

# INTRODUCTION

The growing demand for wireless data transmission imposes the search for alternatives to the current spectrum exploration schemes. In the long term, dynamic spectrum access seems to be the only viable solution, once the technical details for its implementation are solved. In the near term, the use of currently vacant spectrum allocated to TV broadcast is poised to alleviate the spectrum crunch while opening the path for dynamic spectrum access.

We strongly believe that presenting some of the aspects involved in the exploitation of White Spaces (WS) by a group of international experts can be useful to practitioners and regulators interested in the topic. The present work is comprised of independent pieces in which each of the authors express their own viewpoint on the matter (and not necessarily that of the organisation to which they belong). Authors from Africa, Europe, North and South America, delve into both advocacy and regulatory issues, as well as in the technical details of some of the standards envisioned for providing services over this portion of the air waves. Several measurements campaigns have shown that the TV broadcasting spectrum is mostly fallow in sparsely populated areas, specially in developing countries, for the simple reason that there is not enough return of the investment for the broadcasters to provide many simultaneous channels. On the other hand, these are precisely the areas in which Internet access is frequently lacking for the same reasons. White Spaces technology can take advantage of the improved propagation capabilities of these frequencies to provide affordable Internet access in rural areas.

Furthermore, spectrum holes are also present in densely populated areas as a consequence of the transition from analogue to digital TV, and these can be harnessed to address the requirements of wireless sensor networks. The lower frequencies as compared with the ones used for WiFi (which in some places is becoming too crowded), are less attenuated by the walls and offer an interesting alternative also for indoor Internet access, as well as for multimedia distribution.

WiFi has had an unexpected success in the traffic off-loading of cellular networks, so WS could also be deployed for this purpose.

Finally, for machine to machine applications and the "Internet of Things" paradigm WS have significant advantages both for developed and developing economies.

The first part of this booklet addresses the advocacy for White Spaces



exploitation and the pertinent regulatory issues from different perspectives, while the second part provides a glimpse about some of technicalities.

On the topic of advocacy for White Spaces:

Horvitz in chapter 2 discusses two different approaches about spectrum management, the use of a Geo-database or the unfettered access by cognitive radio techniques, with interesting historical and political insights.

Strużak and Więcek in chapter 3 draw from their vast experience in radio management to address the regulatory matters, from the international viewpoint, touching on the thorny issues of cross borders spectrum. A map of White Spaces availability in Poland is also presented.

Song in chapter 4 delves into the relevance of TV White Spaces with regards to development, assessing the relevance of unlicensed as compared with licensed spectrum.

Afonso in chapter 5 exposes the perspective from Brazil, a huge country that is becoming an important player in the technology field, providing also comparisons with the North American TV and cellular landscape.

Brown and Peha in chapter 6 present an innovative generalization of spectrum management by means of "Policy-Based Radios", driven by machine-readable documents that implement on the fly changeable rules on how to make an efficient use of the available spectrum.

Gomez in chapter 7 argues that more than a crowded spectrum we are stranded with inefficient ways of spectrum management for meeting the growing demand of wireless services.

Jensen in chapter 8 also draws from his experience in Africa and other developing countries to assess how White Spaces could be harnessed to foster connectivity.

Moving to the more technical aspects:

Crawford from Strathclyde University in chapter 9 presents the results of a White Spaces deployment in Scotland, in which the impact to and from digital TV transmission was carefully examined, quantifying the interference and the effects of the antenna height and location in the performance of both telecommunication systems.

Doyle in chapter 10, after discussing the Cognitive Radio, ponders about its usefulness for countries in Africa where there appear to be more cost effective solutions.

Woolhouse in chapter 11 explains that machine to machine communication, poised to play an ever increasing role according to most analysts, is constrained by the inadequacy of current protocols and exposes a brand new one, precisely tailored to the requirements of M2M, which is particularly fitted to the WS Spectrum.

Pietrosemoli in chapter 12 emphasizes the importance of Standards in wireless technologies and summarizes the more relevant ones pertaining

to WS.

Büttrich in chapter 13 makes a case for the use of green technologies, not only as the best suited to power telecommunications and networking equipment, but also as the most appropriate and sustainable source of energy for developing countries.

Zennaro and Arcia in chapter 14 show the results of spectrum occupancy campaigns conducted in several countries by means of low cost equipment that have already being instrumental in convincing regulators about the convenience of using TV WS to help alleviate the digital divide.

This is a work in progress, so we expect to be able to offer very soon a second edition of this work in which the results of some of the several pilots of WS deployments can be incorporated.