Mininet-WiFi: Emulating Software-Defined Wireless Networks

Ramon Fontes

joint work with Samira Afzal, Samuel Brito, Mateus Santos and Christian Rothenberg (advisor)

11th International Conference on Network and Service Management (CNSM)
2nd International Workshop on Management of SDN and NFV Systems

CNSM 2015
Barcelona-Spain
Agenda

1. Introduction
2. Mininet-WiFi
3. Case Studies
4. Related Work
5. Limitations and Future Work
6. Conclusions
Introduction
Motivation

Popularity of WiFi Networks
It is important to emulate wireless networks for performance evaluating, testing, and protocol/system debugging.

Software-Defined Wireless Networking
It allows centralized control of wireless networks, separating the data plane and control plane, also allowing the control of the network through the OpenFlow protocol.
Main Goal

Mininet-WiFi

Aims at providing high fidelity emulation of wireless networks enabling real network analysis in fully controlled environments in support of research on Wireless and SDWN.
Challenges

- Wireless channel emulation
  - Propagation
  - Broadcast
  - Modulation
  - Mobility

- Realistic experiments
  - Reproducing real networks behavior
Mininet-WiFi

- Solution for Emulating Software-Defined Wireless Networks
- Fork of Mininet
  (based on lightweight virtualization / Linux containers)
- mac80211_hwsim/softmac
Mininet-WiFi: Emulating Software-Defined Wireless Networks
Working Process

Mininet-WiFi: Emulating Software-Defined Wireless Networks
alpha@alpha-Inspriron-5547:~$ sudo mn --wifi
*** Enabling Wireless Module
*** Creating network
*** Adding controller
*** Adding Station(s):
sta1 sta2
*** Adding Access Point(s):
ap1
*** Associating Station(s):
(sta1, ap1) (sta2, ap1)
*** Starting controller(s)
c0
*** Starting 1 Access Point(s)
ap1 ...
*** Starting CLI:
mininet-wifi> 1
## Working with Mininet-WiFi

### mininet-wifi>

<table>
<thead>
<tr>
<th>Network</th>
<th>Iperf</th>
<th>iw</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ping</td>
<td>sta1 iperf -c 10.0.0.1</td>
<td>sta1 iw dev sta1-wlan0 scan</td>
</tr>
<tr>
<td>sta1 ping sta2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Queries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position</td>
</tr>
<tr>
<td>position sta1</td>
</tr>
</tbody>
</table>
Mininet-WiFi: Emulating Software-Defined Wireless Networks
## Performance Evaluation

<table>
<thead>
<tr>
<th>Operation</th>
<th>Time (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start an AP</td>
<td>17</td>
</tr>
<tr>
<td>Start a Station</td>
<td>63</td>
</tr>
<tr>
<td>Associate two nodes</td>
<td>10</td>
</tr>
<tr>
<td>Start mac80211_hwsim</td>
<td>5</td>
</tr>
<tr>
<td>Stop AP and Stations</td>
<td>350</td>
</tr>
</tbody>
</table>
#3 Case Studies

## #1 Wireless Bicasting

https://goo.gl/NP0QyZ

## #2 Integration with Physical Wireless Interface

https://goo.gl/UcCtZB
Case Studies

#3 Mobility

```
mininet-wifi> sta1 ping sta2
PING 10.0.0.3 (10.0.0.3) 56(84) bytes of data.
64 bytes from 10.0.0.3: icmp_seq=1 ttl=64 time=38.0 ms
64 bytes from 10.0.0.3: icmp_seq=2 ttl=64 time=18.1 ms
64 bytes from 10.0.0.3: icmp_seq=3 ttl=64 time=22.9 ms
64 bytes from 10.0.0.3: icmp_seq=4 ttl=64 time=25.8 ms
64 bytes from 10.0.0.3: icmp_seq=5 ttl=64 time=29.0 ms
From 10.0.0.2 icmp_seq=37 Destination Host Unreachable
```
Mobility

Mobility Models

- RandomWalk
- TruncatedLevyWalk
- RandomDirection
- RandomWaypoint
- GaussMarkov

Video: https://goo.gl/sbDDpH

Mininet-WiFi: Emulating Software-Defined Wireless Networks
Case Studies

#4 Reproducing Related Research
Using all the wireless networks around us

http://goo.gl/siZ2hH
Case Studies

Using all the wireless networks around us within Mininet-WiFi

https://goo.gl/NrlRme

Mininet-WiFi: Emulating Software-Defined Wireless Networks
Related Work

![Chart showing test and evaluation options, with axes for log(cost) and log(realism), and various tools and techniques including Mininet-WiFi, EMANE CORE, NS-3, OMNeT++, Assert BOWL, Orbit, Nitos, iMinds, and R2Lab.](chart.png)
Limitations & Future Work
Limitations & Future Work

➔ Broadcast - 1s/2016
➔ Propagation - 2s/2016
➔ Mobility - 1s/2017
➔ Reproducing Real Network - 2s/2017

Mininet-WiFi: Emulating Software-Defined Wireless Networks
Conclusions

6

Popularity of WiFi Networks

Evaluation in Controlled Environment (HiFi Wireless Emulator)

Community-based collaborative research around Wireless Networking and SDWN
WebSite: http://www.intrig.dca.fee.unicamp.br/
Source: https://github.com/intrig-unicamp/mininet-wifi
Docker: https://hub.docker.com/r/ramonfontes/mininet-wifi/
Videos: https://goo.gl/4P02YB
Thanks!

Any questions?

Ramon Fontes - ramonrf@dca.fee.unicamp.br

WebSite: http://www.intrig.dca.fee.unicamp.br/
Source: https://github.com/intrig-unicamp/mininet-wifi
Docker: https://hub.docker.com/r/ramonfontes/mininet-wifi/
Videos: https://goo.gl/4P02YB