



**TÉCNICO**  
LISBOA

**Appraisal**

**of**

**Energy-Efficient Resource Allocation  
in OFDM Systems with  
Computational Awareness**

**by**

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**submitted to**

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## Analysis of the Manuscript

- Title
  - It fits the contents of the work.
- Abstract
  - It captures the essence of the work and highlights the key contributions.
- Table of Contents / Structure
  - Chapters have a balanced structure.
  - The sequence of the chapters is appropriate.
  - The structure enables to easily capture the state of the art in the area of the dissertation and its novel aspects.
- Lists
  - Major Lists are included.
  - A List of Symbols should have been included.
- *Introduction*
  - Introduction to the area of the dissertation is adequate.
  - A clear motivation for the study undertaken in the dissertation is presented and objectives are clearly listed.
  - Goals are clearly established and of value.
  - The novelty of the dissertation is explicitly addressed, indicating which are the key contributions.
  - It includes the structure and contents of the dissertation.
  - It lists the publications of the author.
- *1. Energy-Efficient Resource Allocation*
  - This chapter presents a brief introduction to the problem of energy-efficient resource allocation in OFDM/OFDMA based wireless communication systems, with the basic aspects from the system viewpoint as well as those related to obtaining a solution to the mathematical problem.
  - References should have been included in the first part of the chapter, where an introduction to the problem is presented.

- It addresses the key aspects of the system problem, i.e., estimation of data rates and of power consumption, presenting a valuable analysis of the trade-off between complexity and accuracy, and including a comparison of pros and cons.
  - In addition, it presents a comparison of methods to solve the optimisation problem.
  - The chapter is properly structured, presenting the information with the adequate level.
- *2. Single OFDM link flexibility for EE*
    - This chapter addresses the optimisation problem for a single user connected to a base station.
    - It starts by presenting the state of the art related to the problem at hands, which is presented in an adequate way.
    - The optimisation problem is clearly formulated, with clear and acceptable assumptions.
    - An algorithm is proposed to solve the optimisation problem, with a complexity analysis, which seems adequate, leading to good results.
    - Results are presented at the end of the chapter, for a given scenario, showing that the proposed algorithm overperforms the water-filling approach, which is the one taken for comparison.
    - The proposed approach is novel and of value.
    - The chapter could have been improved by supplying performance parameters for the proposed approach besides the number of iterations (e.g., running time and metrics for the comparison between approaches) and by presenting a more detailed analysis of results (e.g., providing an absolute and relative analysis).
  - *3. Energy efficiency in a multiuser OFDMA network*
    - This chapter extends the model proposed in the previous chapter to a multiuser framework.
    - The chapter is structured in the same way as the previous one, basically presenting the same good values as well as the same drawbacks.
  - *4. Energy efficiency in multiuser OFDMA relay networks*
    - This chapter extends the model proposed in the previous chapter to relay networks.
    - The chapter is structured in the same way as the previous one, basically presenting the same good values as well as the same drawbacks.

- 5. *Practical aspects of the energy-efficient resource allocation in OFDM/OFDMA links and networks*
  - This chapter provides an analysis of some of the problems occurring from an actual implementation of the proposed solutions and recommendations, which is of great value.
  - This chapter also addresses topics for future work.
- 6. *Conclusion*
  - Conclusions present the main results, but they have no numbers or trends, which they should.
  - The main results are correctly summarised.
- *References*
  - *Bibliography* should have been named as *References*.
  - A total of 114 references are presented, showing that a good survey of the literature has been conducted. However, only around 1/3 of the references are up to 5 years old.
  - References are given in a complete and coherent way.
- *Writing / Style*
  - There are several typos in the dissertation, reflecting some lack of care in the final editing of the manuscript and that a spelling processor hasn't been used.
  - The List of Acronyms doesn't have a uniform style in defining abbreviations, regarding the capitalisation of words.
  - English writing is good, but there are several errors in the construction of sentences. Also, there's a mixture of British and American spellings.
  - The writing style is adequate in general.
  - In general, all symbols are defined after they're introduced in equations, which is appropriate; however, many times their units are not presented, which makes it difficult to fully understand the equations.

### **Research Contributions**

- The dissertation addresses the problem of energy efficiency of Orthogonal Frequency Division Multiplexing based wireless communication systems. It proposes analytical models and algorithms to optimise the energy efficiency in a number of scenarios ranging

from a single user to multiple users in a network with relay base stations, based on computational awareness, i.e., signal processing power consumption and other computations are taken into account at both the transmitter and the receiver.

- The problem solved along the dissertation, for the various scenarios, is the calculation of data rates and powers consumption, hence, obtaining the energy efficiency, which is then optimised under several assumptions and constraints. The dissertation is structured in a way that there's an increasing complexity of the problem to be solved along the chapters.
- The dissertation explores new ideas and presents new results in its area of research. The candidate has developed models that are novel and of value.
- The dissertation uses real data from various sources, concerning networks and systems, which is of value and enables the application of the results to real scenarios.
- The dissertation deals with complex problems in communications systems and uses appropriate mathematical approaches to obtain the desired solutions.
- The research problem is clearly presented, timely and of value, especially given that analytical models are developed; it is well established, as are the objectives to be achieved.
- The review of literature and the state of the art is fairly up to date and comprehensive. Many of the key publications in the area are cited, and the relevant work developed by other authors in the area is properly acknowledged by the candidate.
- The list of publications is quite good: 5 papers in international journals and magazines (one of which in a high-rank journal - IEEE Transactions on Communications), plus 2 recently submitted, being the first author in 3 of them; 8 papers in international conferences (most of them in high-rank conferences), being the first author in 4 of them; 11 papers in national conferences, being the first author in 8 of them. Thus, one can state that the research work and the dissertation has already been adequately sustained in publications.
- My overall evaluation of this dissertation, based on the comments given in this appraisal, is that, despite of the minor flaws in the edition of the manuscript, it should be accepted for public defence.
- Furthermore, given the high quality of the research work, one should consider the possibility to award the distinction of the highest level.