
Curriculum Vitae — Fabrizio Giuliano

PERSONAL INFORMATION

Fabrizio Giuliano

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BIO

was born in Italy on December 22, 1982. He received the Engineering Specialistic Degree in Telecommunication Engineering from the University of Palermo, Palermo, Italy in 2009. He worked as collaborator researcher for CNIT (Consorzio Interuniversitario per le Telecomunicazioni) involved in European Project ICT-FLAVIA.

JOB EXPERIENCE

Research collaborator and software developer at TTI Laboratory - University of Palermo for CNIT FLAVIA - European project.

EDUCATION

2009 Specialistic Degree in Telecommunication Engineering, obtained in April 2009 at University of Palermo, Palermo (PA), Italy.
Thesis title: *MAC overlay solution in local radio networks*.
2001 Scientific high school diploma from I.T.I.S. Vittorio Emanuele III, Palermo (PA), Italy.

RESEARCH

Protocol network, networking programming, cognitive networks, IEEE 802.11 protocol, MAC protocols.

RESEARCH EXPERIENCE

Partecipation Research Activity in the department of Computer Science, UCLA - U.S.A

- Design and implementation of reconfigurable access solution for vehicular networks.

FLAVIA European Project

- Analysis and developing of **WMP** (wireless MAC processor) on a specific commercial wireless card (namely, AirForce One 54g, by Broadcom). The WMP has been implemented by re-flashing the card original firmware with a new one, working as a generic state machine executor.

WMP PROJECT WEBSITE: <http://wmp.tti.unipa.it/>

FLAVIA PROJECT WEBSITE: <http://www.ict-flavia.eu/>

- Analysis and developing of **MAClet manager**, a C program application which interfaces the B43 Linux driver (Broadcom driver) to load, run and dump WMP state machines. MAClet manager is a tool that allows real-time state machine reconfiguration.
- Analysis and developing of **WMP editor**, a Java tool for easy create a state machine for the WMP, working as an graphical editor for describing a MAC program in terms of a graphical representation of state and transitions, after the definition of state machine the tool provide to convert the state machine in a particularity bytecode that represent the MAC.

Collaboration with University of Brescia

- Various developer contribution in the OpenFWWF project (Open FirmWare for WiFi networks), a project that provide open source firmware for Broadcom/AirForce chipset based devices to obtain an easy implementation of a Medium Access Control (MAC) mechanism. OpenFWWF website: <http://www.ing.unibs.it/~openfwwf/>

Research for the TTI Lab. University of Palermo

- Evaluation Testbed, for network application scenarios, for performance, channel occupancy. Testbed developed with embedded Linksys wrt54gl with OpenWrt OS and PC Engines ALIX system Board with GNU Linux OS.
- *Ranging and Positioning using IEEE 802.11 technology*
The huge success of location-aware applications calls for the quick development of a positioning system alternative to GPS for indoor localization based on existing technologies such as 802.11 wireless networks. This work study localization system running on off-the-shelf IEEE 802.11 Access Points and based on time-of-flight ranging of standard terminals. The implementation choice is a programmable firmware architecture that enables a straightforward implementation of the ranging subsystem directly inside commercial cards without affecting the basic DCF channel access algorithm.
Activities:
 - USRP power level measurement of channel occupancy, time-based occupation evaluation and transmission characterization.
 - Characterization measurement of time of flight in MAC programmable wireless cards.

- Ranging measurement test campaign in indoor and outdoor environment.
- Indoor and Outdoor measurement using multi-station algorithms for localization.

PUBLICATIONS

- F. Gringoli, N. Facchi, P. Gallo, D. Garlisi, F. Giuliano, G. Bianchi
Enabling Cognitive-Radio Paradigm on Commercial Off-The-Shelf 802.11 Hardware, ACM WINTech 2013, Miami, Florida USA, September 30th, 2013

Cognitive Radio paradigm (CR) is recognized as key enabler for next generation wireless networking: accessing the limited radio spectrum in an opportunistic manner allows secondary users to boost their transmission performance without interfering with existing primary networks. Full testing and experimenting with this paradigm, however, is still a tough task, given either the i) limited capabilities above the PHY layer of cheap SDR solutions, or the ii) heavy investment required for setting up multi-node testbeds powered by FPGAs. In this demo we show how we leveraged our Wireless MAC Processor architecture to tackle the two issues at the same time, providing a highly reconfigurable cognitive solution for wireless local area networks on top of commercial off-the-shelf (COTS) 802.11 devices. We demonstrate a typical CR use case where local and network-wide cognitive loops interact for configuring secondary users real time channel switching in reaction to channel state mutation. We also prove the flexibility of our Wireless MAC Processor (WMP) architecture for extensive testing of the CR paradigm.

- Gallo, P. ; Garlisi, D. ; Giuliano, F. ; Gringoli, F. ; Tinnirello, I. ; Bianchi, G. *Wireless MAC Processor Networking: A Control Architecture for Expressing and Implementing High-Level Adaptation Policies in WLANs*, IEEE Vehicular Technology Magazine, Dec 2013, volume: 8, issue:4, pages: 81 - 89

The current proliferation of unplanned wireless local area networks (WLANs) is creating the need for implementing different adaptation strategies to improve network performance under mutating and evolving interference scenarios. In this article, we envision a new solution for expressing and implementing high-level adaptation policies in WLANs, in contrast to the current approaches based on vendor-specific implementations. We exploit the hardware abstrac-

tion interface recently proposed by the wireless medium access control (MAC) processor (WMP) architecture and some flow-control concepts similar to the Openflow model for defining MAC adaptation policies. A simple control architecture for disseminating and activating new policies among multiple nodes is validated in an experimental testbed.

Gallo, P., Garlisi, D., Giuliano, F., Gringoli, F., Tinnirello, I., Bianchi, G. *Control Architecture for Wireless MAC Processor Networking*, Future Network & Mobile Summit 2013, Lisbon

In these years, the proliferation of unplanned WLANs is creating the need of implementing different adaptation strategies for improving the network performance under mutating and evolving interference scenarios. Many vendors propose undisclosed MAC/PHY optimization solutions, such as ambient noise immunity schemes, dynamic tuning of operating channels and contention parameters, etc., relying on low-level implementations in the card hardware/firmware. In this paper we envision a new solution for expressing and implementing high-level adaptation policies in WLANs, in contrast to the current approaches based on vendor-specific implementations. We exploit the hardware abstraction interface recently proposed by the Wireless MAC Processor (WMP) architecture, and some flow-control concepts similar to the Openflow model for defining MAC adaptation policies. A simple control architecture for disseminating and activating new policies among multiple nodes is validated in an experimental testbed.

Bianchi, G; Gallo, P; Garlisi, D; Giuliano, F; Gringoli, F; Tinnirello, I *Deploying Virtual MAC Protocols Over a Shared Access Infrastructure Using MAClets*, INFOCOM 2013 (TORINO)

Network virtualization has been extensively researched in the last years as a key enabler for improving the network performance. However, virtualization in wireless networks pose some unique challenges: first, the usual over-provisioning approach for providing isolation between multiple virtual entities is not viable; second, the partitioning criteria are often ambiguous, since the actual resources perceived by each entity depend on many external (and time-varying) factors. In this demo, we show an effective virtualization solution for wireless local area networks, solving the problem of isolation and flexible resource partitioning, based on the concept

of MAClets. MAClets are software programs uploaded and executed on-demand over wireless cards, and devised to change the card's real-time medium access operation. MAClets can be directly conveyed within data packets and executed on hard-coded devices acting as virtual MAC machines. A multi-operator virtualization experiment involving the distribution of MAClets within data packets, and their execution over commodity WLAN cards, shows the flexibility and viability of the proposed concept.

Gallo, P; Garlisi, D; Giuliano, F; Gringoli, F; Tinnirello, I *WMPS: A Positioning System for localizing legacy 802.11 devices*, IEEK Transactions on Smart Processing and Computing (KR) - IEEK Transactions on Smart Processing and Computing Vol.1, October,2 2012

The huge success of location-aware applications calls for the quick development of a positioning system alternative to GPS for indoor localization based on existing technologies such as 802.11 wireless networks. In this paper we propose WMPS, the Wireless MAC Processor Positioning System, that is a localization system running on off-the-shelf 802.11 Access Points and based on time-of-flight ranging of users' standard terminals. We prove through extensive experiments that propagation delays can be measured with the accuracy required by indoor applications despite the different noise components that can affect the result, like latencies of the hardware transceivers, multi-path, ACK jitters and timer quantization. Key to our solution is the choice of the Wireless MAC Processor architecture that enables a straightforward implementation of the ranging subsystem directly inside commercial cards without affecting the basic DCF channel access algorithm. On top of the proposed measurement framework, we develop a simple and effective localization algorithm able to work without requiring any preliminary calibration or device characterization. Finally, our architecture allows to adjust the measurement methodology as a function of the network load or propagation environments at run time, without requiring any firmware update.

G. Bianchi , P. Gallo, D. Garlisi, F. Giuliano, F. Gringoli, I. Tinnirello, *MAClets: Active MAC Protocols over Hard-Coded Devices*, ACM CoNEXT 2012, Nice (FR).

We introduce MAClets, software programs uploaded and executed on-demand over wireless cards, and devised to change the card's

real-time medium access control operation. MAClets permit seamless reconfiguration of the MAC stack, so as to adapt it to mutated context and spectrum conditions and perform tailored performance optimizations hardly accountable by an once-for-all protocol stack design. Following traditional active networking principles, MAClets can be directly conveyed within data packets and executed on hard-coded devices acting as virtual MAC machines. Indeed, rather than executing a predefined protocol, we envision a new architecture for wireless cards based on a protocol interpreter (enabling code portability) and a powerful API. Experiments involving the distribution of MAClets within data packets, and their execution over commodity WLAN cards, show the flexibility and viability of the proposed concept.

- I. Tinnirello, G. Bianchi, P. Gallo, D. Garlisi, F. Giuliano, F. Gringoli - *Wireless MAC Processors: Programming MAC Protocols on Commodity Hardware*, IEEE INFOCOM 2012, Orlando (FL) - U.S.A.

Programmable wireless platforms aim at responding to the quest for wireless access flexibility and adaptability. This paper introduces the notion of *wireless MAC processors*. Instead of implementing a specific MAC protocol stack, Wireless MAC processors do support a set of Medium Access Control "commands" which can be run-time composed (programmed) through software-defined state machines, thus providing the desired MAC protocol operation. We clearly distinguish from related work in this area as, unlike other works which rely on dedicated DSPs or programmable hardware platforms, we experimentally prove the feasibility of the wireless MAC processor concept over ultra-cheap commodity WLAN hardware cards. Specifically, we re-flash the firmware of the commercial Broadcom AirForce54G off-the-shelf chipset, replacing its 802.11 WLAN MAC protocol implementation with our proposed extended state machine execution engine. We prove the flexibility of the proposed approach through three use-case implementation examples.

- D. Garlisi, F. Gringoli, P. Gallo, F. Giuliano, S. Mangione - *MAC-Engine: a new architecture for executing MAC algorithms on commodity WiFi hardware*, WINTECH 2011 Workshop - Las Vegas (NV) - U.S.A.

In this demo, we prove that the flexibility supported by off the shelf

IEEE 802.11 hardware can be significantly extended if we move the control of the MAC programming interface from the driver to the firmware, i.e. from the host CPU to the card CPU. To this purpose, we introduce the concept of MAC-Engine, that is an executor of Programmable Finite State Machines (PFSM) implemented at the firmware level: we show how the card itself can support different protocol logics thanks to PFSM bytecode representations that can be dynamically injected inside the card memory at run-time without incurring in down time issues or network disconnect events. We provide different PFSM examples in order to test the functional thoroughness of the programming interface provided by the MAC-Engine architecture. Finally, we introduce an experimental PFSM development framework, that can translate a graphical PFSM representation into an optimized bytecode.

DEMO

- Jun 2011** *MedHocNet 2011, Favignana (TP), Italy, Jun. 14, 2011.* This demo proved some use-case examples of programmable commodity cards, that shows flexibility of MAC protocol implementation by programmable State Machine Engine Executor.
- Sept 2011** *WINTECH 2011 Workshop, Las Vegas (NV), USA, Sept. 19, 2011.* The Demo consist of a creation, execution and switching of State Machine MAC. The logic of MAC is injected by an application software that fetch and execute the bytecode of the finite state machine. In the demo is also shown real time MAC operating mode switching with a time based proof by packet transmission in wireless communication channel.
- Jan 2012** *Italian Network Workshop 2012, Courmayeur (AO), Italy, Jan. 11, 2012.* Programmable wireless platforms aim at responding to the quest for wireless access flexibility and adaptability. This demo introduces the notion of wireless MAC processors. Instead of implementing a specific MAC protocol stack, Wireless MAC processors do support a set of Medium Access Control "commands" which can be run-time composed (programmed) through software-defined state machines, thus providing the desired MAC protocol operation. We clearly distinguish from related work in this area as, unlike other works which rely on dedicated DSPs or programmable hardware platforms, we experimentally prove the feasibility of the wireless MAC processor concept over ultra-cheap commodity WLAN hardware cards. Specifically, we re-flash the firmware of the commercial Broadcom AirForce54G off-the-shelf chipset, replacing its 802.11 WLAN MAC protocol implementation with our proposed extended

state machine execution engine. We prove the flexibility of the proposed approach through three use-case implementation examples.

Sept 2012 *WiFi World Summit 2012, Barcelona, Spain, Sept. 11, 2012.*
An Exhibition where is described both technical aspect and a development kit of Wireless MAC processor.

TUTORIAL

Aug 2012 *Programmability in Wireless Network – ACM SIGCOMM 2012, Helsinki, Finland, Aug. 17, 2012.*

This tutorial explain the importance of programmability of wireless networks for R&D showing the limitations of current State of the Art. We describe an architecture description, differences to state of the art and new programmability potential. WMP Machine language is described as a Finite State Machine builder (XFSM). Also we show some Programmability illustration examples:

- standard DCF and minor variations
- Implementation of new MACs on commodity hardware
- Time-Division-Multiple-Access
- Multi-Channel MAC

A prove of effective functioning of Wireless MAC processor we developed many software tools to test behaviors of designed MAC verified by tracing throughputs from the user-space and more tests capturing and displaying signals with USRP hardware.

COMPUTER SKILLS **Operating systems** Advanced experience with the most flavors of Linux, Ubuntu, Debian, Slackware.

Programming, scripting and markup languages Python, Bash, PHP, \LaTeX , HTML, CSS. Matlab, C, C++, Java, Assembly.

LANGUAGE SKILLS

Italian: Native tongue

English: Level B1/B2