

# NPF: a new packet filter

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  - boolean expression tree
  - directed acyclic control flow graph
  - if-then-else hell

# A see of firewalls

- IPFilter (ipf)
- FreeBSD's ipfw
- OpenBSD's pf
- NetBSD's npf

# How NPF started out

- Sponsored by The NetBSD Foundation
- Written by Mindaugas Rasiukevicius (rmind@) from scratch, although the design was inspired by the Berkeley Packet Filter
- First imported to -current in August 2010
- Will be widely available with the 6.0 release
- First step in improving NetBSD's networking capabilities
- Second step: removing the big kernel lock (proposal deadline: Oct 31st)

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- Mentoring organizations get \$500 per student, students get \$5000
- It has been running since 2005
  - 2011: 175 mentoring organizations, 1115 students
- NetBSD has participated every year so far with a high success rate
  - 2011: 9 projects, 8 projects ended with success
- My GSoC proposal for 2011 was to add IPv6 support to NPF
  - currently not in -current (soon!)
  - available from <https://github.com/zoltan/ipv6-npf>

# Motivations and goals

- There are a few existing firewalls
- It's easier to design a new firewall from ground up than to clean up existing codebases
- Design goals for NPF:
  - MP-safety and locklessness for scalable MP performance
  - Fast tree- and hash-based lookup support for tables
  - Stateful packet filtering
  - N-Code processor, a general bytecode engine
  - Keep configuration syntax changes to a minimum
  - Modularity, extensibility: an extension API for developers, hooking support
  - Last but not least: simplicity
- Of course it's portable, uses pfil(9) hooks; DragonFlyBSD is considering adoption
- Please keep in mind: it's a moving target currently

- `npfctl` can be used to communicate with `/dev/npf` via `ioctl`s
  - start, stop, reload, flush, stats, tables, sessions, ...
- Rules will be compiled to a bytecode, and it will be loaded as `ruleset(s)`
- Current parser will be replaced by a new one by Martin

# What can it do today?

- Rule syntax is nearly identical to other firewalls
- Group support
- Rule procedures (connection-based packet transformations)
  - IP ID randomization
  - enforcement of TCP minimum TTL
  - enforcement of TCP Maximum Segment Size (MSS)
  - logging
- Tables support
- Application-level gateways (ALGs)



```
ext_if = "wm0"
ext_if = "wm1"
table "1" type "tree" dynamic
procedure "rid" { normalize (random-id) }
procedure "log" { log npflog0 }
group (name "external", interface $ext_if) {
    block in quick from <1>
    pass out quick from $ext_if keep state apply "rid"
    pass in quick proto tcp to $ext_if port ssh apply "log"
    ...
}
group (name "internal", interface $int_if) {
    block in all
    pass in quick from <1>
    pass out quick all
}
group (default) { block all }
```

## N-code engine:

- General purpose bytecode engine, 32-bit words, 4 registers available
- The firewall configuration is compiled to our bytecode format, then loaded
- CISC and RISC-like instructions
- The packets are processed as a byte-stream

## Efficient internal structures

- `npf_addr` (`in6_addr`, 128-bit) for addresses (the first 32 bit is used for IPv4 addresses)
- `uint8_t` for masks
  - instead of generating the appropriate `npf_addr` value from 255.255.255.0 or /24, we just store the mask ( $\leq 128$ )
  - tradeoff: CPU for memory

Let's see what we can work with...

```
typedef struct {
    /* Information flags. */
    uint32_t      npc_info;
    /* Pointers to the IP v4/v6 addresses. */
    npf_addr_t *  npc_srcip;
    npf_addr_t *  npc_dstip;
    /* Size (v4 or v6) of IP addresses. */
    int           npc_ipsz;
    size_t        npc_hlen;
    int           npc_next_proto;
    /* IPv4, IPv6. */
    union {
        struct ip      v4;
        struct ip6_hdr v6;
    } npc_ip;
    /* TCP, UDP, ICMP. */
    union {
        struct tcphdr  tcp;
        struct udphdr  udp;
        struct icmp    icmp;
    } npc_l4;
} npf_cache_t;
```

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- Multiple address per interface support on interface-based rules
- Dynamic interface tracking
  - Let's say you have a rule based on an interface instead of an address...
  - ...you compile and load the rules...
  - ...then change the interface's address?
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- Write more documentation :)

# What we haven't covered today and why...

- Performance testing
  - No point in in-place testing, since the locking of the network stack is not fine-grained enough
  - Will do userspace tests once the current codebase is merged
- Packet sniffing

Questions and answers?

Thank you!