Production Snabb

Simple, fast software networking functions with Snabb

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Andy Wingo wingo@igalia.com

@andywingo
hey
network hackers

Agenda:
- Snabb, a VNF workbench
- New tools since 2015 (!)
- Some batteries included: Snabb in practice
Commodity hardware is capable of high-performance networking

- 1 core at 15MPPS: 65ns/packet

What software to put on the hardware?
q: linux?
A: Nope

Heavyweight networking stack
System/user barrier splits your single network function into two programs
Associated costs both at development-time and run-time
user-space networking

Cut Linux-the-kernel out of the picture; write driver in user space

- tell Linux to forget about this PCI device
- mmap device’s PCI registers into address space
- poke registers as needed
- set up a ring buffer for receive/transmit
- profit!
Multiple open source user-space networking projects having success

Prominent examples:
- Snabb (2012)
- DPDK (2012)
- VPP/fd.io (2016)

(Is this SDN? :))

How do software network functions work?
Snabb aims to be rewritable software
The hard part: searching program-space for elegant hacks
“Is that all? I could rewrite that in a weekend.”
nutshell

A snabb program consists of a graph of **apps**

Apps are connected by directional **links**

A snabb program processes packets in units of **breaths**
local Intel82599 =
    require("apps.intel.intel_app").Intel82599
local PcapFilter =
    require("apps.packet_filter.pcap_filter").PcapFilter

local c = config.new()
config.app(c, "nic", Intel82599, {pciaddr="82:00.0"})
config.app(c, "filter", PcapFilter, {filter="tcp port 80"})

config.link(c, "nic.tx -> filter.input")
config.link(c, "filter.output -> nic.rx")

engine.configure(c)

while true do engine.breathe() end
breaths Each breath has two phases:

- *inhale* a batch of packets into the network
- *process* those packets

To inhale, run `pull` functions on apps that have them

To process, run `push` functions on apps that have them
# Pull function of included Intel 82599 driver

```lua
function Intel82599:pull ()
    for i = 1, engine.pull_npackets do
        if not self.dev:can_receive() then
            break
        end
        local pkt = self.dev:receive()
        link.transmit(self.output.tx, pkt)
    end
end
```
# Push function of included PcapFilter

```lua
function PcapFilter:push ()
    while not link.empty(self.input.rx) do
        local p = link.receive(self.input.rx)
        if self.accept_fn(p.data, p.length) then
            link.transmit(self.output.tx, p)
        else
            packet.free(p)
        end
    end
end
end
```
struct packet {
    uint16_t length;
    unsigned char data[10*1024];
};
struct link {
    struct packet *packets[1024];
    // the next element to be read
    int read;
    // the next element to be written
    int write;
};
// (Some statistics counters elided)
At this point, you can rewrite Snabb (Please do!)
But you might want to use it as-is...
inventory apps: software components that developers compose into network functions

programs: complete network functions

**bold**: new since last talk

*I*italics*: not yet merged to mainline
app catalog: 
i/o

Intel **i210/i350/82599/XL710**
Mellanox *ConnectX-4/5*
VirtIO host **and guest**
UNIX socket
Linux: **tap** and “raw” (e.g. eth0)
Pcap files
Flooding and learning bridges

VLAN insert/filter-and-remove/mux

ARP / NDP
IPv4/v6 fragmentation and reassembly
IPv4/v6 splitter
ICMPv4/v6 echo responder
Control plane delegation (nh_fwd)
(No routing yet)
app catalog: transport

IPsec ESP

Lightweight 4-over-6 AFTR

“Keyed IPv6 Tunnel” (draft-tr-mkonstan-keyed-ipv6-tunnel-01)
app catalog:

monitoring

Netflow capture and export

L7 monitor / filter (using libndpi)

pcap filter (with machine-code backend)
Many workload generators
$ src/snabb
Usage: src/snabb <program> ...

This snabb executable has the following programs built in:
  lisper
  lwaftr
  packetblaster
  pci_bind
  snabbmark
  snabbnfv
  snabbvmx
  snsh
  top
  wall

For detailed usage of any program run:
  snabb <program> --help
program: packet blaster

Generally useful tool: fill TX buffer of NIC with packets and transmit them over and over again

snabb packetblaster replay \ packets.pcap 82:00.1

Measures received (return) traffic too

Easily saturates 10G links
program: lwaftr

“Lightweight 4-over-6”: RFC 7596
Snabb-implemented border router for lw4o6
IPv4 for entire countries!
Remarkable deployment report from OTE engineer Kostas Zordabelos, April 2017:
https://www.youtube.com/watch?v=EEpUWieTr40&t=1h46m
Why Snabb?

- Fast, fluid development
- RFC only finalized during development
- Good speed
- Open source
- Cheap
program: nfv

Host switch providing network connectivity to QEMU instances

“Original” Snabb app

Like Open vSwitch with DPDK datapath, or OpenContrail

OpenStack integration never landed... but the market has moved on

(Has the market moved on from classic NFV?)
Program: vmx

Idea: Snabb data plane, external control and management planes

Contributed by Juniper engineer Marcel Wiget

Possibility to delegate to Juniper vMX to determine next hops; or to an image with Linux

Juniper Tech Club, March 2017:
https://www.youtube.com/watch?v=N_CjXgyrUcY

snabb snabbvmx lwaftr --help
program: snabbwall

L7 firewall that optionally uses nDPI

http://snabbwall.org/

Collaboration between Igalia and NLnet foundation

Landed upstream in 2017
program: ipfix

Prototype NETFLOW collector and exporter (v9 and IPFIX)
Currently only 2.6MPPS, working on single-core improvements then moving to RSS
Pending to land upstream
program: l2vpn
Alexander Gall’s L2 VPN over IPv6
Pending to land upstream; used in production AFAIU
Ideal Snabb use case: programmer-operator builds bespoke tool
programs: Snabb upstream open to include new network functions
your vnf here
Repository will grow as people build new things
deploy

From prototype to production: what do you need?

(Re)configurability

State monitoring
YANG is great!!!

Native YANG support in Snabb

- Load and serialize textual configurations
- Compiled compilations (useful for big routing tables)
- Incremental update
- State query
App & link graph a function of config
Update config? Diff graphs, apply incremental changes

Carefully built to scale

- Fast-paths for some incremental updates, e.g. add lwAFTR softwire
- Config/state query avoids touching data plane process
- Updates cause minimal change
- Subquery built-in
snabb config

Command-line tool, `snabb config`  
NETCONF via Sysrepo bridge  
Other configuration agents possible
near future

100G in production Snabb

Multiple coordinated data-plane processes

Horizontal scaling via BGP/ECMP: terabit lw4o6 deployments

Performance x-ray: where to focus effort to improve speed?

[Your cool hack here!]

Work in progress!
thanks! Make a thing with Snabb!

git clone https://github.com/SnabbCo/snabb

cd snabb
make

wingo@igalia.com

@andywingo
oh no here comes the hidden track!
Storytime! Modern x86: who’s winning? Clock speed same since years ago Main memory just as far away
“We need to do work on data... but there’s just so much of it and it’s really far away.”

Three primary improvements:

- CPU can work on more data per cycle, once data in registers
- CPU can load more data per cycle, once it’s in cache
- CPU can make more parallel fetches to L3 and RAM at once
Networking folks can win too. Instead of chasing zero-copy, tying yourself to ever-more-proprietary features of your NIC, just take the hit once: **DDIO into L3**. Copy if you need to – copies with L3 are not expensive. Software will eat the world!
Networking folks can win too

Once in L3, you have:

- wide loads and stores via AVX2 and soon AVX-512 (64 bytes!)
- pretty good instruction-level parallelism: up to 16 concurrent L2 misses per core on haswell
- wide SIMD: checksum in software!
- software, not firmware