Software Defined Networking

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3D Reference model of ISDN
Hourglass reference model of a TCP/IP network

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Signaling Systems (Control Plane)

Mobile Cellular Network

Optical Transport Networks (GMPLS)

IP Multimedia Subsystem
Network Management
# Our methodology – Our tools

<table>
<thead>
<tr>
<th></th>
<th>Performance Fidelity</th>
<th>Scale</th>
<th>Real User Traffic?</th>
<th>Complexity</th>
<th>Open</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simulation</td>
<td>medium</td>
<td>medium</td>
<td>no</td>
<td>medium</td>
<td>yes</td>
</tr>
<tr>
<td>Emulation</td>
<td>medium</td>
<td>low</td>
<td>no</td>
<td>medium</td>
<td>yes</td>
</tr>
<tr>
<td>Software Switches</td>
<td>poor</td>
<td>low</td>
<td>yes</td>
<td>medium</td>
<td>yes</td>
</tr>
<tr>
<td>NetFPGA</td>
<td>high</td>
<td>low</td>
<td>yes</td>
<td>high</td>
<td>yes</td>
</tr>
<tr>
<td>Network Processors</td>
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<td>medium</td>
<td>yes</td>
<td>high</td>
<td>yes</td>
</tr>
<tr>
<td>Vendor Switches</td>
<td>high</td>
<td>high</td>
<td>yes</td>
<td>low</td>
<td>no</td>
</tr>
</tbody>
</table>
Network Ossification

Routing, management, mobility management, access control, VPNs, ...

- Million of lines of source code
- 6000+ RFCs
- Barrier to entry

- Billions of gates
- Power Hungry

Many complex functions hidden into the infrastructure:

- OSPF, BGP, multicast, differentiated services,
- Traffic Engineering, NAT, firewalls, MPLS, redundant layers, ...

An industry with a “mainframe-mentality”, reluctant to change
Legacy network device

Ethernet Switch
Legacy network device

Control Path (Software)

Data Path (Hardware)
Openflow a first step towards SDN

OpenFlow Controller

OpenFlow Protocol (SSL/TCP)

Control Path

OpenFlow

Data Path (Hardware)
OpenFlow usage

OpenFlow offloads control intelligence to a remote software
OpenFlow 1.0 Basics Flow Table Entries

Rule | Action | Stats

Packet + byte counters

1. Forward packet to zero or more ports
2. Encapsulate and forward to controller
3. Send to normal processing pipeline
4. Modify Fields
5. Any extensions you add!

Switch Port
VLAN ID VLAN pcp MAC src MAC dst Eth type IP Src IP Dst IP ToS IP Prot L4 sport L4 dport

+ mask what fields to match

Crosslayering!
Possible uses: write your code!

- Simple learning switch
- Per Flow switching
- Network access control/firewall
- VLANs
- Her own new routing protocol: unicast, multicast, multipath
- Home network manager
- IPv x

- VM migration
- Server Load balancing
- Mobility manager
- Power management
- Network monitoring and visualization
- Network debugging
- Network slicing
Current Internet
Closed to Innovations in the Infrastructure
Software Defined Networking

Network Operating System

- Operating System
- Specialized Packet Forwarding Hardware
- App

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Software Defined Networking

1. Open interface to hardware

2. At least one good operating system
   Extensible, possibly open-source

3. Well-defined open API

Network Operating System

- Simple Packet Forwarding Hardware
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Trends

Computer Industry

Virtualization layer

x86 (Computer)

Windows (OS)

Linux

Mac OS

Network Industry

Virtualization or “Slicing”

NOX (Network OS)

Network OS

OpenFlow

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Simple Packet Forwarding Hardware

Virtualization or “Slicing” Layer

Isolated “slices”

Many operating systems, or Many versions

Network Operating System 1

App

App

App

Network Operating System 2

App

App

App

Network Operating System 3

App

App

App

Network Operating System 4

App

App

App

Open interface to hardware

Open interface
Problem: 20.000 server -> 400.000 VM.

Keeping 20.000 devices in sync with 400.000 entities.

SDN can help programming the switches with a central DB.
Datacenter in a Box

We decided to realize a platform in order to carry out some SDN Cloud-DC experiments and also let other researchers to perform their own.

Our Emulator is composed by:

- A VM requester
- A Web Platform
- A DC controller (called OFVN controller)
- A slightly modified mininet Virtualization environment.
Another activity is the one concerning the European Project OFELIA.

In this project we deployed an SDN Framework composed by several switches and Xen server to allow users to deploy their own network applications.

Our contribution is related to a network control application that allows to the allocate virtual machines deciding from a network perspective.
Ofelia UNIPI island

- netFPGA
- OpenFlow switch
- Server
- Server
- Server

UNIPI site

Control Network

Experimental Network

• exp.cnit.pi.fp7.ofelia.eu
• fv.cnit.pi.fp7.ofelia.eu

VPN Gateway

GARR

GEANT

OFELIA IBBT Site

VPN

OF Controller

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Sessione su SDN & NFV

11 Ottobre 2013

Orario 16-18
Aula PS1
Piano terra Edificio E
Polo Fibonacci

Parteciperanno

- DELL
- CISCO
- ERICSSON
- INTECS
- ISCOM
- JUNIPER NETWORKS
- NEXTWORK
- ...

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Centrali telefoniche con “controllo a programma archiviato”

Grazie

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1 ESS – Storage Program Control 1965