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

We intend to design and implement a SDN-oriented global network optimization algorithm.
This algorithm will use flow steering and will be applied on an SDN[1] architecture in which the end-terminals are 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.
  - Statistics 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 of 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.

2. Second year
Part 1
- Designing a Global Network Optimization Algorithm.

Part 2
- Mile stone: Submitting a paper (June 2016) [6]

3. Third year
Part 1
- Develop a successful flow based access point assignment algorithm and take advantage of the SDN and TSA architectures.

Part 2
- Implement different profilers to help the controller with access point assignment:
  - Flow profiler.
  - Mobility profiler.

Next Year Planning

- Test the efficiency of the algorithms on a real network emulation with real terminals scenarios
- Implementing and testing the user profiler on the network
- Preparing an article to submit to a network journal
- Writing the Thesis

Results & Discussion

We applied Kalman filtering, to predict terminal positions [4] [5].

We managed to predict the right position of the terminal with a success rate of *75%*.

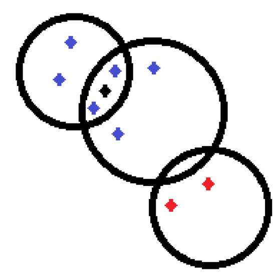
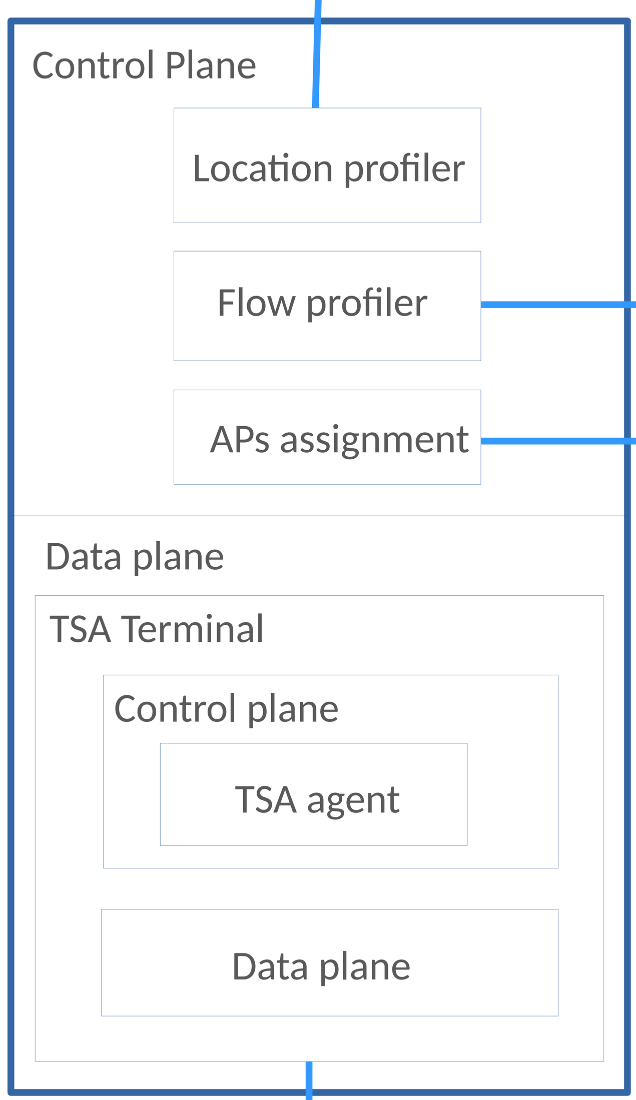


Fig 1 : Terminal position prediction

We developed a flow predictor that is able to predict the next flow type generated by the terminals with an average F1 value of **0,85**. It was presented in the IPIN 2016 [6].



TSA is an architecture created by the AtlantTIC research group. it have been tested [9] and published [1][10].

Algorithm

We developed a new algorithm that takes into consideration the flow generated by the users A and the bandwidth available in the network access points B.
The algorithm uses a modified genetic algorithm to assign the terminals to the right access points

$$Fit = (\alpha \times A) + ((1-\alpha) \times B)$$

$$A = \frac{\sum_{i\epsilon AP} N_i;}{Total\ number\ of\ requested\ flows}$$

N_i: number of rightly assigned flow.

$$B = \frac{\sum_{i\epsilon AP} BW_{Assigned}\,;}{\sum_{i\epsilon AP} BW_{AP}\,;}$$

Calibration

Choosing the right α :

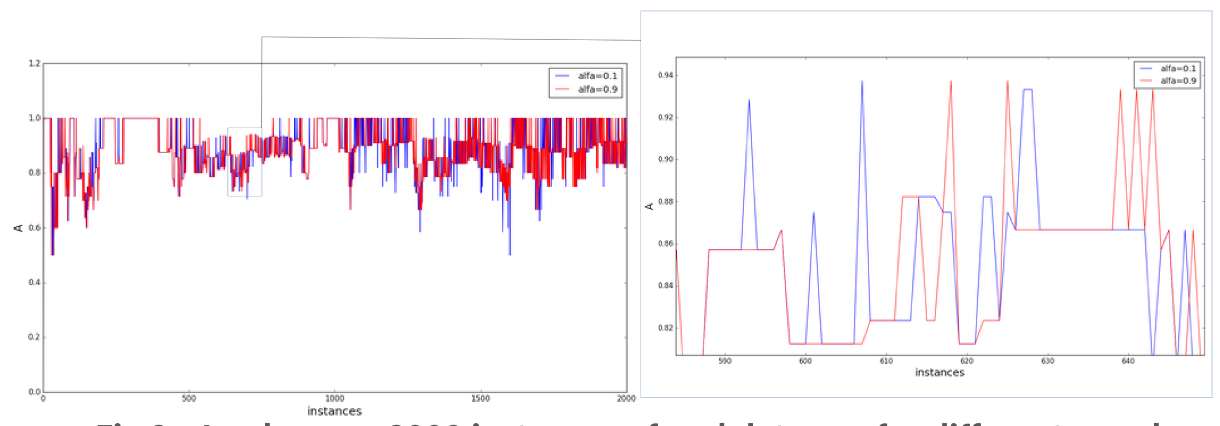


Fig 2 : A values vs. 2000 instances of real data [11] for different α values

We ran the algorithm with multiple values of and we check A for α = 0,1 and α = 0,9.
For an α = 0,1, we obtain an improvement of 81,7% in A.

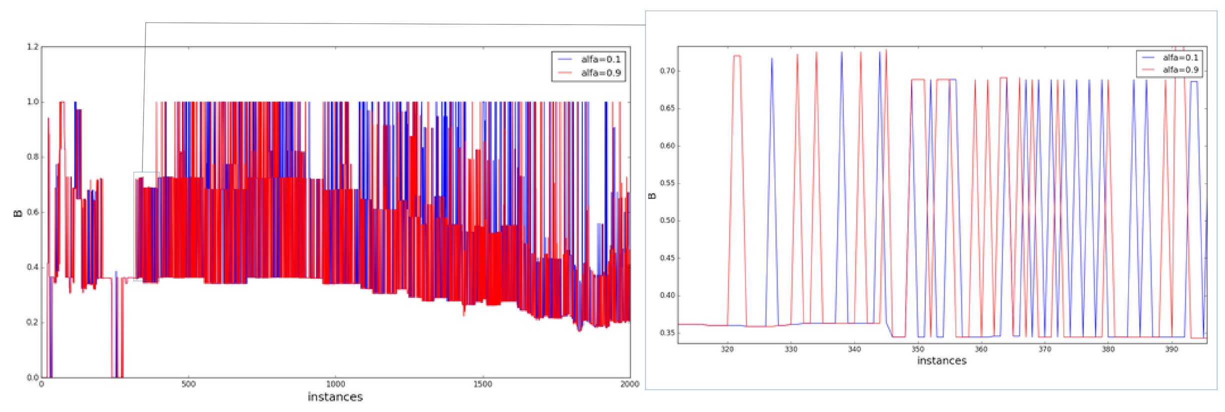


Fig 3 : B values vs. 2000 instances of real data [11] for different α values

We ran the algorithm with multiple values of α and check B for α = 0,1 and α = 0,9.
for α = 0,1, we obtain an improvement of 75,95% in B values.

Choosing the right number or genetic algorithm iterations :

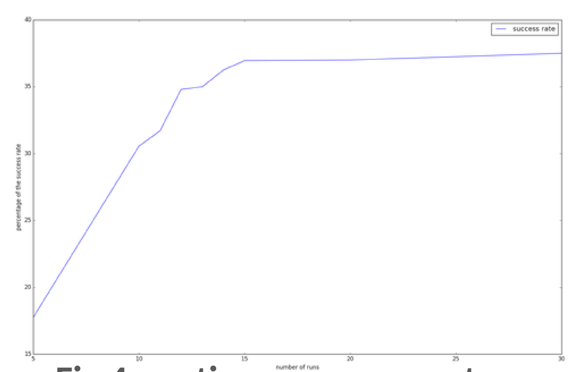


Fig 4 : optimum success rate vs. number of iterations

The algorithm achieves its optimum performance after 15 iterations .

We set a limit of 15 iterations on the genetic algorithm for α=0,1.

Results

Using real flow and position data :

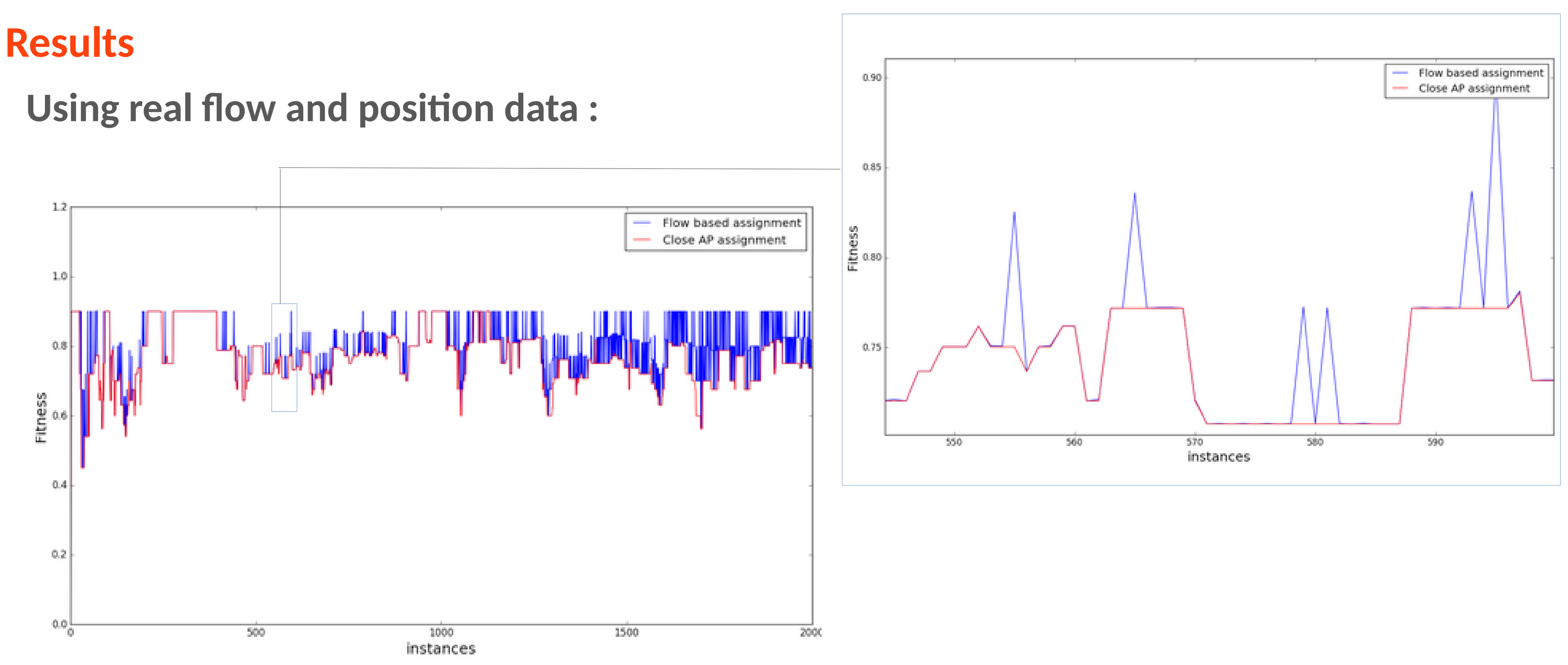


Fig 5 : Fitness values vs. 2000 instances of real data with 15 iterations and α = 0,1

Running our flow based access points assignment algorithm with 15 iterations and an α = 0,1, our AP assignment algorithm provides a 52,17% better Fitness value than closest-AP assignment [7] [8] over the first 2000 instances of real data taken from the campus of Rice university[11] .

Overall, our AP assignment algorithm provides a 31,98% better Fitness value than closest-AP assignment [7] [8] over all the instances of real data.

Using real flow data and predicted position data :

Update interval	Percentage of rightly assigned terminals	Terminal assignment success rate
60s	77,82%	40,59%
45s	78,29%	40,84%
30s	78,55%	40,97%

Fig 6 : Table of assignment success rate with predicted position data

Running our flow based access points assignment algorithm with 15 iterations and α = 0,1, our AP assignment algorithm provides 40,8% better Fitness value than closest-AP assignment [7] [8] over the first 2000 instances of real data with predicted positions.

References

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