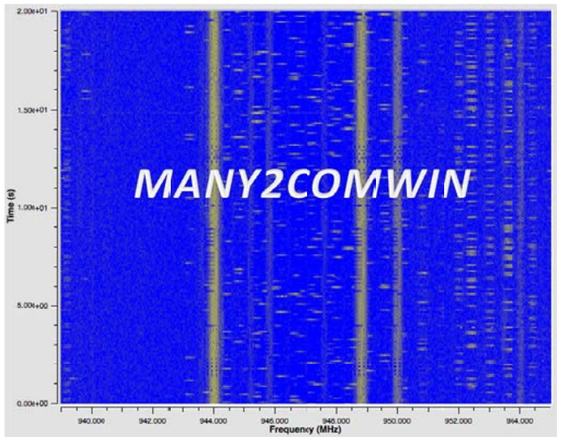
MANY2COMWIN

Many-to-Many Communication Architectures for Wireless Networks

MANY2COMWIN explored the role of innovative techniques to facilitate many-to-one (M2O) and many-to-many (M2M) communications in distributed wireless networks. Adopting multiple techniques already proposed for the physical layer of wireless systems, the project characterized the performance of a cross-layer design able to support M2O and M2M communications without the need of a central coordinator.



Main Project Team

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Funding Agencies

Fundação para a Ciência e a Tecnologia	**25,506€**
Start Date	01/04/2014
Ending Date	31/07/2015

Indicators

Journal Papers	6
Conference Papers	16
Patents	1
Concluded PhD	1
Concluded MSc	5

Two Main Publications

L. Irio, R. Oliveira, L. Bernardo, **Aggregate Interference in Random Waypoint Mobile Network**s, IEEE Communications Letters, Vol. 19, No. 6, pp. 1021 - 1024, June, 2015

F. Ganhão, L. Bernardo, R. Dinis, R. Oliveira, P. Pinto, **Uplink Performance Evaluation of Packet Combining ARQ for MPR Prefix-Assisted DS-CDMA**, IEEE Transactions on Communications, Vol. 63, No. 7, pp. 2685 - 2697, July, 2015 no. 8, pp. 1214-1225, Aug. 2011

PROJECT WEBPAGE URL

http://tele1.dee.fct.unl.pt/projects/many2comwin/web/default.html

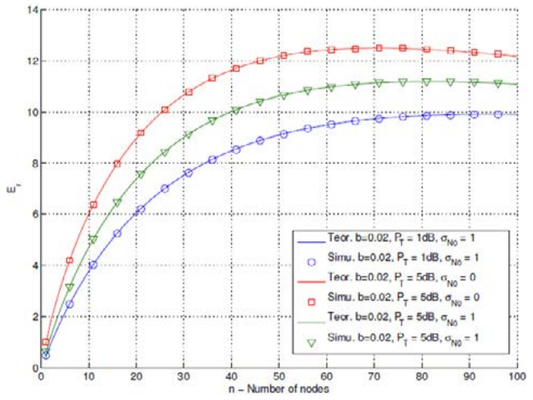

Fig. 1 M2O physical-layer model: average number of packets successfully received (Er) when n nodes simultaneously transmit.

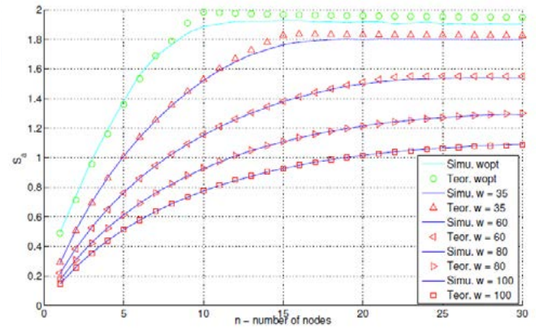

Fig. 2 Throughput evaluation of multiple parameterizations of the proposed M2O MAC protocol for different number of competing nodes.

GENERAL MOTIVATION AND OBJECTIVES

The traditional one-to-one (O2O) communication approach implemented today in most of wireless communication systems considers that if one or more transmitted signals interfere with a received one they are treated as noise. Contrarily, the capability of decoding multiple packets in the receiver (a many-to-one (M2O) approach), which were transmitted at the same time from different sources, is known to increase the throughput capacity of wireless networks. M2O demands for new scheduling policies able to combine the signals from different sources in an efficient way, rather than avoiding interference. However, the M2O approach is inherently restricted to the uplink. To overcome M2O's downlink communications inability, multi-packet receptions and multi-packet transmissions can be considered as occurring simultaneously. Such an approach greatly increases the capacity of wireless networks, and is referred to as a many-to-many (M2M) wireless communication system. But M2M requires a more complex transmission scheduling scheme than M2O's approach, demanding for novel communication architectures where the uplink requests are scheduled to avoid interference between multiple M2O communications and to maximize M2O MPR's capability.

CHALLENGE

MANY2COMWIN investigated efficient architectures to support M2O and M2M communications in wireless networks. Following recent advances in full-duplex radios operating in a single frequency channel, MANY2COMWIN defined a first principles approach to the design of M2M communication architectures addressing fundamental challenges that were not considered so far, including the lack of a central coordinator and the influence of the spatial distribution of the nodes in a multi-hop scenario.

WORK DESCRIPTION AND ACHIEVEMENTS

The IT team provided answers to the three pillars described in the original proposal. Within the first pillar the team created a M2O model able to describe the behavior of different physical layer technologies implementing wireless multi-packet reception schemes. The work included a model the interference perceived by a receiver when multiple mobile or non-mobile nodes communicate in a M2O way. Regarding the integration of full-duplex techniques in the wireless receivers, the research team derived a full-duplex model able to characterize a multitude of different interference cancelers, having characterized the distribution of the residual interference. Within the second pillar, different types of M2O medium access protocols were proposed and evaluated, which encompassed a first attempt to architect decentralized management policies able to be adopted in infrastructureless networks. Several approaches were studied and formally characterized and/or simulated. To support the advertisement of M2O communication pairs avoiding a common control channel, the IT team investigated the use of a split-phase operation mode, where the M2O pairs are firstly advertised in a first stage and then the nodes may communicate in a second stage. While not requiring a common control channel, which is an important feature because the nodes may operate with a single radio, the protocol was also optimized and designed to support M2M communications, which was the third and last pillar of the project. M2M communications may then be achieved by selecting the pairs of nodes able to communicate in a M2O manner, which is particularly simple and effective to be implemented in a distributed way. Finally, the proposed architecture was evaluated in different scenarios, from centralized ones (e.g. cellular networks) to completely distributed ones, including multi-hop communications.