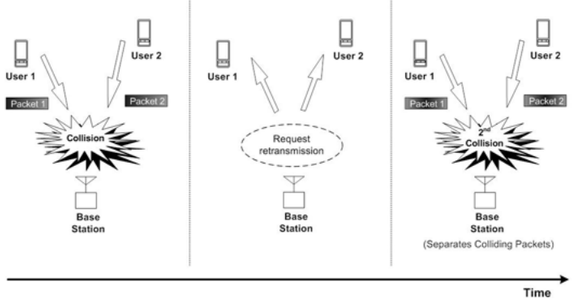
Advanced PHY/MAC Design for Infrastructure-less Networks

The main goal of the project was to investigate if the theoretical capacity of Infrastructure-Less Wireless Networks could be achieved by practical communication systems and evaluate how far an optimized solution is from the theoretical capacity bound. It was an intention of the project to propose an architecture for each node based on a cross-layering design between the physical and the MAC sub-layer.



Main Project Team	
Nuno Manuel Branco Souto	**(Local Coordinator) RS-Lx**
Atílio Manuel da Silva Gameiro	RS-Lx
Rui Miguel Henriques Dias Morgado Dinis	RS-Lx
Rodolfo Alexandre Duarte Oliveira	RS-Lx
Funding Agencies	
FCT-PTDC	**100,358€**
Start Date	01/07/2013
Ending Date	31/12/2015
Indicators	
Journal Papers	25
Conference Papers	53
Concluded PhD	2
Concluded MSc	9

Two Main Publications

M. P. Pereira, L. Bernardo, R. Dinis, R. Oliveira, P. Carvalho, P. Pinto, **Optimization of a p-persistent Network Diversity Multiple Access Protocol for a SC-FDE System**, IEEE Transactions on Wireless Communications, Vol. 12, No. 12, pp. 5953 - 5965, December, 2013

N. S. Souto, R. Dinis, A. Correia, C. Reis, **Interference Aware Iterative Block Decision Feedback Equalizer for Single Carrier Transmission**, IEEE Transactions on Vehicular Technology, Vol. 64, No. 7, pp. 3316 - 3321, July, 2015

PROJECT WEBPAGE URL

https://www.it.pt/Projects/Index/1845

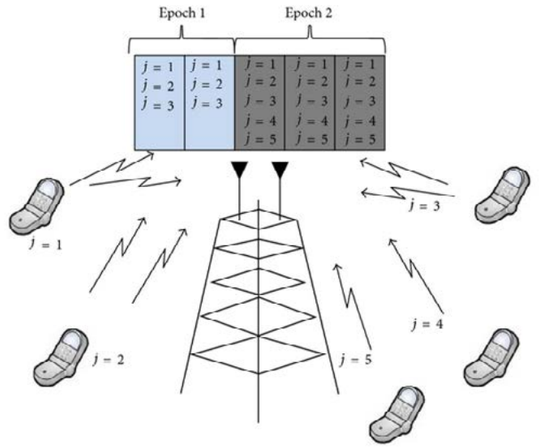


Fig. 1 Random-access network assisted by retransmission diversity and multipacket reception.

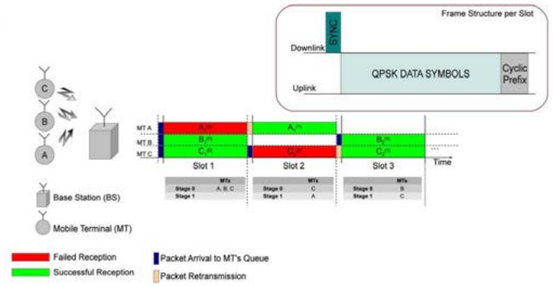


Fig. 2 PC ARQ prefix-assisted DS-CDMA Reception scheme example and frame structure per slot.

GENERAL MOTIVATION AND OBJECTIVES

It is well known that the capacity of Infrastructure-Less Wireless Networks (ILWNs) can be surprising low, namely for the case of multi-pair unicasts. However, several innovative radio technologies developed in the last years, including Multi-Packet Reception (MPR), Interference Cancellation (IC), PHY-cooperation, Retransmission Diversity (CRD) and Adaptive Modulation (AM) were shown to increase ILWNs' capacity. While this observation was already validated by several works, none of the works had adopted a physical layer integration of MPR, IC CRD, and AM. Moreover, these works did not study the impacts of the techniques used in the physical layer at the MAC layer, and vice-versa.

The main goal of the project was to investigate if the theoretical capacity of ILWNs could be achieved by practical communication systems, or at least evaluate how far an optimized solution, such as the one proposed in the project, is from the theoretical capacity bound. It was an intention of the project to propose an architecture for each node based on a cross-layering design between the physical and the MAC sub-layer. The PHY-MAC architecture design should be defined in order to coordinate and optimize the different radio technologies and node's medium access, in a decentralized way.

CHALLENGE

This project aimed to integrate MPR, IC CRD, and AM technologies into a single architecture particularly tailored for Infrastructure-Less Wireless Networks (ILWNs), which is itself a challenging task due to the lack of a central coordinator and to the spatial distribution of the nodes.

The IT research team combined physical layer and data link layer researchers, to address both issues in an integrated, cross-layered approach. The physical layer team was responsible for the design of the architecture and the modelling of the physical systems. The data link layer team was responsible for the design of the proposed PHY-MAC architecture. The project involved a substantial interaction between all team members since the MAC layer ran on top of the MPR physical layer.

WORK DESCRIPTION AND ACHIEVEMENTS

During the course of project ADIN all the planned objectives were accomplishes, among which we highlight the following:

· An architecture for nodes in a infrastructure-less wireless network (ILWN) based on a cross-layering design between the physical and the MAC sub-layer was proposed and evaluated.

· Several radio systems were characterized and evaluated in the framework of ILWNs.

· Interference models for the different technologies considered for integration into the ILWN architecture were developed and evaluated for several scenarios.

· Decentralized energy-based localization schemes using different optimization techniques were studied and used for the design of practical interference estimation methods.

· Following a decentralized approach, an optimized MAC scheme was proposed for ILWNs

· Joint MAC-PHY MPR schemes were studied considering: diversity combining, different access schemes and multipath dispersive channels.

· Software packages were implemented for simulation and evaluation of MPR schemes and the PHY/MAC cross-layer architecture, in single-hop and multi-hop network scenarios.