Monitoring and measuring wireless network performance in the presence of middleboxes

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Introduction and motivations

Monitoring and measurement of wireless networks play an important role for a number of reasons. In current networking scenarios, middleboxes (NAT, firewall, PEP, PCMS, ...) are more and more common.
In this poster we present preliminary results of our ongoing work on the monitoring and measurement of the performance of real operational wireless networks in the presence of middleboxes.
We analyze the 3G network of two of the major operators in Europe and the satellite network of one of the major European providers of satellite connectivity.
Our results show how middleboxes can deeply change the results of an experiment: in the presence of such devices, the performance parameters of interest can obtain completely different values when measured with different tools and methodologies.
We propose an approach to cope with these issues composed of both active and passive techniques, considering several layers in a combined fashion, using different traffic profiles, and looking at both side of the considered middleboxes.

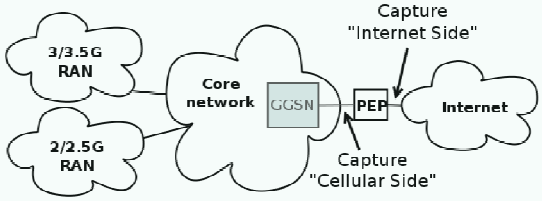
Reference scenario

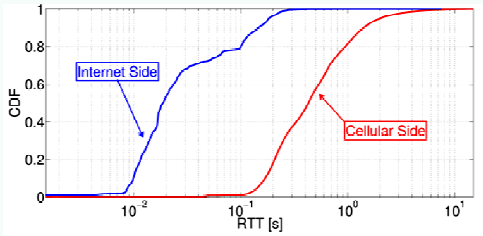
We use the definition given in [1] for the term middlebox: *"any intermediary box performing functions apart from normal, standard functions of an IP router on the data path between a source host and destination host".* In this work we focus on two particular kinds of MBs, that are PEPs and PCMSs:
a) PEP: A Performance Enhancement Proxy is a very wide-spread MB, whose aim is helping the users of a certain network to improve his/her quality of experience. The proxying functionalities are normally implemented by terminating the TCP connections on the client side and opening new TCP connections towards the server. The performance enhancement features can be multiple, and depend on the network and application on which the PEP has to operate. They span over multiple layers of the protocol stack, typically from the transport to the application ones.
b) PCMS: Packet Classifiers Markers and Schedulers allow to identify and classify the packets of the different applications in order to provide a specific service for each traffic class.

[1] B. Carpenter and S. Brim, "Middleboxes: Taxonomy and issues," February 2002, RFC 3234.

Experimental analysis

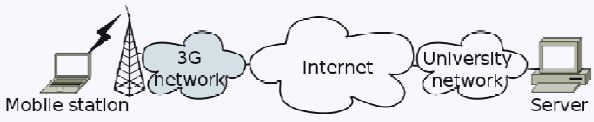
To show how monitoring and measurement of network parameters in presence of PEPs can provide highly different results if parameters are observed in different parts of the network, we performed a set of experiments over an operational cellular network which employs a PEP

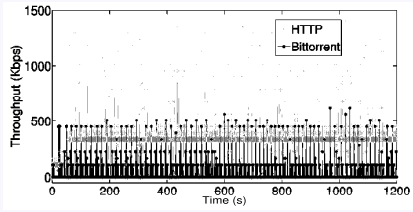


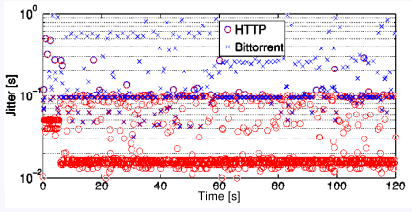


it is important to take into the proper account the presence of such device when performing network measurements: it can be useful for those interested in estimating the performance as seen by the users - in fact, they only see the cellular side - while being an issue for those interested in looking at the end-to-end performance.

To show how performance parameters can be highly different if measured with different traffic profiles, we performed a set of experiments over the cellular network of another European 3G/4G network operator

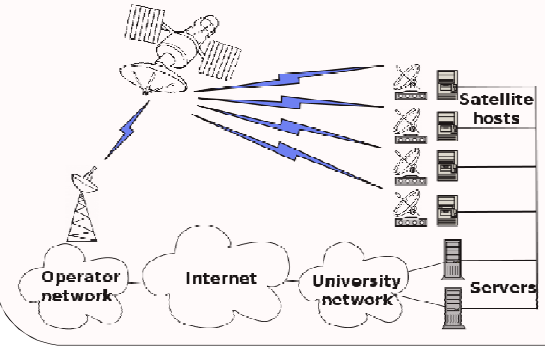


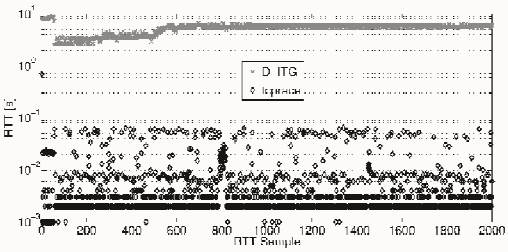




The throughput of the HTTP-like flow is higher with respect to the other flow, their average values being 350Kbps and 58Kbps respectively. Also, the jitter of the two flows achieve different values over time. The average value for the HTTP-like is 32ms, while for the Bittorrent-like flow is 191ms. This is the effect of a PCMS.

To show how adopting a different point of view when performing performance measurements may imply a completely different result, we performed a set of experiments over a network testbed comprising satellite links from one of the major European providers





The RTT of a flow of TCP packets calculated by D-ITG and by tcptrace are very different. The difference is due to the fact that the TCP connections are terminated by the PEP located inside the satellite modem. Therefore, the RTT seen at transport layer, reported by tcptrace, is only related to the local network between the modem and the end-host.

PS / PR	D-ITG RTT [s]	tcptrace RTT [s]
64 / 10	0.6280	0.0528
128 / 10	0.5934	0.0475
256 / 10	0.6028	0.0344
512 / 10	0.6912	0.0423
64 / 1000	4.4296	0.0064

Measuring the performance of current middlebox-rich networks requires more awareness of the experimenter. To reveal the presence of such devices and to cope with them, we have proposed an approach using both active and passive techniques, using different traffic profiles, looking at different layers of the protocol stack and at both side of the middlebox.

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