Software-Defined Networking
сегодня

presented by
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Inception
Evolution
It always happens
...and even more
Control Plane contains rules for packet forwarding

Data Plane forwards packets according to rules

Controller installs rules in Control plane

SDN: Concept
SDN: Big Picture

Application Layer
- Business application

Control Layer
- SDN Control Software
- SDN Control Data Plane interface
- API

Infrastructure Level
- Network Device
- Network Device

OpenFlow
- OpenFlow Controller
- OpenFlow Switch
- OpenFlow protocol
OpenFlow: Switch

OpenFlow Controller

OF Protocol

Secure channel
Group Table
Flow Table 0
Flow Table N

PORT 0
PORT N

Network
Switch: Pipeline

[1] Packet may be transferred to other table;
[2] Packet header may be modified;
[3] Packet may be forwarded to given port or just dropped;
[4] Packet may be applied to given QoS.
Switch: Table Entry

**Match criteria:**
- Ingress-port
- Ethernet MAC
- ARP
- IPv4 and IPv6
- TCP ports
- VLAN, MPLS etc.

**Instruction:**
Go-To Table
Modify Metadata
Action Set {forward, apply QoS, drop, Apply to Group}
### OpenFlow programs

<table>
<thead>
<tr>
<th>Switching</th>
<th>Switch port</th>
<th>MAC src</th>
<th>MAC dst</th>
<th>Eth type</th>
<th>VLAN ID</th>
<th>IP Src</th>
<th>IP Prot</th>
<th>TCP sport</th>
<th>TCP dport</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port3</td>
<td>00:20..</td>
<td>00:1f</td>
<td>0800</td>
<td>Vlan1</td>
<td>1.2.3.4</td>
<td>5.6.7.8</td>
<td>4</td>
<td>17264</td>
<td></td>
<td>Port6</td>
</tr>
</tbody>
</table>

| Firewall           | *           | *       | *       | *        | *       | *      | *       | *         | *         | 22         | Drop       |

| Routing            | *           | *       | *       | *        | *       | 5.6.7.8 | *       | *         | *         | *          | Port6      |

| VLAN switching     | *           | *       | 00:1f   | Vlan1    | *       | *      | *       | *         | *         | Port6, port7, port8 |

OpenFlow can be compared to the instruction set of a CPU
### Aspects:
- All
- Select
- Indirect
- Fast Failover
Metaprogramming

OF Configuration Point

OF-Config

OF Controller

OF Logical Switch

Secure channel

OF Protocol

Flow Table 0
Flow Table N
Port 0
Port N

OF Resources

OpenFlow–Capable Switch
OpenFlow evolution
Controller

This slide is intentionally left blank
CPqD – optimal SDN

CPqD
• OpenFlow Switch on C
• OpenFlow Controller on C++ and Python
• OpenFlow Driver
FloodLight – SDN platform

FloodLight Platform
- Flooflight: Java OpenFlow platform, Extensible with Plugins
- Indigo: Create a Firmware
- LoxiGen: Generate OpenFlow driver on the Language you like
Concurrency be Design

FlowForwarding.org

Erlang VM
• LINC Software Switch
• Loom Controller
• Tapestry Analyzer

Java VM
• Warp OF Driver
• Akka–based Controller
• Scala actors
Warp. LINC.

- JVM
- Warp
  - OpenFlow API
  - Python
  - Java
  - C++
  - Apache Avro
  - OpenFlow 1.0
  - OpenFlow 1.3

- Erlang VM
  - LINC Switch
    - Logical Switch
    - Logical Switch
    - Logical Switch
Our Tapestry
Build SDN Agilely

Ryu
- Well-defined API
- Integrated in OpenStack
- Tested against 12 Switches
- The main event of Developers track of ONS–2013
Mininet: pocketnetwork

```bash
mininet@mininet-vm:~$ sudo mn --controller=remote,ip=192.168.56.101
*** Creating network
*** Adding controller
Unable to contact the remote controller at 192.168.56.101:6633
*** Adding hosts:
h1  h2
*** Adding switches:
s1
*** Adding links:
  (h1, s1) (h2, s1)
*** Configuring hosts
h1  h2
*** Starting controller
*** Starting 1 switches
s1
*** Starting CLI:
mininet>
mininet>
mininet>
mininet>
mininet>
mininet>
mininet>
mininet>
mininet>
mininet>
mininet>
mininet>
mininet>
mininet>
```
def monitor_noserver_ef():
    return(Filter((inport_p(2)
              & srcport_p(80))-
              dstip_p("10.0.0.9"))
    Lift(size) |o|
    GroupByTime(30) |o|
    Lift(sum))
OpenDaylight: Free SDN

Network Orchestration Application and Services
- OpenStack Neutron
- DDos Protection

Controller Platform
- Base Service Networking Functions
- Service Abstraction Layer

Data Plan Elements
- Network Device
- OpenFlow Switch
- Open vSwitch

Southbound Interfaces and Protocol Plugins: OpenFlow, NETCONF, etc
OpenStack

SDN – is a Virtualization
Thank you!