High-speed traffic encryption on x86_64 with Snabb

FOSDEM 20

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Vita

whoami

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Open source hacker, working on Snabb since 2014

Consulting on software networking (in userspace), protocols, optimization...

Vita

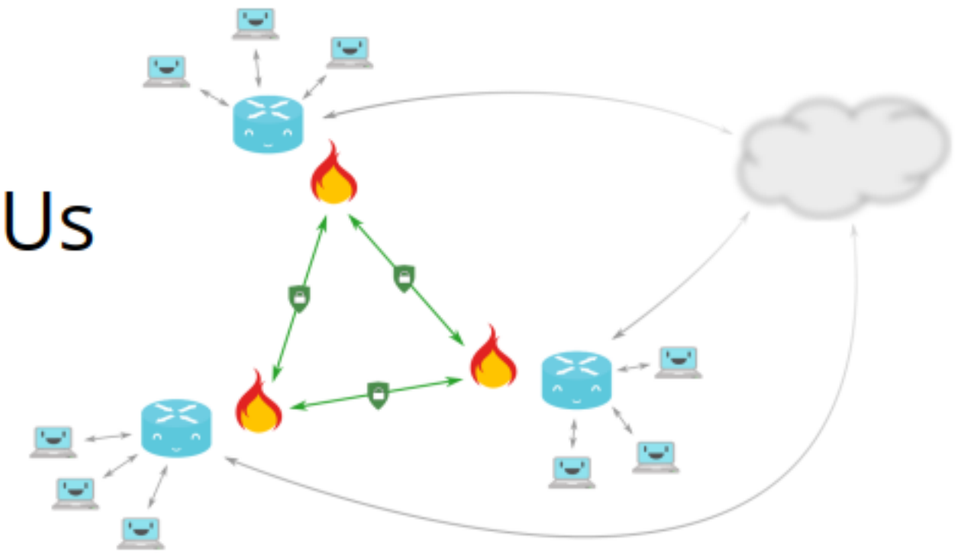
inter—
stellar

Vita

Vita is a high-performance site-to-site VPN gateway

Fully open source (and hackable!)

Runs on generic x86_64 server CPUs



Vita

Based on  snabb

Written in a high-level language (Lua) RAPTORJIT

Made possible by nlnet FOUNDATION

snabb

```
while not link.empty(input) do

   local p = link.receive(input)

   if ipv4_ttl(p) > 0 then
      link.transmit(output, p)
   else
      link.transmit(time_exceeded, p)
   end

end
```

Vita

~3 Mpps per core on a modern CPU (duplex)

...or ~5 Gbps of IMIX traffic per core

Medium-term goal: 100 Gbps at 60 byte packets on a generic x86 server

How?

In Snabb-land we like to write software that is both fast and simple

...and we don't like vendor lock-in

No QuickAssist, crypto cards... Only x86_64!

Vita

How?

For crunching numbers (encryption): AES-NI, AVX2 (optimized AES-GCM implementation written in DynASM)

```
function ghash_mul(Dst, gh, hk, t1, t2, t3)
  | vpclmulqdq xmm(t1), xmm(gh), xmm(hk), 0x11
  | vpclmulqdq xmm(t2), xmm(gh), xmm(hk), 0x00
  | vpclmulqdq xmm(t3), xmm(gh), xmm(hk), 0x01
  | vpclmulqdq xmm(gh), xmm(gh), xmm(hk), 0x10
  | vpxor xmm(gh), xmm(gh), xmm(t3)
  ...
```

Vita

How?

For route lookups (longest prefix match):
Optimized Poptrie implementation (again, DynASM)

```
function lookup (Dst, Poptrie, keysize)
   if Poptrie.direct_pointing then
      -- v = extract(key, 0, Poptrie.s)
      local direct_mask = bit.lshift(1ULL, Poptrie.s) - 1
      -- v = band(key, direct_mask)
      | mov v_dw, dword [key]
      | and v, direct_mask
   ...
```

Vita

How?

RaptorJIT + FFI
(simple and fast implementation of IPsec ESP)

```
esp_head = ffi.typeof[[
   struct {
     uint32_t spi;
     uint32_t seq_no;
   } __attribute__((packed))
 ]]
```

```
esp_tail = ffi.typeof[[
   struct {
     uint8_t pad_length;
     uint8_t next_header;
   } __attribute__((packed))
]]
```

Vita

How?

DSL for match-action pipeline, based on pcap-filter(7) language (code generation at runtime)

```
pf_match.compile(([[match {
   ip dst host %s and icmp => icmp4
   ip dst host %s => protocol4_unreachable
   ip => forward4
   arp => arp
   otherwise => reject_ethertype
}]]):format(conf.node_ip4, conf.node_ip4))
```

Vita

How?

Problem: can not parallelize SA

Every packet on an SA gets a unique sequence number

Synchronization problem if spread across cores

Vita

How?

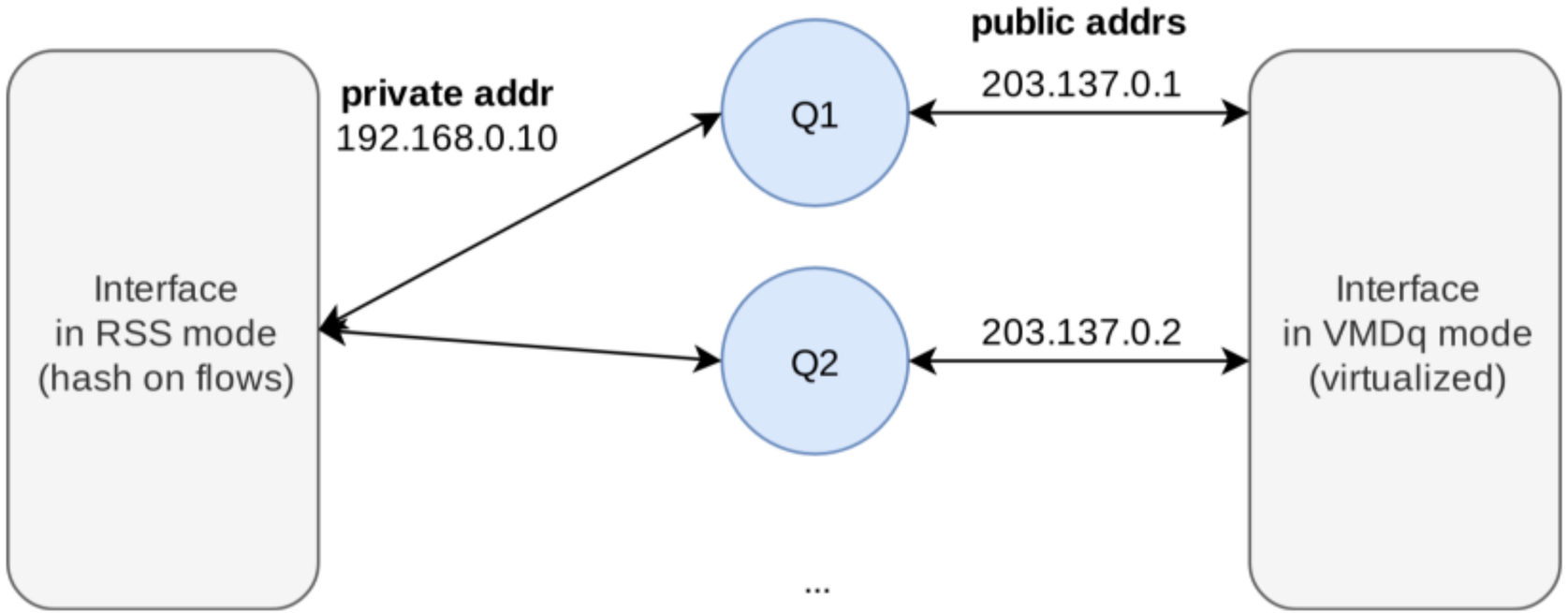
Solution: scale out (multiple SAs per route)

RSS on private interface: distribute onto SAs

VMDq on public interface: aggregate SAs

Vita

How?


public addrs
private addr
192.168.0.10
Q1
203.137.0.1
Interface
in RSS mode
(hash on flows)
Q2
203.137.0.2
Interface
in VMDq mode
(virtualized)
...

Vita

Network Drivers

The Snabb way: simple drivers written in Lua

New: Snabb drivers for XDP, Intel AVF

Vita

XDP?

Immediate goal: make Vita easily deployable in cloud

XDP: - a bit heavy to setup, currently some limitations
- working with kernel upstream looks promising (kudos to Björn Töpel)

Vita

AKE (authenticated key exchange)

Cycle SAs often and without loosing packets
(perfect forward secrecy)

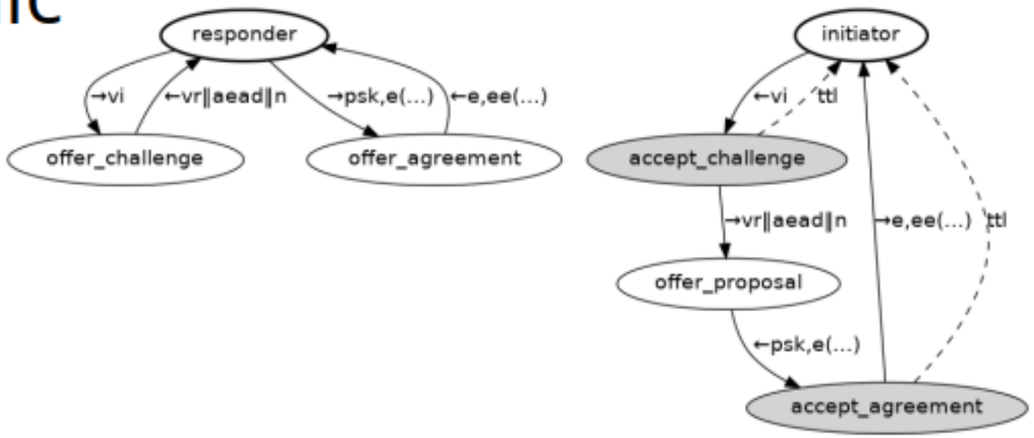
Low-throughput, but largest attack surface

Vita

AKE (authenticated key exchange)

Simple PSK based protocol
(based on the Noise protocol framework)

Using minimal set of cryptographic primitives, constructions and protocol implemented in Lua



Vita

AKE (authenticated key exchange)

Alternatively: IKEv2 via StrongSwan

SWITCH engineer Alexander Gall developed StrongSwan plugin+interop with Snabb

Vita

Configuration & operation

Based on a YANG model

...includes runtime statistics

```
module vita-esp-gateway {
    ...
```

Vita

Configuration & operation

Query/update configuration via RPC

Query runtime statistics via RPC

```
$ snabb config get-state vita /gateway-state/private-interface
```

Vita

Thanks!

Get involved:
github.com/snabbco/snabb
github.com/inters/vita

Get support and consulting:
https://inters.co

inter—
stellar

Email me:
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Gritty details on my blog:
https://mr.gy/blog