateway

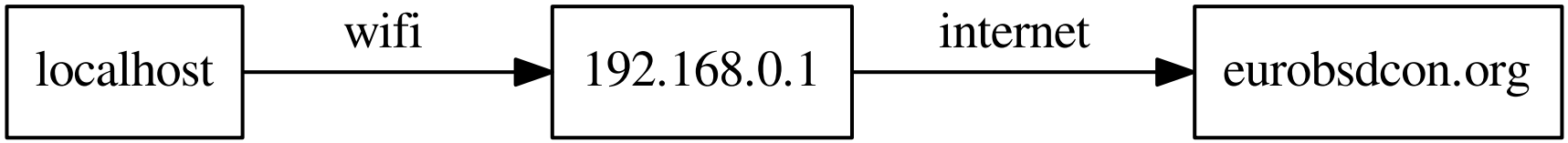
Gateway route

sys/net/route.c



Gateway route

sys/net/route.c

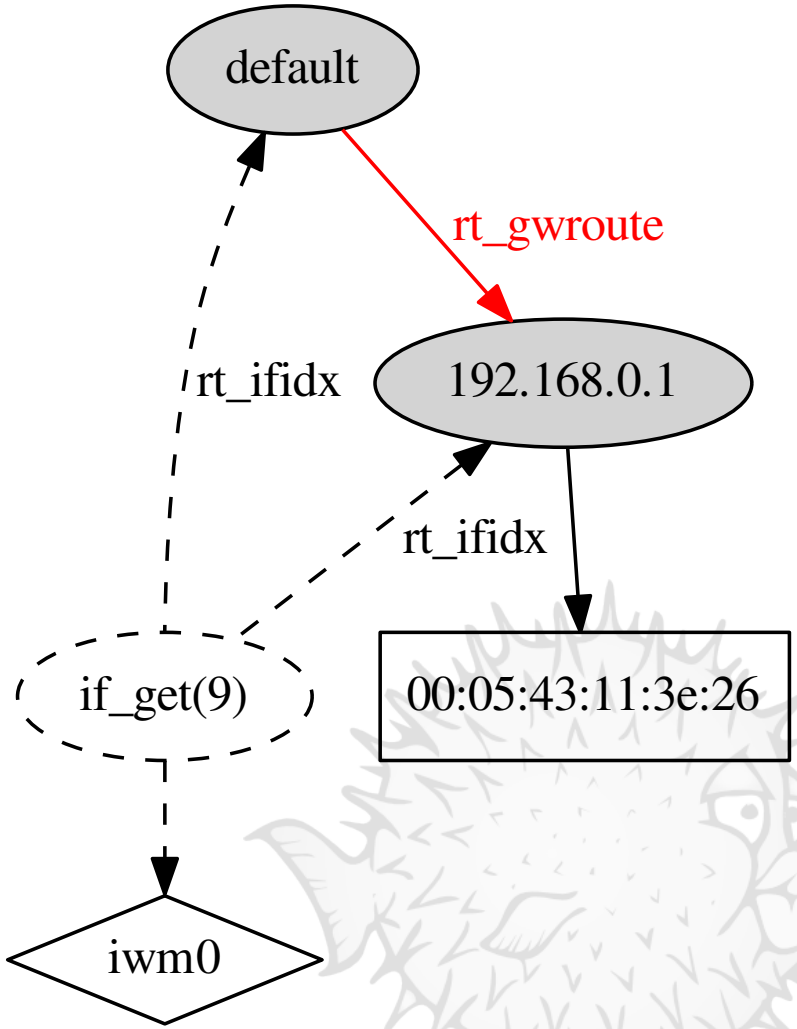



```
$ netstat -rnf inet

Routing tables

Internet:
Destination        Gateway            Flags    Refs      Use   Mtu  Prio Iface
default            192.168.0.1        UGS        20      420     -     8 iwm0
192.168.0/24       192.168.0.6        UC          2       10     -     4 iwm0
192.168.0.1        00:05:43:11:3e:26  UHLch       1      241     -     4 iwm0
192.168.0.6        00:bc:24:bd:af:7c  UHLl        1        4     -     4 iwm0
```

Link layer address of the gateway

sys/net/if_ethersubr.c

Single shared cache



Link layer address of the gateway

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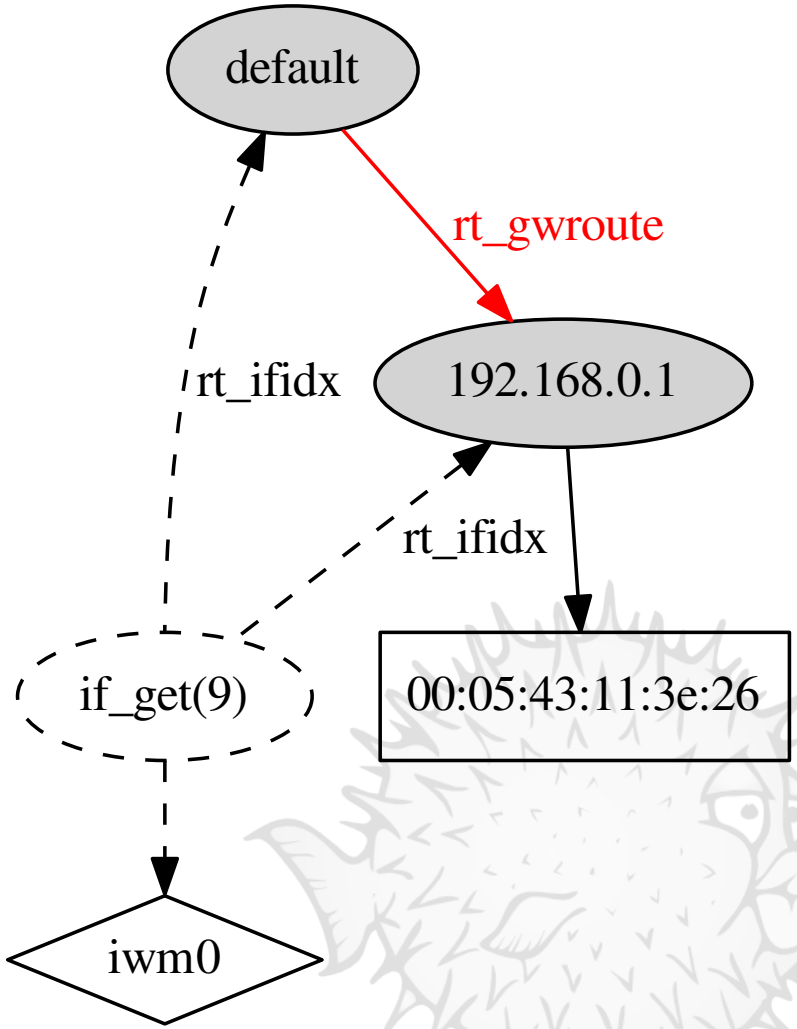
Single shared cache

- Proxy reference count



Link layer address of the gateway

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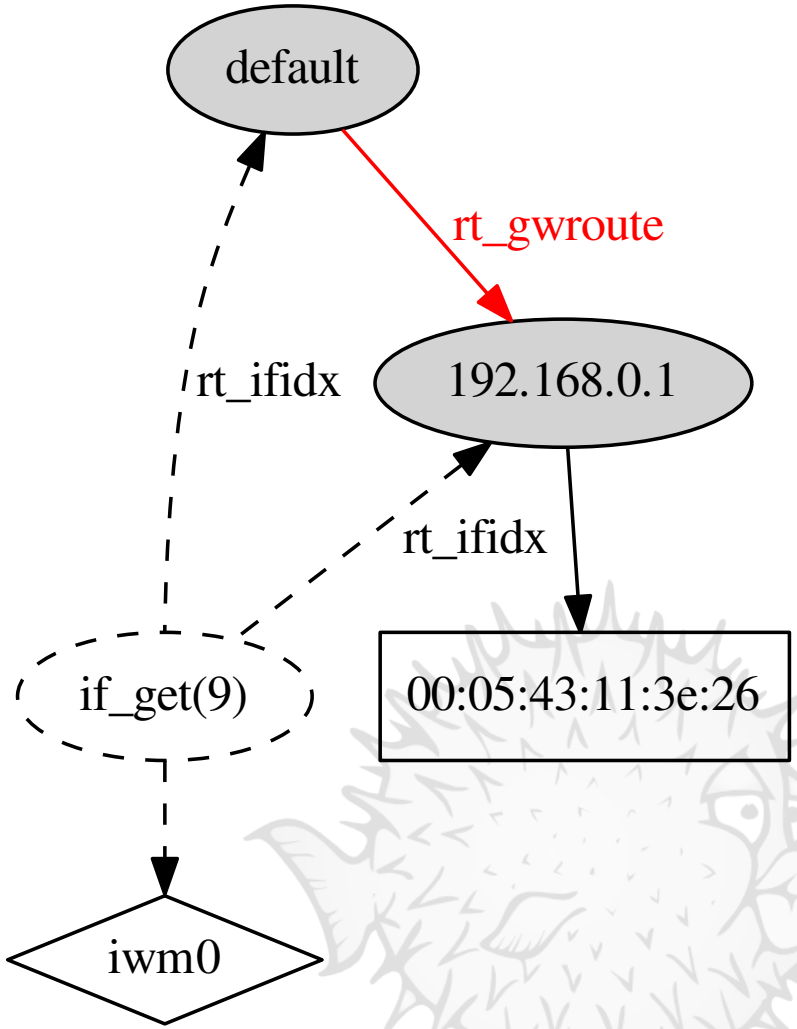
Single shared cache

- Proxy reference count
- Immutable pointer

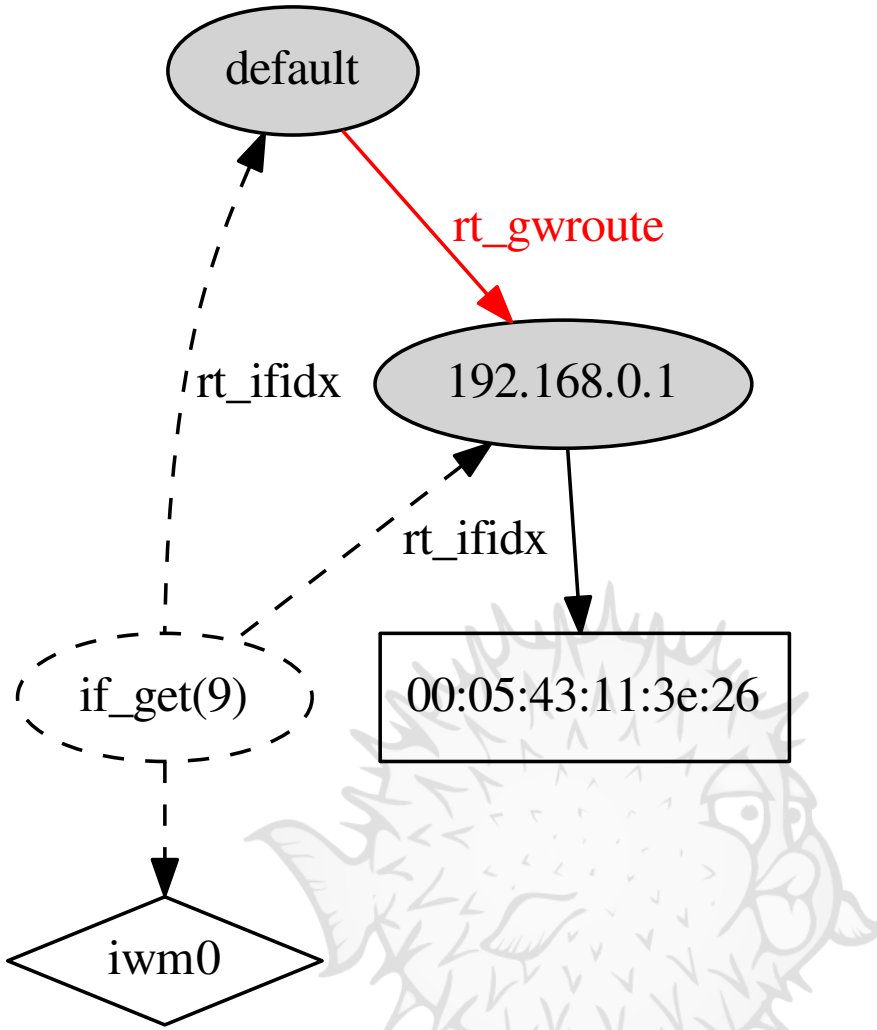


Link layer address of the gateway

sys/net/if_ethersubr.c

Single shared cache

- Proxy reference count
- Immutable pointer
- Flag it RTF_CACHED



Link layer address of the gateway

sys/net/if_ethersubr.c

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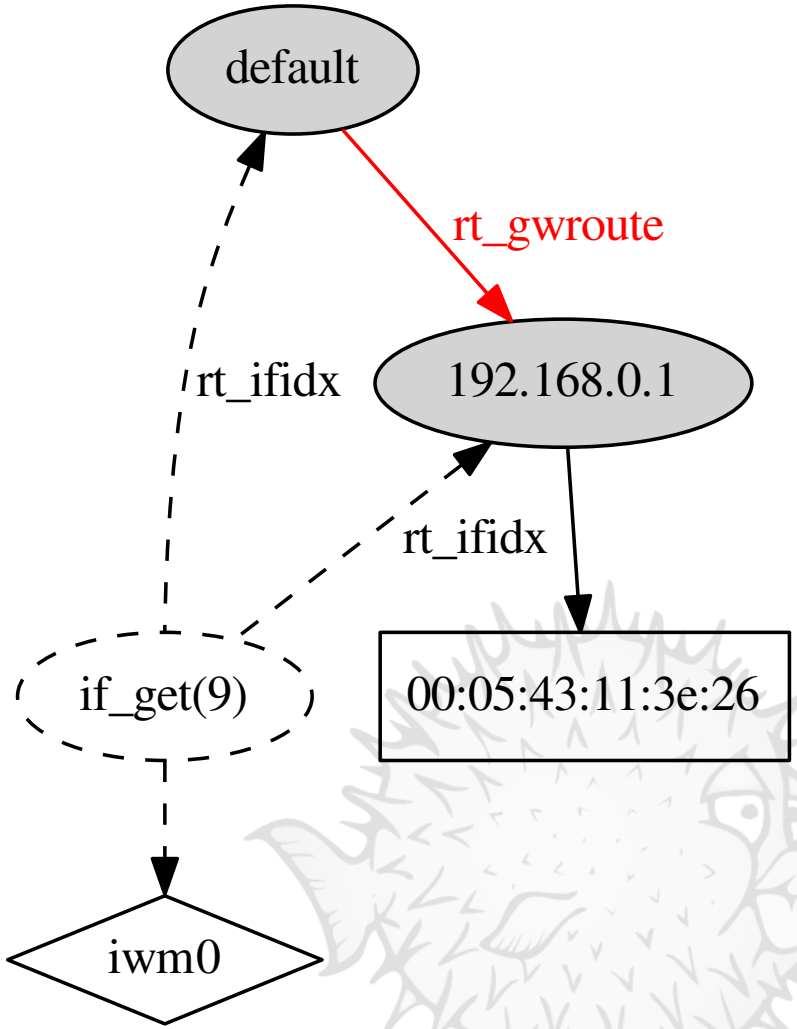
- Immutable pointer
- Flag it RTF_CACHED
- Checks during insertion
  - No second route lookup



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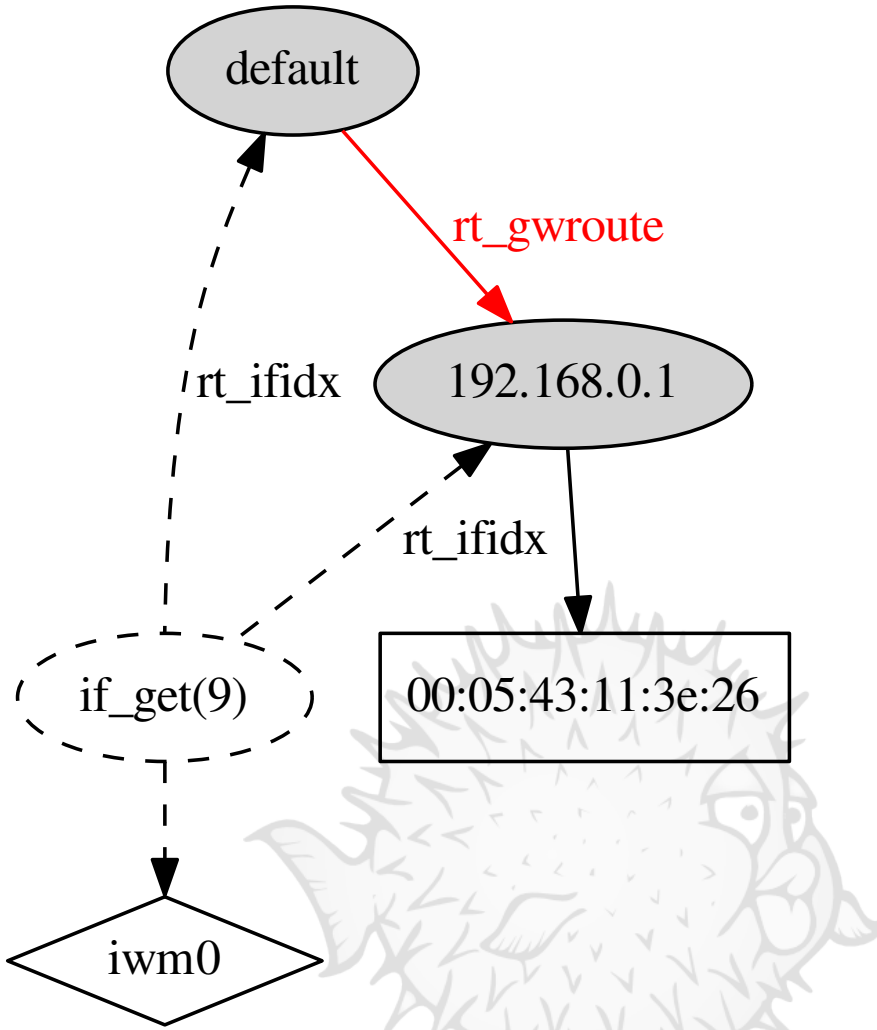
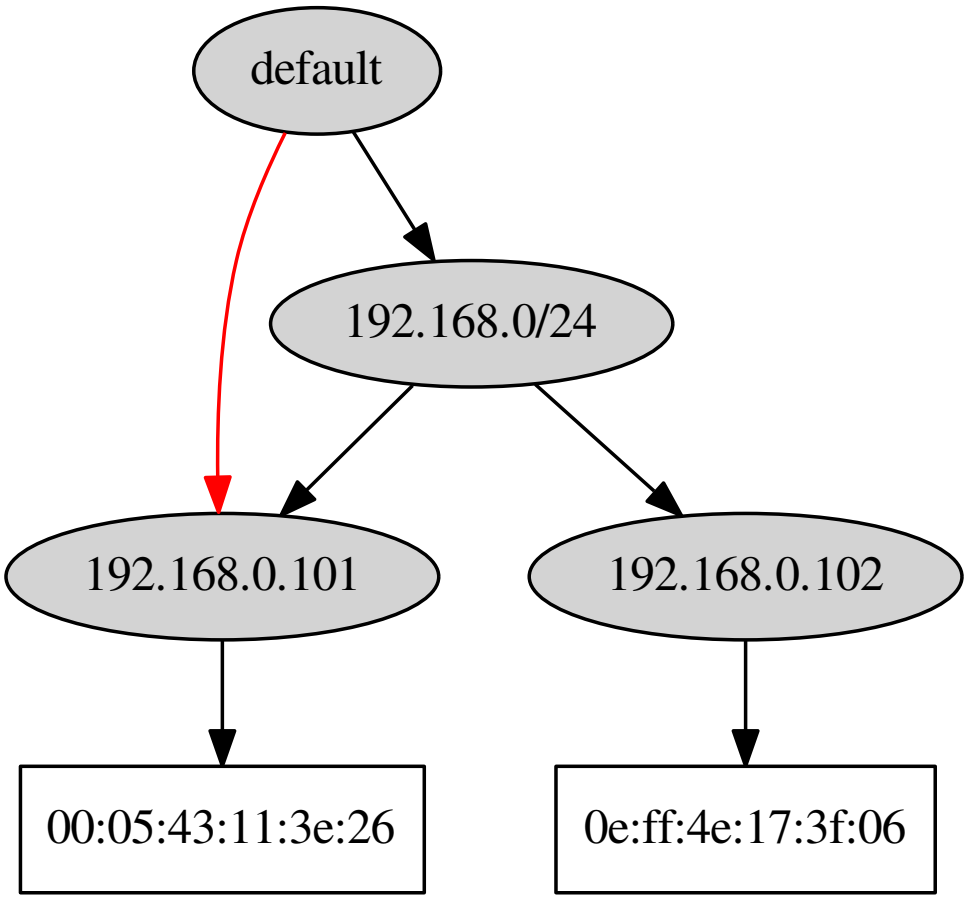
- No atomic operations



Multipath

sys/net/radix_mpath.c



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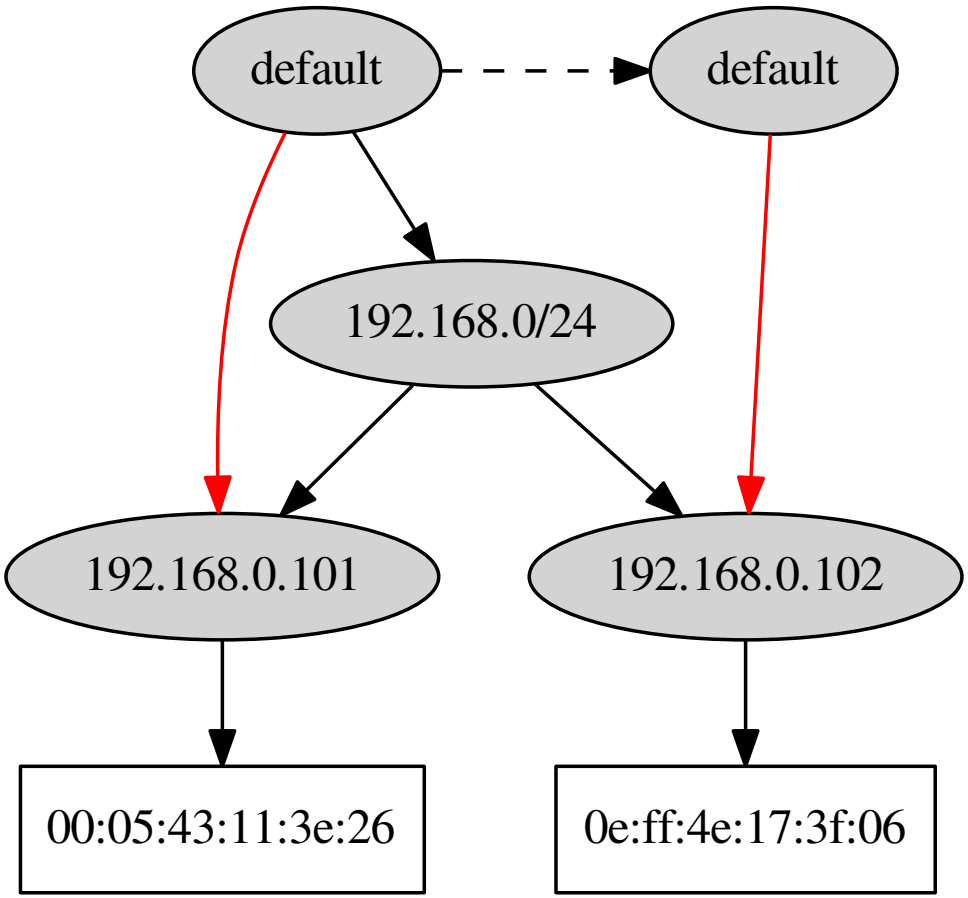

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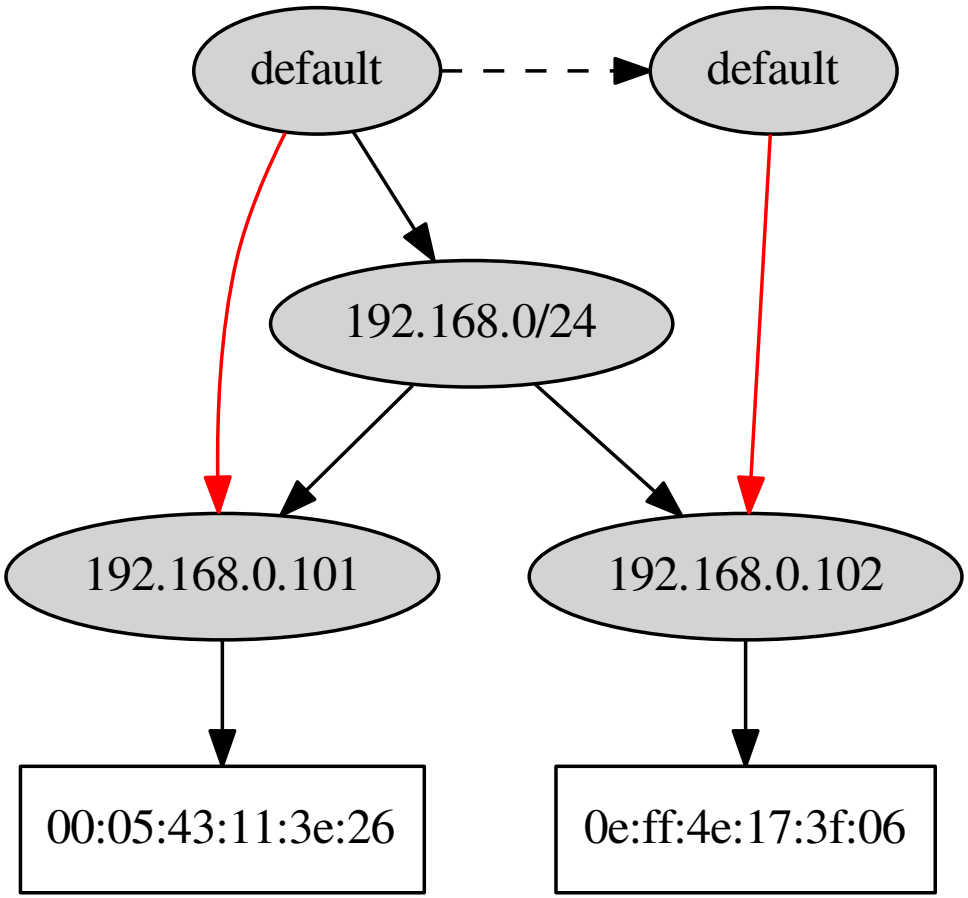

- Introduced by KAME
  - for sending/forwarding

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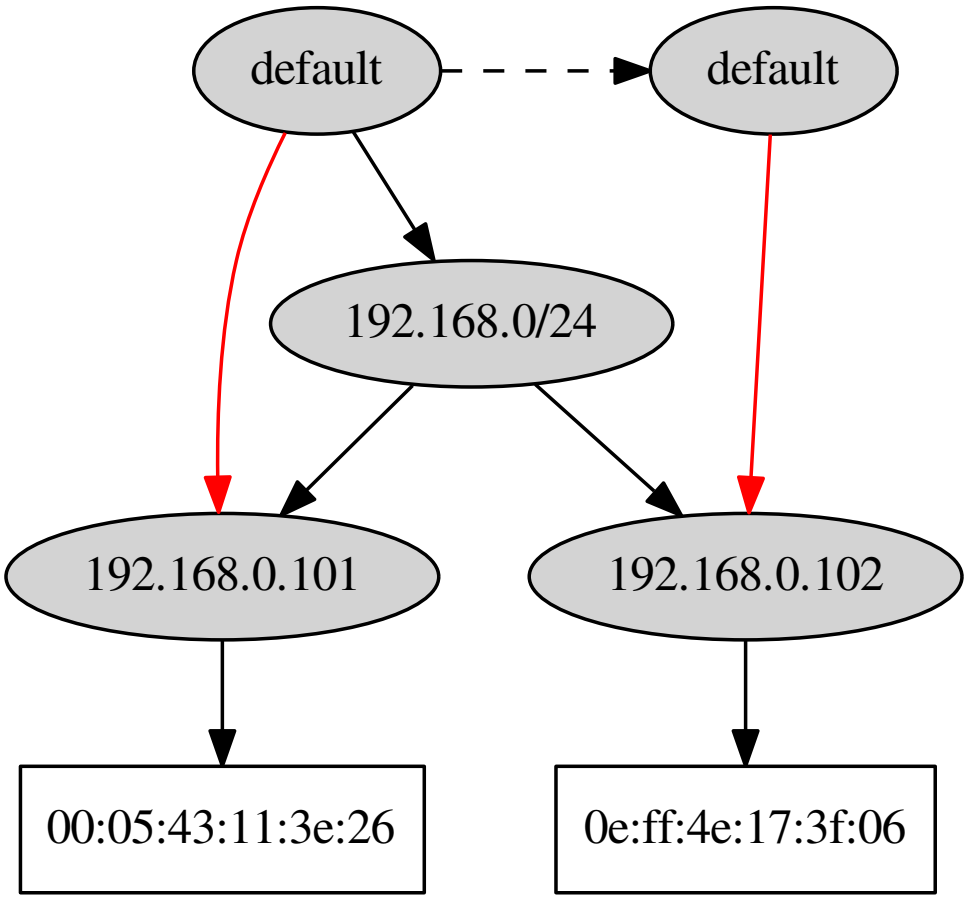

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  - different priority, or
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Multipath

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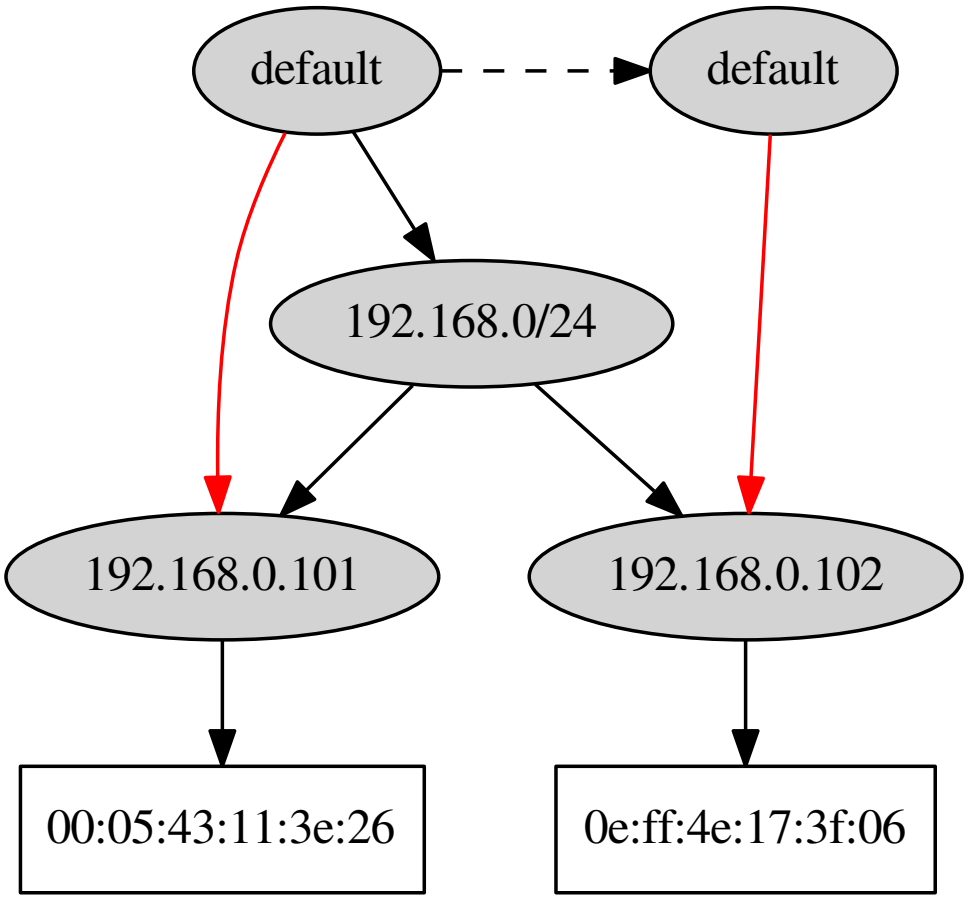

- Introduced by KAME
  - for sending/forwarding
- Identical *keys* in the tree
  - different priority, or
  - different gateway
- Extended to
  - Connected routes
  - ARP proxy entries
  - (Multicast groups)

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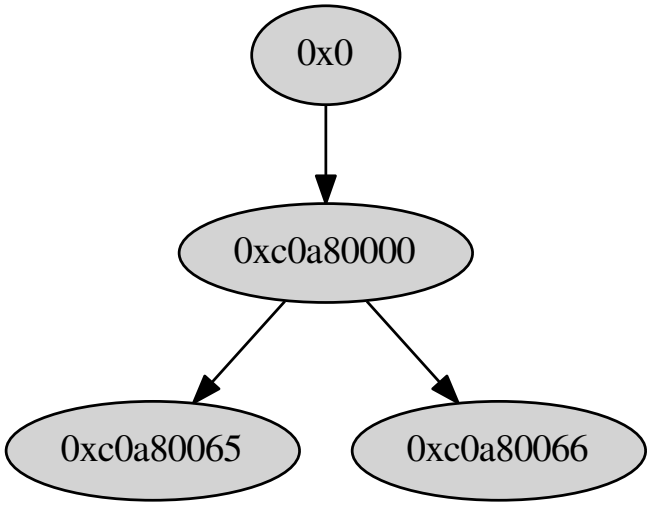
Why?

sys/net/radix_mpath.c

```
/*
 * Stolen from radix.c rn_addroute().
 * This is nasty code with a certain amount of magic and dragons.
 [...]
 */
```

Everything is multipath

sys/net/rtable.c



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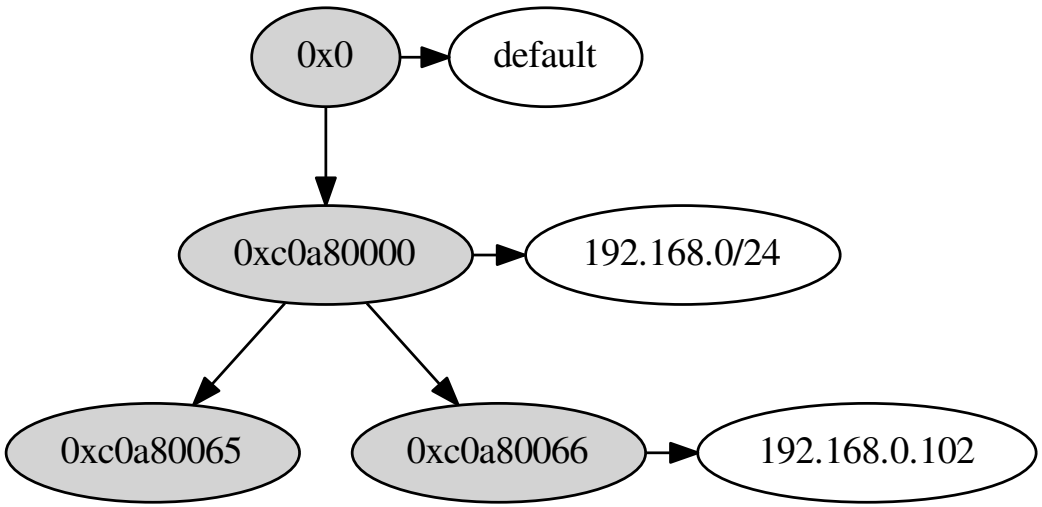

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  - network agnostic
  - *value* is a pointer

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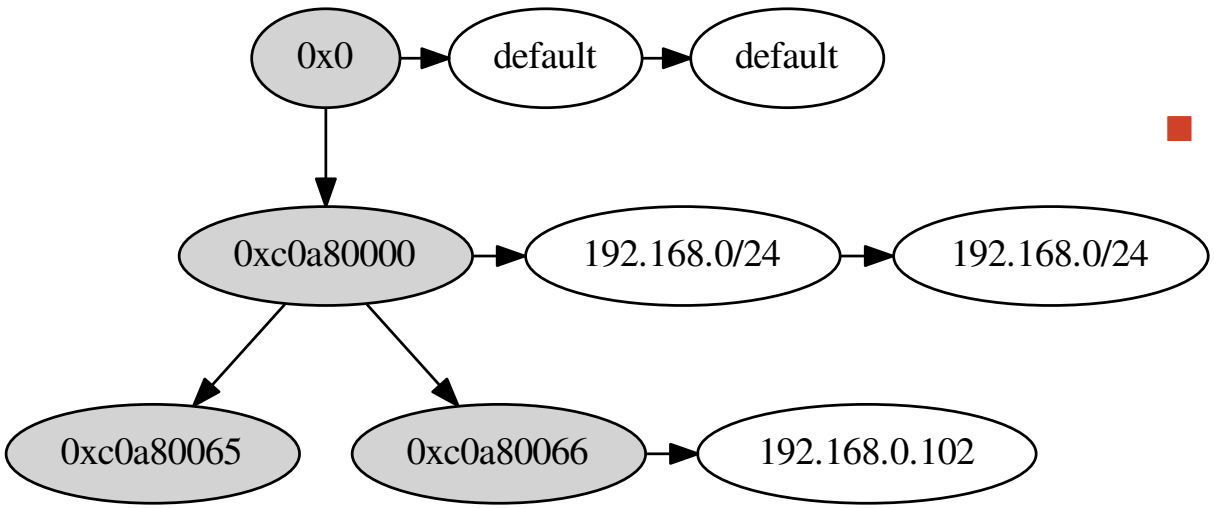

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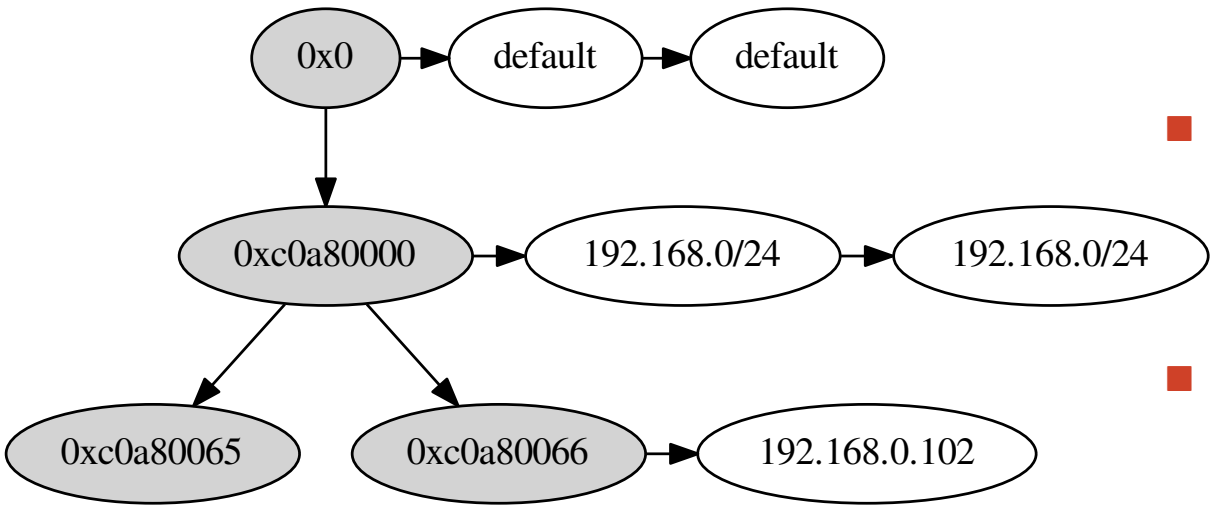

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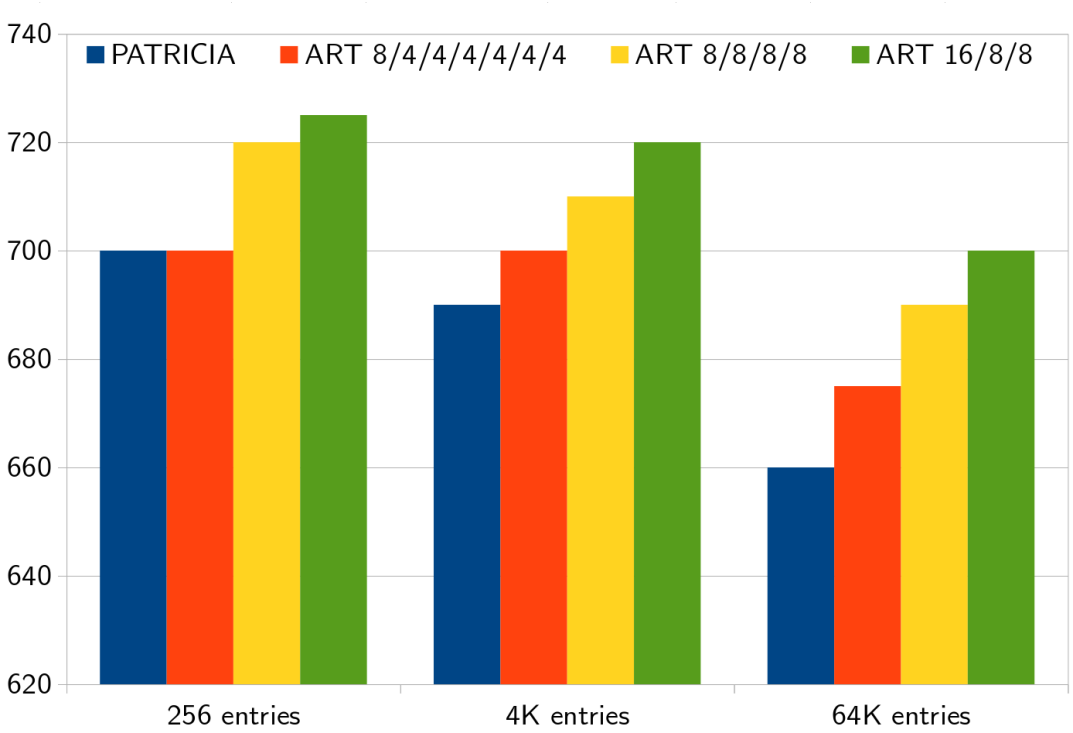
- MP ready
  - different lifetimes
  - separated refcount
  - no backpointer

Allotment Routing Table

sys/net/art.c

Number of packets received

while sending 800Kpps



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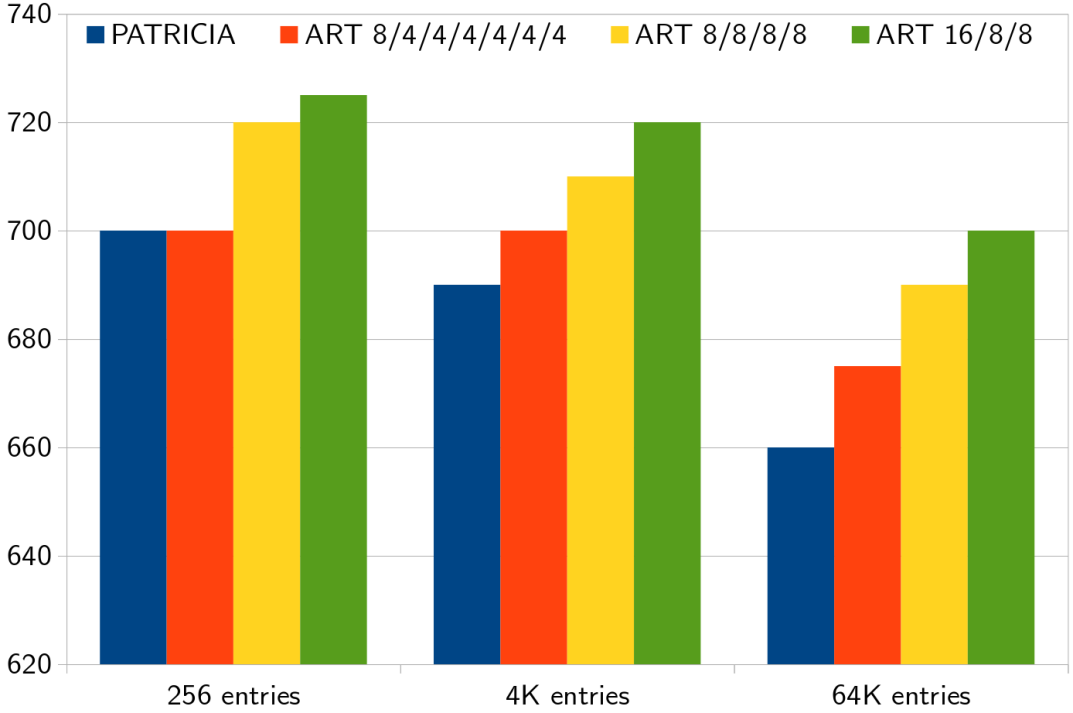

Shared code & knowledge

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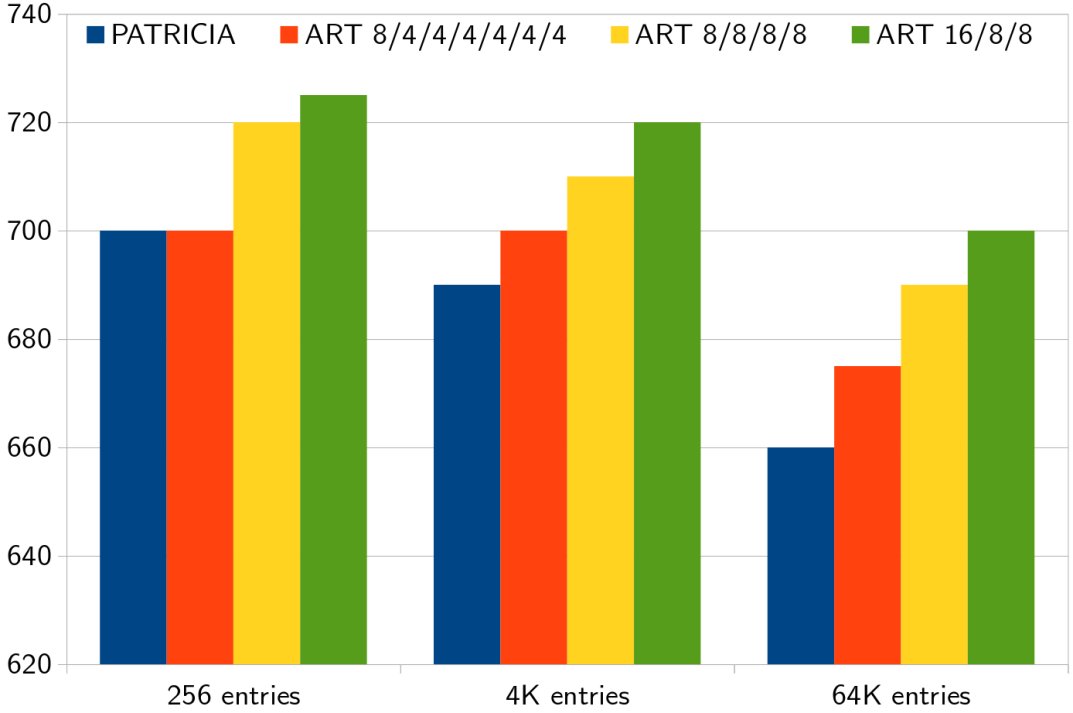

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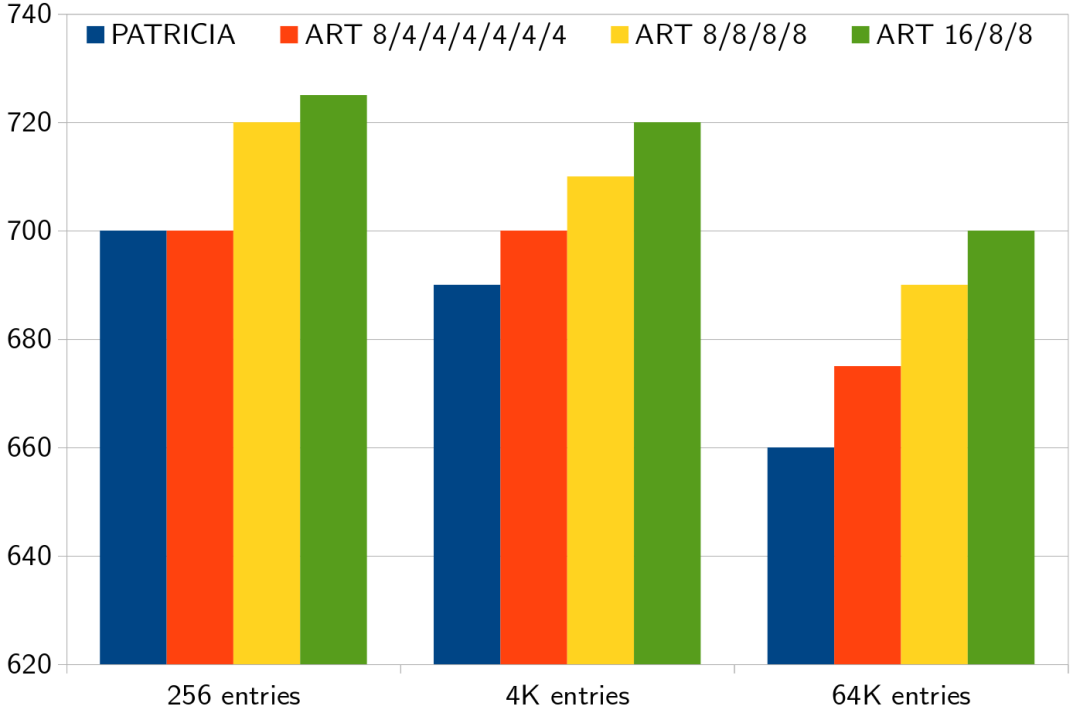

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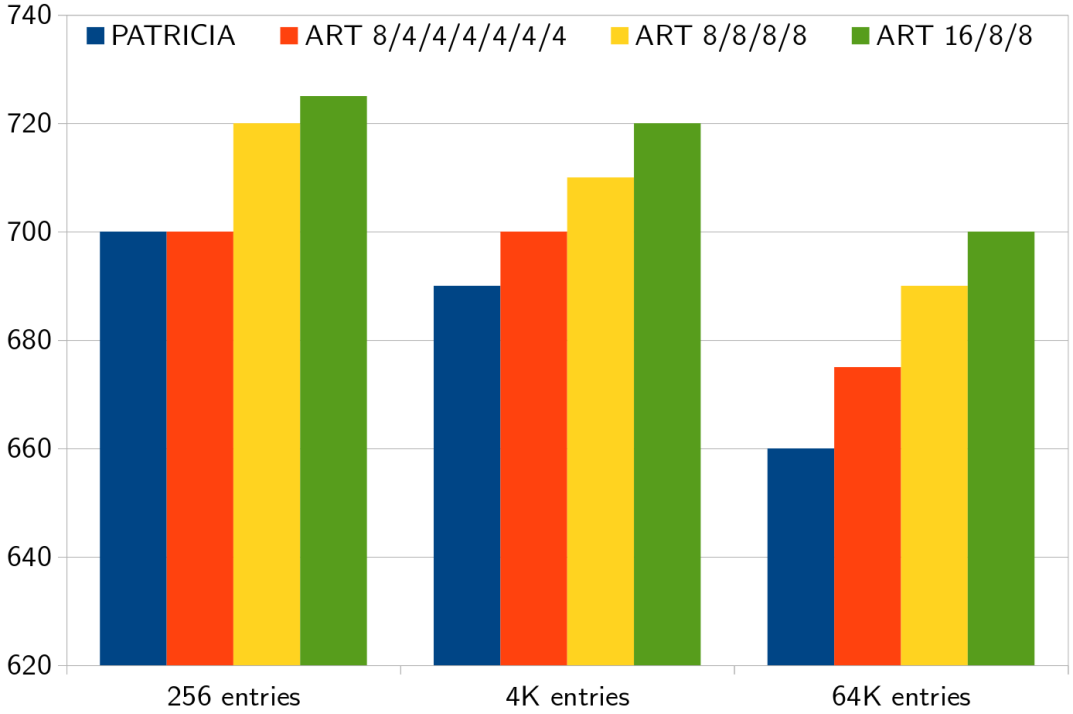

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- Integrated by **Martin Pieuchot**
- Lock free lookup by **Jonathan Matthew** & **David Gwynne**

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sys/net/rtable.c

- Routing table as **single** *gobal data structure*

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- Generic, multi-use *multipath* implementation
- **Faster** route lookup via *ART*
- Interface didn't change

Questions?

Slides on http://www.openbsd.org/papers/

More stories on http://www.grenadille.net

Coming soon!

sys/net/pf.c