SDN-ORIENTED GLOBAL NETWORK OPTIMIZATION ALGORITHM

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Motivation of the work

Currently, mobile terminals feature multiple interfaces to adapt to the steadily increasing number of available wireless access networks. This provides a suitable ground for offloading data from cellular to different WIFI access points using the integration of WIFI and LTE offered by LTE v.12 and v.13. There is a parallel trend towards network programming relying on centralized controllers, of which the Software-Defined Network (SDN)[1] architecture with the OpenFlow[2] protocol is a clear exponent.

Thesis Objectives

Taking into account the current networking trends and the interests of hosting group, We intend to design and implement a SDN-oriented global network optimization algorithm.
This algorithm will use flow steering techniques to deal with the increasing data traffic and will be applied on an SDN[1] architecture where the end-terminals will be integrated with the core network.[3]

Research plan

1. First year

Part 1

• Establishing an essential knowledge of cellular standards.
• Establishing an essential knowledge of network protocols:
  ◦ Network managing protocols: ICMP, SNMP.
  ◦ Network managing flow-based protocols: OpenFlow, NetFlow, sFlow.
  ◦ Remote terminal configuration protocols: SNMP, NetConf, TR-069, OMA LWM2M.
  ◦ Statics collection daemons: collectd, sFlow.
•Mastering SDN:
  ◦ Applying the SDN approach to control a wireless network using the Mininet test bed.
  ◦ Using the RYU controller to monitor, configure and manage flows in a network.

Part 2

• Design a specification for a network prototype.
• Use the Mininet test bed to emulate a backhaul network based on the designed prototype.
• Control the network using the RYU controller.
• Design a network optimization algorithm.

2. Second year

Part 1

• Designing a Global Network Optimization Algorithm.

Part 2

• Mile stone: Submitting a journal paper (March 2016)

3. Third year

part 1

• Adding user profiling to upgrade optimization algorithm performance.

Part 2

• Enhance the optimization algorithm by developing and adding a mobility plug-in.
• Mile stone: Submitting a journal paper (March 2017)

Objectives

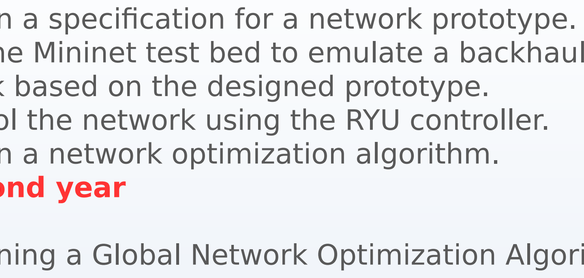

Fig 2 : Specification of the network

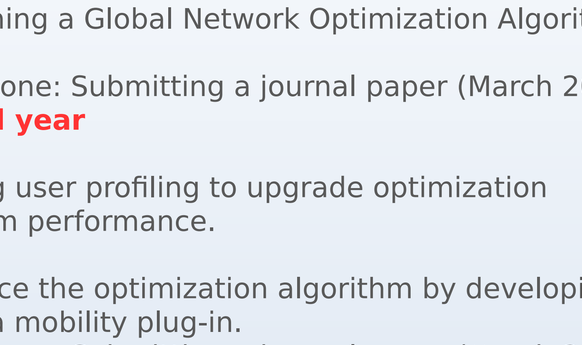

Fig 3 : Specification of the controller

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State of the art

Software-defined networking (SDN)[1]

an approach to **computer networking** that allows **network administrators** to manage network services through **abstraction** of lower-level functionality. This is done by decoupling the system that makes decisions about where traffic is sent (the **control plane**[4]) from the underlying systems that forward traffic to the selected destination (the **data plane**[4]).

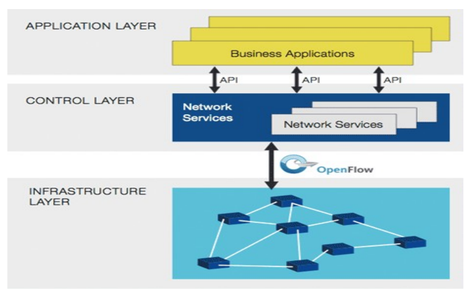


Fig 1 : SDN Layer Architecture

OpenFlow[2]

a **communications protocol** that gives access to the **forwarding plane** of a **network switch** or **router** over the network. It enables controllers to determine the path of network packets through the network of switches by allowing the remote administration of a layer 3 switch's packet forwarding tables, by adding, modifying and removing packet matching rules and actions.

Network Protocols

Since our aim is to control the whole network through a centralized controller by configuring the network and analyzing the network flow in order to decide the best flow steering destination, we needed to investigate the existing network protocols.
In order to manage a network, we have to establish the communication protocols, and since we intend to control every part of the network including the client devices, we needed to search for remote terminal configuration protocols such as SNMP[5], NetConf[6], TR-069[7] and OMA LWMM[8]. Then in order to analyze flows in the network we examined the existing static collecting and analyzing techniques such as collectd[9]. Finally we explored some of the major network managing protocols such as ICMP[10] and SNMP[5] also the flow-based managing protocols such as OpenFlow[2], NetFlow[11] and sFlow[12].

Methods and approaches

We started by characterizing the Galician wireless access networks of different operator such as R Cable y Telecomunicaciones Galicia aiming to model accurately the wireless access segment of our global network architecture. Then we implemented an advanced simulation framework for SDN networks of the discovered wireless access network combining the FNSS tool with the Mininet emulator (e.i. see figure 4).

- We also created a controller that:
- Can discover all the nodes and links of the network using the key components topology/. This controller functionality will be useful for future implementation of graph optimization algorithms such as the Dijkstra algorithm.
- Can configure the network by executing the configuration commands directly on the devices.
- Is able to access the link utilization of every link by accessing the byte and packet counters in the network devices. This option is useful for future flow steering decisions.

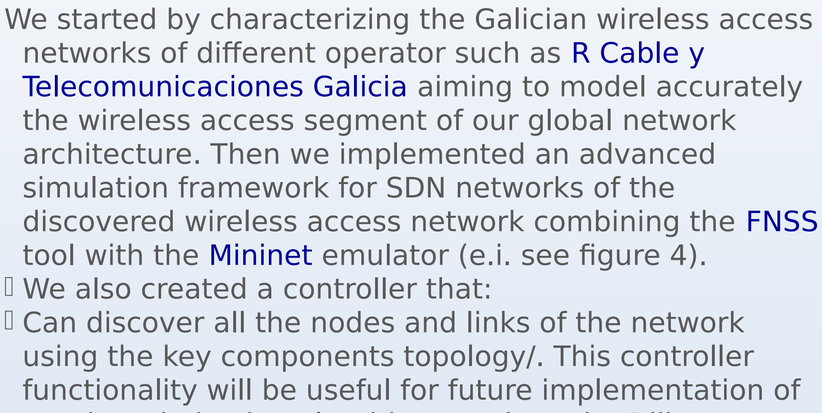
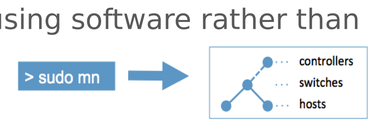


Fig 4 : Characterizing and implementing the network backhaul

Tools

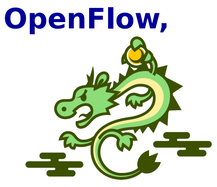
- **Mininet**[11]
  - A *network emulator*. It runs a collection of end-hosts, switches, routers, and links on a single Linux kernel. It uses lightweight virtualization to make a single system look like a complete network, running the same kernel, system, and user code. Mininet's virtual hosts, switches, links, and controllers are the real thing they are just created using software rather than hardware.



- **FNSS (Fast Network Simple Setup)**[12]
  - A powerful tool to generate a large scale realistic fully functional topologies . This tool provides capabilities for parsing topologies from datasets or generating them synthetically, assign desired configuration parameters and generate traffic matrices or event schedules.
  - FNSS uses a Link capacity estimation method that take into consideration:
    - Edge between centrality : number of shortest path passing through the link.
    - Degree centrality gravity : number of neighbors.
    - Communicability centrality gravity : number of distinct closed walks passing through.

RYU controller[13]

- A component-based software defined networking framework. Ryu provides software components with well defined API that make it easy for developers to create new network management and control applications. Ryu supports various protocols for managing network devices, such as **OpenFlow,** Netconf, OF-config, etc.



Results

We have a real network implemented in Mininet, this network can be discovered, controlled and monitored by an external RYU controller.

Current work

- Assign traffic matrices to the topologies and decide how the traffic will be modeled by choosing the number of current flow, their origin, destination and characteristics.
- Define traffic steering steering objectives and Algorithm.

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