



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



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PhD in Information Technology and Electrical Engineering - XXXI Cycle

Pasquale Imputato

1. 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

2. Study and Training activities

a. Courses

1. “Communicating and disseminating your research work”, Prof. Mo Mansouri, Ad hoc module, 14/3/2016 – 16/3/2016, 3 CFU
2. “Scientific Writing”, Prof. Paolo Russo, Ad hoc module, 5/4/2016 – 24/5/2016, 5 CFU
3. “Analisi e Prestazioni di Internet”, Prof. Antonio Pescapè, MS module, 7/3/2016 – 8/6/2016, 6 CFU
4. “Modelli, metodi e software per l'Ottimizzazione”, Prof. Antonio Sforza, Prof. Claudio Sterle, Ad hoc module, 18/3/2016 – 15/6/2016, 8 CFU

b. Seminars

1. “Model Based and Pattern Based GUI Testing”, Prof. Ana Paiva, 23/11/2015, 0.80 CFU
2. “Verifica e Validazione di sistemi Safety Critical”, Ing. Alessandro Di Nocera, Ing. Gabriele D'Avino, 4/12/2015, 0.40 CFU
3. “Security Operations in una Telco, esperienze e riflessioni dal campo”, Ing. Fabio Zamparelli, 4/12/2015, 0.40 CFU
4. “Radar Adaptivity: Antenna Based Signal Processing Technique”, Dr. Alfonso Farina, 12/2/2016, 0.40 CFU
5. “Perception-based surround sound recording and reproduction”, Dr. Enzo De Sena, 22/2/2016, 0.20 CFU
6. “Programmable network conjugations”, Dr. Roberto Bifulco, 26/2/2016, 0.40 CFU
7. “Speech Technologies at Trinity College – Dublin”, Dr. Loredana Cerrato, 2/3/2016, 0.20 CFU
8. “NetFlow ed IPFIX Dalla teoria alla pratica”, Ing. Maurizio Molina, 11/4/2016, 0.80 CFU
9. “Il Monitoraggio della Qualità del Servizio oltre gli indicatori Standard: l'esperienza sulla rete mobile di Telecom Italia”, Dott. Alma Fazzolari, 16/5/2016, 0.40 CFU
10. “An overview on image forensics with emphasis on physics-based scene verification”, Dr. Christian Riess, 18/5/2016, 0.20 CFU

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11. "Internet: la dimensione immateriale dell'esistenza", Prof. Stefano Quintarelli, 19/5/2016, 0.40 CFU
12. "Misure in crowdsourcing e su videostreaming per reti cellulari", Vodafone Italia, 23/5/2016, 0.40 CFU
13. "Methodologies for Embedded Software Valifation", Teoresi Group, 25/5/2016, 0.20 CFU

c. External courses

1. "Building Trust in the Information Age", Summer School on Computer Security & Privacy, September 5-9, 2016, Pula - Italy, 3 CFU

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Cycle XXXI

	Credits year 1								Credits year 2								Credits year 3								Total	Check
	Estimated	1	2	3	4	5	6	Summary	Estimated	1	2	3	4	5	6	Summary	Estimated	1	2	3	4	5	6	Summary		
Modules	20			3	5	6	8	22	10							0	0							0	22	30-70
Seminars	5	1,6	1	1	1,6		3	8,2	5							0								0	8,2	10-30
Research	35	4	7	7	4	4	4	30	45							0	60							0	30	80-140
	60	5,6	8	11	10,6	10	15	60,2	60	0	0	0	0	0	0	0	60	0	0	0	0	0	0	0	60	180

3. 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 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

4. Products

a. Publications

- i. P. Imputato and S. Avallone. Design and implementation of the traffic control module in ns-3. In Proceedings of the Workshop on Ns-3, WNS3 '16, pages 1-8. ACM, June 2016. **Best Paper Award.**
- ii. P. Imputato and S. Avallone. Evaluating the benefits of dynamically sizing the network device buffers through simulations. To be submitted to "Journal of Network and Computer Applications".

5. Conferences and Seminars

a. Details

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Workshop on Ns-3, WNS3, June 15-16, 2016, Seattle, WA, USA.

Workshop on Wireless Network Performance Evaluation, June 17, Seattle, WA, USA

b. Presentations made

P. Imputato and S. Avallone. Design and implementation of the traffic control module in ns-3.

6. Activity abroad

7. 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.