PhD in Information Technology and Electrical Engineering

Università degli Studi di Napoli Federico II

PhD Student: Pasquale Imputato

XXXI Cycle

Training and Research Activities Report – First Year

Tutor: Stefano Avallone

Information

    a. Pasquale Imputato, MS in Computer Engineering – University of Naples "Federico II"

    b. XXXI Cycle - ITEE - University of Naples "Federico II"

    c. Fellowship type: University of Naples "Federico II"

    d. Tutor: Stefano Avallone

1. Study and Training activities

    a. Courses

        1. "Network Security", Prof. Simon Pietro Romano, MS module, 21/9/2016 – 16/12/2016, 6 CFU

        2. "Le imprese e la ricerca", Prof. Francesco Bellucci, Dr. Marco Frizzarin, Ad hoc module, 28/2/2017 – 2/3/2017, 4 CFU

    b. Seminars

        1. "Diritti umani e nuove tecnologie", Dott. Daniele Amoroso, 9/11/2016, 0.50 CFU

        2. "Security Operations in una Telco, esperienze e riflessioni dal campo", Ing. Fabio Zamparelli, 11/11/2016, 0.40 CFU

        3. "Lateral technology for power devices: concepts, state of the art and applications", Dr. Gianluca Camuso, 24/11/2016, 0.40 CFU

        4. "MINIX3: A Reliable and Secure Operating System", Prof. Andrew S. Tanenbaum, 30/11/2016, 0.40 CFU

        5. "L'innovazione nel mercato IT", Dott. Giovanni Pirollo, Ing. Aldo Francesco Fucito, 1/12/2016, 0.80 CFU

        6. "ImpSAR – An alternative to conventional SAR", Prof. Giorgio Franceschetti, 12/12/2016, 0.20 CFU

        7. "GaN for power applications: devices and switching performances", Dr. Giorgia Longobardi, 15/12/2016, 0.40 CFU

        8. "Verifica e Validazione di sistemi Safety Critical", Altran Italia, 16/12/2016, 0.40 CFU

        9. "Smart nanodevices for theranostics", Prof. Ilaria Rea, 24/2/2017, 0.30 CFU

        10. "How to organize and write a scientific rebuttal", Prof. Pasquale Arpaia, 10/3/2017, 0.40 CFU

        11. "Scaling Adaptive Streaming Systems with Network Support", Dr. Ali C. Begen, 13/3/2017, 0.30 CFU

12. "Fuzzy Logic, Genetic Algorithms and their Application to next Generation Networks", Prof. Leonard Barolli, 10/3/2017 e 14/3/2017, 0.80 CFU

13. "Wireless Opportunistic Networking", Prof. Gunnar Karlsson, 28/9/2017, 0.30 CFU

c. External courses

Student: Pasquale Imputato   **Tutor: Stefano Avallone**   **Cycle XXXI**
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	Credits year 1								Credits year 2								Credits year 3									
	Estimated	1 bimonth	2 bimonth	3 bimonth	4 bimonth	5 bimonth	6 bimonth	Summary	Estimated	1 bimonth	2 bimonth	3 bimonth	4 bimonth	5 bimonth	6 bimonth	Summary	Estimated	1 bimonth	2 bimonth	3 bimonth	4 bimonth	5 bimonth	6 bimonth	Summary	Total	Check
Modules	20			3	5	6	8	22	10	6		4				10	0							0	32	30-70
Seminars	5	1,6	1	1	1,6		3	8,2	5	3,5	0,3	1,5			0,3	5,6	0							0	13,8	10-30
Research	35	4	7	7	4	4	4	30	45	3	9	5	10	10	9	46	60							0	76	80-140
	60	5,6	8	11	10,6	10	15	60,2	60	12,5	9,3	10,5	10	10	9,3	61,6	60	0	0	0	0	0	0	0	121,8	180

2. Research activity

a. Title: Improving the performance of WiFi networks through innovative Active Queue Management algorithms

b. Study: traffic control, queueing discipline, bufferbloat, active queue management, queue sizing, dynamic queue sizing, network simulation, performance evaluation, 802.11 standard

c. Research description:

Keeping the delay experienced by packets while travelling from a source to a destination below certain thresholds is essential to successfully deliver a number of services nowadays. Most of the packet delay can be usually ascribed to the time spent in the many queues encountered by the packet. In this context, the term bufferbloat has been recently coined to denote the uncontrolled growth of the queuing time due, among others, to the excessive size of the buffers and the attitude of TCP to increase the sending rate until a packet is dropped. In Wifi the bufferbloat problem is exacerbated by a number of peculiar mechanisms. For instance, the rate adaptation techniques, that aim at reducing the time needed to transmit the frames, can lead to growing queues, thus worsening the problem.

Reducing the queuing time at the network layer is the objective of a number of scheduling algorithms developed in the past years and known as Active Queue Management (AQM) algorithms. The reduction of the network latency is achieved by signalling to the end point of the transmission the status of congestion so as to stimulate a reduction of the sending rate of the packets within the network. Some AQM algorithms like Random Early Detection (RED) drop a packet in the tail of the queue when the queue size exceeds a certain threshold. This class of AQM needs a fine tuning for the network scenario where they operate. When tuned conveniently, this AQM leads to a considerable reduction of the network delay. However, the need of the prevented a wide use of this AQM strategy. To overcome the limit of the old

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generation, a new class of AQM algorithms has been introduced having the design goal of requiring (almost) no parameters. An AQM like CoDel monitors the delay experienced by the packets. Also, it drops the packets in the head of the queue so as to reduce the time to notify the network status. The scheduling algorithms are effective when the backlog of packets is under their control. Conversely, when the backlog is limited by large device buffer they are ineffective.

Reducing the time spent while in the buffer of the network device driver has instead received much less attention, though it may have a considerable impact on performance. The device buffers are usually limited by a maximum number of packets that the device can hold. A fixed value is difficult to define. A proper device queue size depends on the service rate. In the case of Wifi, a value for a period of time is inappropriate for another period of time due to different transmission rates in use by the device. Also, a packet based measure of the device queue size hides the variability of the time needed to empty the queue due to variable packets size. An algorithm called Byte Queue Limits (BQL), recently introduced in the Linux kernel, overcomes this problem by introducing a byte based measure of the device buffer for wired network devices. It can assume a fixed service rate in case of wired networks. The Wifi standard recurs to fixed size to meet some need derived from mechanism defined by the standard itself to improve the network throughput (e.g. the frame aggregation).

The activity intends to explore some techniques to contrast the delay experienced in the Wifi networks and that lead to poor performance. A dynamic sizing in Wifi devices intends to reduce the queueing time within the device. The main obstacle is to cope with the need of the rate adaptation algorithms (RAA) and of the frame aggregation (FA). Innovative RAA can be designed to alleviate the bufferbloat problem and to cooperate with the AQMs. Within this design falls the possibility to introduce a flow guarantees in Wifi. Some scheduling algorithms with fairness guarantees (e.g. Quick Fair Queueing) can be studied. The activity is supported by network simulation. We intend to introduce some models in ns-3 to accurately evaluate behaviours that occur in a real system.

d. Collaborations

During the second year of operations, we collaborated with ns-3 and ESA for the introduction of a new device in ns-3 to improve the network emulation support in ns-3. Also, we defined a collaboration with the CTTC on advanced traffic-control techniques.

3. Products

a. Publications

i. P. Imputato and S. Avallone. 2017. Traffic Differentiation and Multiqueue Networking in ns-3. In Proceedings of the Workshop on ns-3 (WNS3 '17). ACM, New York, NY, US.

ii. P. Imputato, S. Avallone, An analysis of the impact of network device buffers on packet schedulers through experiments and simulations, In Simulation Modelling Practice and Theory, Volume 80, 2018, Pages 1-18, ISSN 1569-190X.

iii. P. Imputato, S. Avallone and T. Pecorella. 2017. Network Emulation Support in ns-3 Through Kernel Bypass Techniques. In Proceedings of Valuetools 2017.

4. Conferences and Seminars

   a. Details

      Workshop on Ns-3, WNS3, June 13-14, 2017, Porto, Portugal.

   b. Presentations made

      P. Imputato and S. Avallone. Traffic Differentiation and Multiqueue Networking in ns-3.

5. Activity abroad

6. Tutorship

   Exam assistant to the BS course of Calcolatori Elettronici I and MS course of Protocolli per reti mobili. Seminar on bufferbloat to the MS course of Protocolli per reti mobili.