VOSYSwitch port to ARMv8
and ODP integration

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Agenda

- Snabb and VOSYSwitch
- Porting to ARMv8
- DEMO description and performance results
- Further development
Virtual Open Systems developed a vSwitch solution based on the open source Snabb network toolkit. It is written in a high-level scripting language – Lua.

The objective was to create a pure user-space, portable solution suitable for NFV deployments.

One of the achievements that were created within this project is “vhost-user” which is now a de-facto standard for provisioning virtio-net based KVM virtual machines.

Almost all of the code is written in Lua, with some syscalls in C (now in process of migration to Lua). There is a small amount of Assembly too.
Lua (ˈluːə/ LOO-ə, from Portuguese: lua ['lu.(w)ɐ] meaning moon) is a lightweight multi-paradigm programming language designed primarily for embedded systems and clients. Lua is cross-platform since it is written in ANSI C, and has a relatively simple C API.

https://en.wikipedia.org/wiki/Lua_(programming_language)

The Snabb toolkit implements a high speed, user space, packet processing in Lua. The secret sauce to make it “fast” is the JIT compiler.
LuaJIT is a multi-architecture (x86, PPC, ARM, MIPS), multi-platform (Linux, BSD, OSX, Windows) tracing JIT compiler.

Tracing just-in-time compilation is a technique used by virtual machines to optimize the execution of a program at runtime. This is done by recording a linear sequence of frequently executed operations, compiling them to native machine code and executing them. This is opposed to traditional just-in-time (JIT) compilers that work on a per-method basis.

As most of the software stacks, snabb is composed of several building blocks

- Snabb core – where the “main” lives
- Library – tools and utilities
- Apps – the building blocks
- Programs – a set of apps chained together
The available Snabb apps are:

- Intel 82599 10Gbps driver with VMDq support; Solarflare
- Vhost-user and virtio-net on the device side
- Virtio-net driver, for running it in VMs
- Packet filter with connection tracking; Rate limiter
- IP/GRE tunnels
- Learning bridge
- Single process/ single thread
- Linux/x86_64 only
local Intel82599 = require("apps.intel.intel_app").Intel82599
local VhostUser = require("apps.vhost.vhost_user").VhostUser

local c = config.new()
config.app(c, "nic", Intel82599, {pciaddr = "0000:00:01.00"})
config.app(c, "vh1", VhostUser, {socket_path="/tmp/vh1.sock"})

config.link(c, "nic.tx -> vh1.rx")
config.link(c, "vh1.tx -> nic.rx")

engine.configure(c)
engine.main()
Virtual Open Systems created VOSYSwitch solution for the end user, by amending Snabb features with:

- JSON configuration to define a packet processing graph
- Multi-process, single thread
- OpenStack Mitaka integration
- Performance optimizations (VM2VM)
- Packet scheduler – PQ, FQ, WFQ
- A software switch with VLAN and IGMP support
- RPM/DEB packaging, systemd integration
Virtual Open Systems is currently working on a number of new (substantial) features which are to be released this year:

- OpenFlow 1.4 support
- More overlay networks - VxLAN, NSH
- ARM/v8
- ODP
The previous example implemented in VOSYSwitch’s JSON:

```json
{
    "switch1" : {
        "core" : "0x1",
        "devices" : {
            "igbl1" : {
                "type" : "EthPCI",
                "args" : {"pciaddr" : "0000:XX:00.1"},
                "links" : { "tx": "vh1.rx"}
            },
            "vh1" : {
                "type" : "VhostUser",
                "args" : {"socket_path" : "/tmp/vh1.sock"},
                "links" : { "tx": "igbl1.rx"}
            }
        }
    }
}
```
More complex topologies within the same configuration:
VOSYSwitch - performance on x86_64

Ixia RFC2544, simple vSwitch with 2 interfaces on the host

Host switching throughput performance (RFC2544)

Packet Size (Bytes)

Throughput (Mbps)

- 0.0004% Loss Tolerance
- 0.01% Loss Tolerance
- 5% Loss Tolerance
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The porting effort started with a lot of low-level details:

- **LuaJIT limitations:**
  - AArch64 - interpreter
  - AArch32 – ARMv7 full support
  - 47bit VA limitation (LuaJIT/issues/49)

- **Snabb limitations** (VA/PA conversion by mask)

- **64k vs 4k pages**
  - AArch32 compat mode

- **SSE/AVX port to NEON**

- **gcc-armhf -march=armv8-a+crc**
The initial effort was done with linux-generic on x86. Mostly without problems.

- Modules used *odp_pool, odp_packet, odp_pktio*
- API inconsistencies, even in the same API level
  - `#define ODP_EVENT_INVALID _odp_cast_scalar(odp_event_t, 0xffffffff)`
  - `#define ODP_EVENT_INVALID _odp_cast_scalar(odp_event_t, NULL) //in ODP-DPK`
- Inline functions in the API headers
- `platform/linux-dpdk/include/odp/packet.h`

```c
static inline uint32_t odp_packet_len(odp_packet_t pkt) {
    return *(uint32_t *)((char *)pkt + pkt_len_offset);
}
```
DPDK’s ARM support is still not mature enough. The main ODP-DPDK development was done in x86. Some of the issues found:

- `odp_pktio_send()` implementation returns -1 when no packets have been sent which is considered an error on ODP side, but not on DPDK side.
- `-msse4.2` – This code was never compiled for ARM?
- `virtio-net` driver for ARM
- `dpdk_memcpy` on arm/arm64 is a `#define`, so this does not work:

```
return (*dpdk_memcpy)(dst, src, num);
```
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By Leveraging the ODP API, VOSYSwitch achieved very important goals.

- Extend the number of supported platforms:
  - ODP-linux-generic
  - ODP-DPDK
  - ODP-NADK

- Single binary running on multiple hosts
  - VOSYSwitch for ARM running on both LS2085A and Juno board

- Single binary can access multiple HW resources at once, i.e. DPAA2 + Intel DPDK
VOSYSwitch running on LS2085ARDB

VM
NGiNX-OFP
OFP
odp-dpdk

VM
VOSYSwitch
packet filter
odp-dpdk

VOSYSwitch vSwitch
odp-generic
odp-nadk

pktgen

httpperf

10Gbps
```json
{
    "switch1": {
        "core": "0",
        "devices": {
            ...
        }
    },
    "switch2": {
        "core": "1",
        "devices": {
            "vh_fw_out": {
                "type": "VhostUser",
                "args": {
                    "socket_path": "/tmp/vh_fw_out.sock",
                    "is_server": true
                },
                "links": {
                    "tx": "odp0.rx"
                }
            },
            "odp0": {
                "type": "EthODP",
                "args": {
                    "ifname": "dpni-0",
                    "platform": "nadk"
                },
                "links": {
                    "tx": "vh_fw_out.rx"
                }
            }
        }
    }
}
```
{  
  "switch1" : {  
    "core" : "0x1",
    "devices" : {  
      "odp_in" : {  
        "type" : "EthODP",
        "args" : {"ifname" : "0", "platform" : "dpdk", "platform_params" : "-m32"},
        "links" : { "tx": "odp_out.rx"}
      },
      "fw" : {  
        "type" : "Firewall",
        "args" : {"filter" : "arp or icmp or tcp port 80", "state_table" : true},
        "links" : {"tx" : "odp_in.rx"}
      },
      "odp_out" : {  
        "type" : "EthODP",
        "args" : {"ifname" : "1", "platform" : "dpdk", "platform_params" : "-m32"},
        "links" : { "tx": "fw.rx"}
      }
    }
  }
}
Using the Apache Bench tool to get the number of connections per second which the demo infrastructure can handle. Using 10 parallel streams we are able to handle 5000 connections, using single two dual core VNFs and a single core vSwitch.

- `ab -n 10000 -c 1 100.0.0.4/`  
  - 1500 conn/s

- `ab -n 10000 -c 10 100.0.0.4/`  
  - 5000 conn/s
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ODP API proved to be very flexible and more parts of it will be adopted.

- ODP_CRYPTO
- ODP_QUEUE, ODP_SCHEDULER
- ODP_CLASSIFICATION

Virtual Open Systems is already investigating into a better LuaJIT support for ARMv8. It is becoming a major supported platform in VOSYSwitch and bringing the best performance and experience out of it is a major goal.
VOSYSwitch Roadmap

**VOSYSwitch 15.12**
VMtoVM, IPv6 GRE tunnels, filtering, traffic limiter, OpenStack Mitaka support, QoS, VLAN and IGMP, 40Gbps Ethernet support, etc.

**VOSYSwitch 16.03**
ARMv8 support, ODP, OFP, link aggregation

**VOSYSwitch 16.06**
OpenFlow 1.5, VXLAN, GRO, etc.

**VOSCON 16.12**
VOSYSwitch 16.06 FPGA, GPU and DSP acceleration support for VNFs

**VOSCON 17.06**
Multitenancy support vTPM and RT, HA

**Custom related development services and support**

Q4 2015 | Q1 2016 | Q2 2016 | Q4 2016 | Q4 2017

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Could we get some of these in the future:

- Tunneling interfaces offload – VxLAN, GRE
- OpenFlow switch
Questions

See our demo
In the LNG room
and on

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