PhD in Information Technology and Electrical Engineering

Università degli Studi di Napoli Federico II

PhD Student: Stefania Zinno

XXX Cycle

Training and Research Activities Report – First Year

Tutor: Giorgio Ventre – co-Tutor: Stefano Avallone

1. Information

My name is Stefania Zinno and I was awarded the master Science degree in “Ingegneria delle Telecomunicazioni” at University of Naples Federico II.

I am a PhD Student in Information Technology and Electrical Engineering, XXX Cycle, Università degli Studi di Napoli Federico II.

I completed the industrial master "SIRIO-FORM Servizi per l'Infrastruttura di Rete wIreless Oltre il 3G” held by CNIT - Consorzio Nazionale Interuniversitario per le Telecomunicazioni in partnership with VoiSmart srl and Seconda Università degli Studi di Napoli – Dipartimento di Ingegneria Industriale e dell'Informazione.

I work under the supervision of Prof. Giorgio Ventre and Prof. Stefano Avallone.

2. Study and Training activities

A. Courses

- **“Three core issues for the Internet: things, security and economics”**, occasionally provided ad hoc module, held by Prof. Henning Schulzrinne, 2 CFU
- **“Designing and writing scientific manuscripts for publication in english language scholarly journals, and related topics”**, held by Barnett Parker, 3 CFU

“Security and Dependability of Computer Systems” – Valentina Casola, 6 CFU

- **“Network Security”** – Simon Pietro Romano, 6 CFU

B. Seminars

- **“Lagrangean Relaxation and Set Covering””** - Manlio Gaudioso, 1CFU
- **"Evoluzioni a lungo termine delle reti mobili"** held by ing. Silvio De Nicola, 0.4 CFU
- **“V model Design – descrizione e implementazione di un modello di sviluppo nelle realtà aziendali”** Mario Cesarelli, 0.4 CFU
- **"Regularization of two-fold bifurcations in planar piecewise-smooth systems"** held by Mario di Bernardo, 0.4 CFU
- **"La Ricerca nel Settore Scientifico Disciplinare della Elettrotecnica negli ultimi decenni"** Prof. Mario Salerno, 0.4 CFU
- **"Fundamentals of Molecular Communications, and Communication Theoretical Foundations of Nervous System Towards BIO-inspired Nanonetworks and ICT-inspired Neuro-treatment”** - Prof. Ozgur B. Akan, 1.2 CFU
- **“On the complexity of Temporal Equilibrium Logic (joint work with David Pearce)”** held by Laura Bozzelli, 0.2 CFU

Δ. Summary

Student: stefania Zinno **Tutor: Giorgio Ventre** **Cycle XXX**

stefania.zinno@unina.it giorgio.ventre@unina.it

	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			2		3		12	**17**								**0**								**0**	**17**	**30-70**
Seminars					1,8		1,8	**3,6**																**0**	**3,6**	**10-30**
Research		10	8	10		10		**38**								**0**								**0**	**38**	**80-140**
	0	10	10	10	4,8	10	13,8	**58,6**	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	**0**	**58,6**	**180**

Type	CFU	Activity	Lecturer
M	3	"Designing and writing scientific manuscripts for publication in english language scholarly journals, and related topics"	Prof. Barnett Parker
S	0.4	"Evoluzioni a lungo termine delle reti mobili"	Prof. Silvio De Nicola
S	0.4	V model Design – descrizione e implementazione di un modello di sviluppo nelle realtà aziendali	Prof. Mario Cesarelli
S	0.4	"Regularization of two-fold bifurcations in planar piecewise-smooth systems"	Prof. Mario di Bernardo
S	1	"Lagrangean Relaxation and Set Covering"	Prof. Manlio Gaudioso
S	0.4	"La Ricerca nel Settore Scientifico Disciplinare della Elettrotecnica negli ultimi decenni"	Prof. Mario Salerno
S	1.2	"Fundamentals of Molecular Communications, and Communication Theoretical Foundations of Nervous System Towards BIO-inspired Nanonetworks and ICT-inspired Neuro-treatment"	Prof. Ozgur B. Akan
S	0.2	On the complexity of Temporal Equilibrium Logic (joint work with David Pearce)	Prof. Laura Bozzelli
M	6	Network Security	Prof. S.P. Romano
M	6	Security and Dependability of Computer Systems	Prof. Valentina Casola
M	2	Three core issues for the internet: things,security and economics	Prof. Henning Schulzrinne

3. Research Activities

- **Improving LTE Performance and efficiency**

The aim of my activity is to improve performance and efficiency in LTE network environment.
High-speed and seamless broadband services can be achieved by detecting and avoiding security threats and failures and on the other hand by exploring new features such as for example the usage of unlicensed bands presented in 3GPP Release 13.

- **Security threats in LTE: A load balancing algorithm against DDoS Attacks**

The LTE technology gives access to higher bandwidth and assures efficiency at network lever for TLC operators. 4G provides a reliable and continuous data traffic flow allowing the exchange of information of every kind. Users, both personally and in their business lives became more and more dependent on the Internet, especially on mobile connection. It is therefore, necessary to guarantee a network protection from threats and failures.

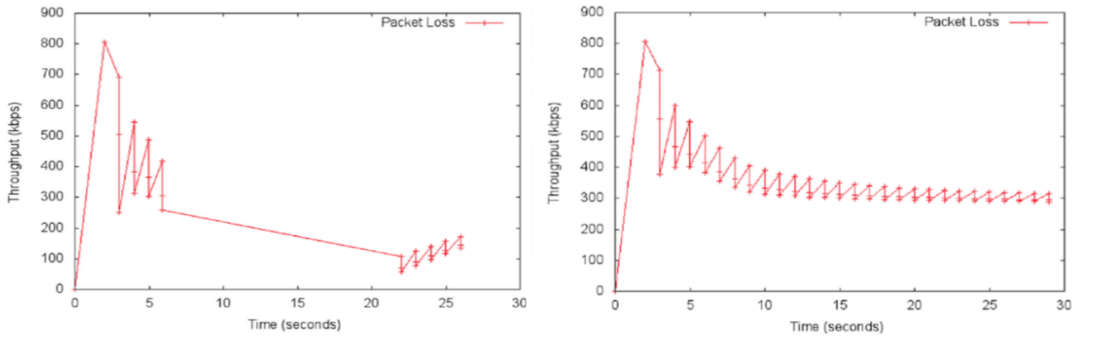
Traditionally, the security community focuses its attention on unauthorized access to system holding private information.

Denial of Service as an malicious attack has been long ignored due to its nature. It cannot provide with sensitive information nor private data. Literally, Denial of Service attacks aim at exhausting a system resources as for example a web service until it become unreachable. Today this kind of threats is considered quite dangerous. When the client-server paradigm is used, overload of a system is very easy. A certain number of resource requests are sent to the target. The requests themselves are not malicious in any case. What compromises the target and performs the attack is the large amount of requests sent.

In the mobile world DDoS are often performed by botnets, i.e. (ro)bots network. Botnets are overlay networks composed by corrupted users' mobile devices. Such botnets are administered by botmasters, cybercriminal individuals working on Botnets creation and spreading. Devices are commonly infected through email attachments.

An innovative aspect of LTE is taken into consideration, which is its ability to work as a Self-Organizing Network (SON). Self-organizing networks are an emerging network paradigm. We leverage such a paradigm to design and deploy a technique able to defend LTE networks against DDoS attacks. Self Organizing Networks design aims at supporting three main features which are *self healing*, *self optimization* and *self configuration*. The technique identifies congested cells or cells under attack and takes care of redistributing users among eNodeBs. In particular, a subset of the UEs located at the congested cells are requested to perform an handover procedure towards less congested cells. The result of such operation is a more homogeneous network, from a traffic point of view, which increases the capacity of the overall system to perform as expected for legitimate users. A technique is presented that can be proficiently employed to cope with DDoS attacks on current LTE infrastructures. A load balanced traffic configuration is achieved through an algorithm that relocates users among eNodeB to lower the pressure on congested cells. The algorithm is as follows:

each eNodeB is requested to continuously collect data about the usage of its resources (by the connected users). Moreover, periodically, each eNodeB sends such data to their immediate neighbours. In this way, each eNodeB is aware of the usage of its resource as well as of those of its neighbours. If one of the eNodeB identifies a state of congestion of its cell, due to a DoS attack or to a too high number of users, it can start a procedure that can lead to the handover of some of its users to neighbouring cells with sufficient resources. In the following, fig. 2, the mean throughput of the network is shown when the proposed technique is active and inactive.



(a) Algorithm Inactive (b) Algorithm Active

Fig. 1 Network Mean Throughput

– **Licensed Assisted Access: a fair coexistence of LTE and WI-FI in 5Ghz unlicensed band**

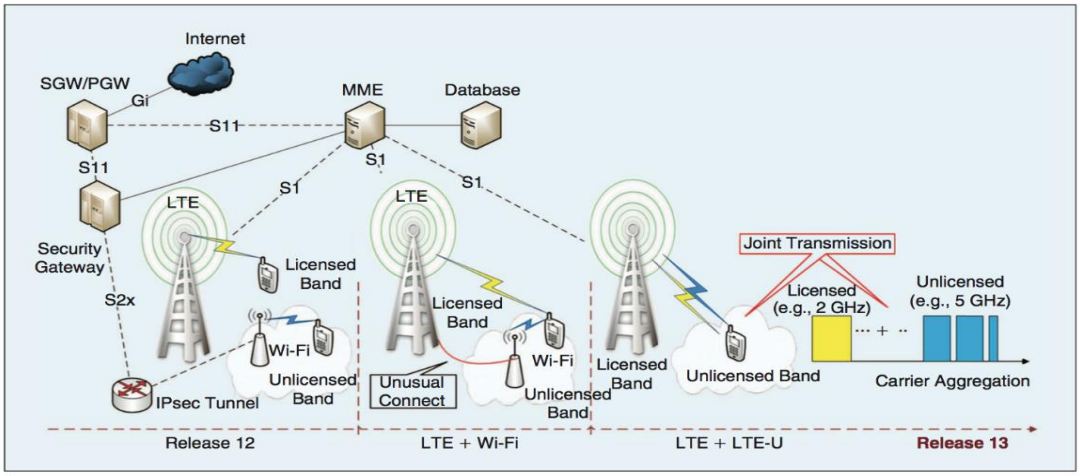


Fig. 2 Lte Architecture in Unlicensed Band

Wireless networks are generally classified in cellular networks and wifi networks. Each network is characterized by specific elements and allocated spectrum. Cellular networks use mainly licensed bandwidth while Wi-Fi technologies use unlicensed spectrum. Recently the idea of LTE working in the unlicensed spectrum to achieve greater efficiency has been exploited.

Releases 10–12 carrier aggregation (CA) technology aggregates multiple small band segments into maximum 100 MHz virtual bandwidth to achieve a higher data rate. Eventually 3GPP proposed a new concept for LTE radio access network (RAN) to operate in the unlicensed spectrum as part of a Release 13 as shown in fig.1. It is possible for user to adaptively change from using LTE or Wi-Fi. Obviously a coordination between different RATs is needed and also modification to protocols stacks and interface functionalities need to be improved. Resource allocation becomes an issue to resolve as also user service continuity. In order to meet these requisites, Licensed-Assisted Access-Long Term Evolution (LAA-LTE) is emerging as the candidate technology to be utilized in unlicensed spectrum for wireless data traffic

offloading. LAA-LTE uses carrier aggregation combining licensed and unlicensed bands, delivering cellular services to mobile users in the 5-GHz unlicensed band.

LAA technology is suitable for a small area. The deployment of most interest is small cell, which provides access to both licensed and unlicensed spectrum for indoor and outdoor environment.

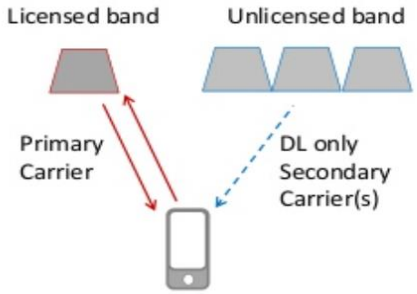


Fig.3 Primary and Secondary Component Carrier

Each user is always connected first to a licensed carrier, called the primary component carrier (PCC), and only after to several unlicensed carriers, called Secondary component carrier (SCCs) as shown in fig.2. To each UE several SCC are accessible at the same time. According to the user traffic demand and cell load, configuration information can be conveyed via PCC to dynamically remove/add SCCs.

There are two operation modes for LAA: supplemental downlink (SDL) and time-division duplex (TDD). SDL mode is the simplest form where the unlicensed spectrum is only used for downlink transmission, as downlink traffic is typically much heavier than uplink traffic. In TDD mode, the unlicensed spectrum is used for both downlink and uplink, just like the LTE TDD system in licensed bands. TDD mode offers the flexibility to adjust the resource allocation between downlink and uplink, at the cost of extra implementation complexity on the user side, such as LBT features and radar detection requirements on the user equipment (UE).

The research activity focuses mostly on evaluating LTE performance analysing all the aspect involved in Wi-Fi- LTE coexistence. For example, most Wi-Fi nodes use bandwidth of 20MHz, possible bandwidths of LAA-LTE, as seen in Release 12, can be 1.4/3/5/10/15/20MHz. The bandwidth change can affect the crosstalk interference. It is interesting to understand how LAA-LTE interference with different bandwidth affects Wi-Fi transmissions.

In Wi-Fi networks, nodes perform clear channel assessment (CCA) before transmissions. If CCA indicates channel busy, nodes do not transmit. LTE is characterized by a centralized MAC and the use of OFDMA. Operating in unlicensed bands would incur continuous interference to WiFi systems since WiFi adopts a contention-based MAC and will keep backing off when it detects LTE transmissions. It is possible for LAA-LTE interference to trigger channel busy indication during Wi- Fi CCA and make Wi-Fi nodes not transmit, which causes throughput degradation. LTE devices are required then, to detect before transmission whether the target channel is occupied by other systems. This procedure is referred to as listen-before-talk (LBT). It is quite necessary to investigate a mechanism of fair coexistence between the two RATs.

4. Products

A Load Balancing Algorithm against DDoS Attacks in Beyond 3G Wireless Networks

Stefania Zinno, Giovanni Di Stasi, Stefano Avallone, Giorgio Ventre - IEEE Conference Publications - Euro Med Telco Conference (EMTC), 2014

5. Conferences

- Italian Networking Workshop Jan. 14-16, Cavalese, TN.

6. Activity Abroad

7. Tutorship

I am teaching assistant for the courses of Reti di Calcolatori I, Bachelor's degree in ComputerEngineering, Scuola Politecnica delle Scienze di Base, Università degli Studi di Napoli Federico II.