Funded by the Erasmus+ Programme of the European Union

**Project title**: Coordinated Frequency Allocation Problem in WiFi Networks

**Number of students** (minimum 2)**:** 3-4

**Project duration** (1-6 months): 6

**Project frame** (Bachelor/Master, small project): Bachelor and master

**Background:**

A WiFi network is managed by an access point (AP) which selects a single operating frequency among several possible frequencies. Nowadays, due to the extremely saturated condition of the WiFi frequencies, correct selection of this operating frequency becomes very important for the performance of the WiFi network. This problem is called the Frequency allocation problem (FAP) and a classical wireless communication problem. In FAP, a limited number of frequencies are asked to be assigned to a given set of AP’s operating in the same vicinity where no APs that are in range of each other should be allocated to the same frequency to avoid interference between them. AirTies AP’s manage their operating frequencies based on the current and past interference level of each potential frequency. However, in case where there are many AirTies AP’s operating in the same vicinity such a greedy frequency allocation schemes will lead to sub optimal solutions. Instead, a centralized global frequency selection method is required.

**The challenge:**

In this project, you are expected to work on the FAP problem in 802.11 wireless LAN (WLAN’s) operating in the 5 GHz band utilizing the IEEE 802.11n and IEEE 802.11ac standards. FAP is at its core, a generalization of the graph colouring problem and therefore known to be an NP-hard problem. Hence, finding an analytical solution to this problem is extremely difficult if not outright impossible. Instead, heuristic algorithms are being developed to find good local optimal solutions given the network topology. FAP has been studied extensively for the last several decades with heuristics for different special conditions. For the specific case of FAP in 802.11 WLANs again a variety of solutions have been proposed in the academic literature as explained in **[1]**. However, all of these solutions are specific for the 802.11 standards that work in the 2.4 GHz frequency band (i.e., 802.11b, 802.11g, and 2.4 GHz version of 802.11n) which do not take into consideration some key features that only exist in the 802.11 standards that work in the 5 GHz frequency band such as dynamic channel bandwidth and dynamic frequency selection (DFS) channels.

The assignment comprises the following subtasks:

* Understand the FAP under the context of 2.4 GHz and 5 GHz bands by learning the basic physical and data link layer components of the 802.11 protocol stack **[2, 3, 4]**.
* Develop an efficient heuristic for the FAP problem in 802.11 WLANs operating in the 5 GHz band considering these 5 GHz-band-specific features (i.e., dynamic channel bandwidth and DFS channels)
* By implementing the developed heuristic, show the results of your heuristic in several small to medium sized AP topologies.

**The company:**

Founded in 2004, AirTies is the most widely deployed provider of smart Wi-Fi solutions to service providers around the globe. AirTies provides broadband operators with a full portfolio of advanced Wi-Fi solutions, including Mesh software for gateway enhancement, extenders, set-top boxes, apps and cloud-based performance monitoring & real-time troubleshooting tool that enables ISPs to provide a managed Wi-Fi Mesh solution for their subscribers. AirTies technologies are powering more than 25 million homes worldwide and our customers include AT&T, Deutsche Telekom, Singtel, Sky, EyeNetworks, Orange España, WAOO, SMINN and many others.

Number of employees: >200

Head quarter: Istanbul

Further locations: Izmir, London, Paris, Austin – USA

**Supervisor:**

Mehmet Şükrü Kuran (sukru.kuran@airties.com) is a senior research engineer at AirTies. He received his M.S. degree in Systems and Control Engineering, and Ph.D. degree in Computer Engineering from Bogazici University, Turkey in 2007 and 2012 respectively. After graduation he has worked in academia, mainly focusing on telecommunication and networking, in LINCS research centre at Telecom ParisTech, France and in Computer Engineering Department of Abdullah Gul University, Turkey as an assistant professor. He has joined AirTies in mid 2018 where he is responsible for designing and developing advanced features to AirTies wireless networking products.

**Candidate background:**

The candidates ideally should be composed of 1 M.S. or Ph.D. student and 2-3 B.Sc. student having one of the following subjects: computer science, computer engineering, industrial engineering, electronical engineering. The candidates can divide the challenge based on the specific components of the project: 1 WiFi specialist (B.Sc. level), 1 optimization and modelling specialist (B.Sc. level), and 1 telecommunication and networking researcher (M.S. or Ph.D. level).

The candidates should have experience in

* Work with virtual teams
* Coding

WiFi experience including

* Basic knowledge with computer networking
* Basic knowledge with wireless communication
* First experience with Linux/Unix bash script

Optimization and modelling experience including

* Advanced knowledge with modelling and optimization
* Basic experience with the CPLEX optimization software package

Telecommunication and Networking researcher experience including

* Conducting academic research
* Basic-to-advanced knowledge with Graph theory
* Designing algorithms

**References and complementary description:**

**[1]**: “Channel Assignment Schemes for Infrastructure-based 802.11 WLANs: A Survey,” S. Chieochan, E. Hossain, and J. Diamond, IEEE Communications Surveys and Tutorials, 2010.
**[2]**: “802.11 Wireless Networks: The Definitive Guide,” M. S. Gast, 2nd Edition, O’Reilly 2005.
**[3]**: “802.11n A Survival Guide: Wi-Fi Above 100 Mbps,” M. S. Gast, 1st Edition, O’Reilly 2012.
**[4]**: “802.11ac A Survival Guide: Wi-Fi at Gigabit and Beyond,” M. S. Gast, 1st Edition, O’Reilly 2013.