SWITCHD

An OpenFlow implementation for OpenBSD – BSDCan 2016

Reyk Flöter (reyk@openbsd.org) – ESDENERA NETWORKS GmbH

This presentation introduces switchd(8) and switch(4), a simple OpenFlow controller and virtual switch for ***OpenBSD***. After vxlan(4), this presentation is the second part about the

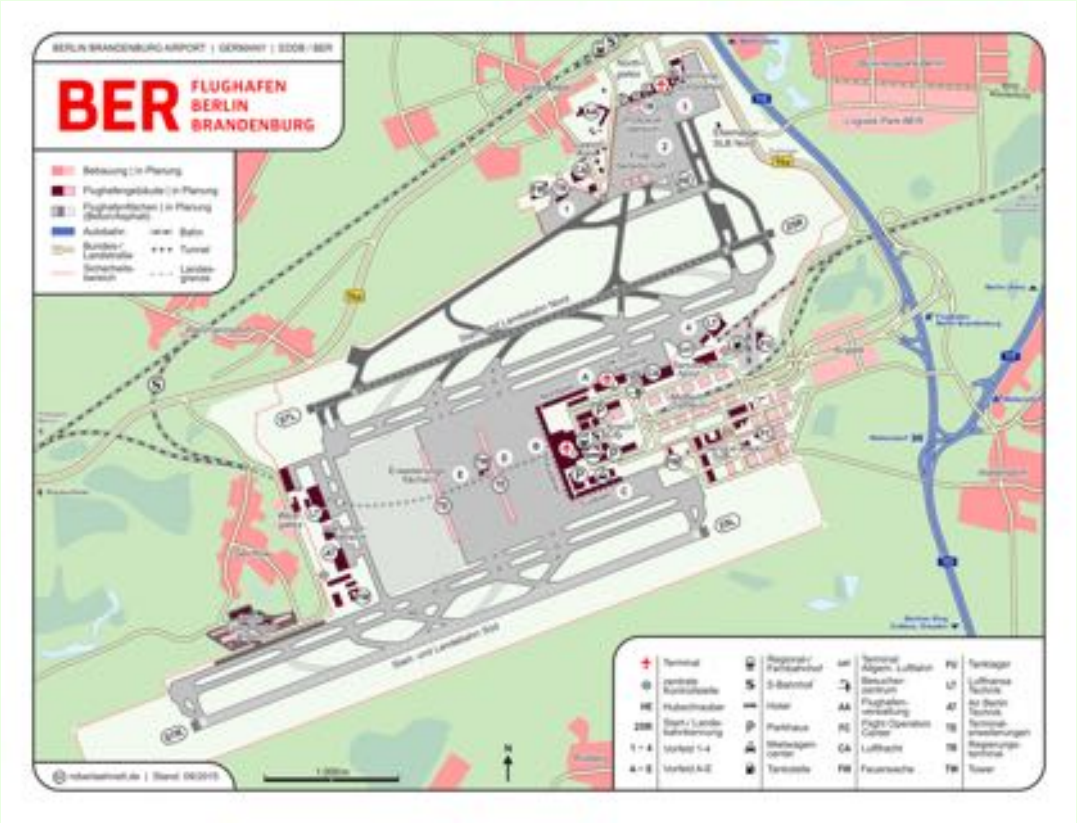
CLOUD NETWORKING STACK – PART II

CLOUD NETWORKING STACK

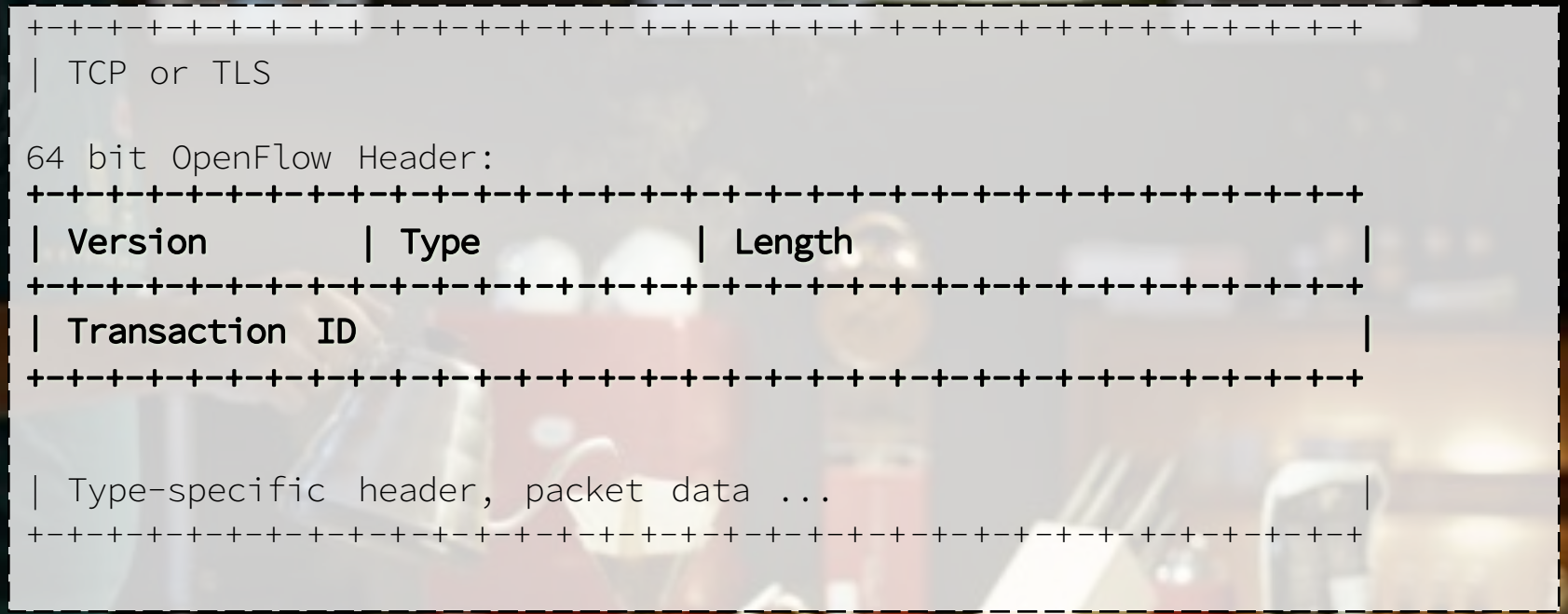
APPLICATION LAYER	relayd, httpd		…	
TCP/IP	Routing Domains		pf (Packet Filter)	
VIRTUAL NETWORKS	vxlan(4)	*NVGRE* *gre(4)*	vlan(4) svlan(4)	VPN …
VIRTUAL ETHERNET	**OpenFlow**, SDN		**switch(4) and switchd(8)**	
VIRTUAL DEVICES	Virtual I/O: vic(4), vio(4), vmx(4), xnf(4), *hvn(4)*			

ROME WASN'T BUILT IN A DAY

- Disclaimer
  - switchd(8) and switch(4) haven’t been released yet
  - The code exists and will (hopefully) show up in –current soon
  - It will not be enabled soon and there is still a lot of work to do



THE OPENFLOW PROTOCOL



THE OPENFLOW PROTOCOL

- A method to decouple the switch data and control plane
- A switch can ask a remote controller to make forwarding decisions
- OpenFlow is a TCP-based protocol between switch and controller
- Protocol message types:
  - HELLO: connection setup
  - PACKET-IN: switch-controller message with full Ethernet packet
  - PACKET-OUT: controller-switch response with packet or buffer ID
  - FLOW-MOD: controller installs a “flow” in the switch
  - That is enough to implement a “learning switch” on the controller
    - But the complexity is in the details, sub-types and classifiers

THE OPENFLOW PROTOCOL

- Evolution of the OpenFlow Protocol
  - openflow-spec-v1.0.0.pdf 42 pages – simple and nice
  - openflow-switch-v1.1.0.pdf 56 pages – MPLS & VLAN, TTL
  - openflow-switch-v1.2.pdf 85 pages – IPv6, Extensible Match
  - openflow-switch-v1.3.5.pdf 177 pages – VXLAN, ...
  - openflow-switch-v1.4.pdf 206 pages – ...
  - openflow-switch-v1.5.1.pdf 283 pages – ...

AN OPENFLOW EXPERIMENT

- Around 2013, I experimented with the OpenFlow 1.0 protocol
- When I looked at it, all existing controllers were either really bad or big
  - Written in Java (most popular), Python, Ruby, “insecure C”, ...
- So I implemented a little daemon (ofpd)
  - It provided very basic support for OpenFlow 1.0
- There was no real use case for it and it didn’t even have a name
  - ~~openflowd~~ – The OPENFLOW™ trademark is too restrictive
  - ~~ofpd~~, ~~sdnd~~, ~~sdnflowd~~, ~~OpenWolf~~ – Not nice and not funny
- Put it on hold and stopped thinking about it

THE BRIDGE

- Three main problems:
  1. We are suffering from the aging bridge(4) code in OpenBSD
  2. bridge(4) is in the way of the MP network stack overhaul
  3. The control plane is integrated and not sufficient as a “vswitch”
     - And I promised mlarkin@ to provide one for vmm(4)
- The bridge(4) has many special features
  - bridge rules, blocknonip, VXLAN integration, IPSec bridge, WLAN failover, PF tags, STP ...
  - ... and tentacles everywhere

THE BRIDGE

- Three possible solutions:
  1. We tried to clean it up and to incrementally improve it
     - Code has been improved, but there are conceptual limitations
  2. We looked at alternatives and experimentally ported Open vSwitch
     - It turned in to a HUGE diff for the kernel code and data path
     - The license is not suitable for OpenBSD's kernel (Apache 2)
  3. Re-implement it as a new driver: switch(4)
     - Using the desin of Open vSwitch would be a massive effort
     - So I had an idea ...

... “Why don’t we use my experimental OpenFlow controller as a vSwitch and talk to it with OpenFlow from the kernel?”

SWITCHD(8)

THE ~~BRIDGE~~ SWITCH

Name	Open vSwitch		***Open*BSD**
Remote	Controller		*Controller*
User	ovsdb-server	ovs-vswitchd	Controller or forwarder: switchd(8)
User - Kernel	”dpif” DataPath InterFace		OpenFlow via /dev/switch*
Kernel	Kernel Datapath		switch(4)

THE SWITCH

- I implemented the userland daemon, a.k.a. switchd(8)
- goda@ and yasuoka@ implemented the kernel switch(4) driver
  - Partially based on OpenBSD's bridge(4):
    - if_switch.[ch] – the network interface "cloner"
    - switchctl.c – the optional control plane
    - switchofp.c, net/ofp.h – the OpenFlow implementation
    - /dev/switch* – each switch(4) has a char device
  - It currently shares some code with it:
    - if_bridge.h – share structures for STP etc.
    - bridgestp.c – the spanning tree implementation

CONFIGURATION EXAMPLES

switchd(8) configuration

```
- Currently in /etc/switchd.conf:
listen on 0.0.0.0 port 6633
device ”/etc/switch0”
device ”/etc/switch1” \
    forward to tcp:192.168.100.1

- Planned:
switch ”edge” {
    listen on tcp:0.0.0.0:6633
    connect to device:/dev/switch0
    forward to tls:192.168.100.1
}
```

switch(4) configuration

```
- Almost like the bridge(4)

# ifconfig switch0 create
# ifconfig switch0 add em0
# ifconfig switch0 add vxlan2
# ifconfig switch0 up

- Unlike bridge, IPs can only be
assigned to routing ”IRB” interfaces

# ifconfig vether0 create 10.1.1.1
# ifconfig switch0 add vether0
```

FUTURE WORK

- switchd(8)
  - Convert it from OpenFlow 1.0 to 1.3.5
    - Implement all MUST options of the protocol
  - Support multiple independent switch contexts/sections
    - *switch “foo” { ... }, switch “bar” { ... }*
  - Support multiple switches per switch context
    - Switch “foo” and “bar” are joined to a “big switch”
  - Enable pledge, turn privsep from “fork” into “fork and execute”

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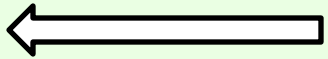
  - openflow-spec-v1.0.0.pdf 42 pages  switchd(8)
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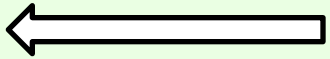
  - openflow-switch-v1.3.5.pdf 177 pages  switch(4)
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  - openflow-switch-v1.5.1.pdf 283 pages

FUTURE WORK

- switch(4)
  - Some cleanup, commit, review, and test
  - Some mallocs have to be replaced with pools
  - Support (old) in-kernel control plane from bridge(4) as a fallback
  - Eventually remove bridge(4)
- Other
  - VXLAN will support IPv6 and OpenFlow-integration
  - NVGE is still not supported

FUTURE WORK

- vmd(8) integration
  - vmm(4) is OpenBSD's virtual machine monitor
  - Networking support is currently very simple

```
# OLD:
vm "openbsd" {
    interfaces 1
    ...
}
```

```
# NEW:
vm "openbsd" {
    kernel "/bsd"
    memory 512M
    disk "/home/vm/OpenBSD.img"
    interface on "vnet1"
}

switch "vnet1" {
    # uplink interface
    interface em0
    #controller 10.1.1.1
}
```

Questions?

...and please keep supporting the OpenBSD project!

http://www.openbsdfoundation.org/campaign2016.html

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