Measurement of the duty cycle of WLAN in different environments

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INTRODUCTION

Nowadays, Wireless Local Area Networks (WLANs) are commonly deployed in office buildings and at home. As a consequence, many people are exposed to the electromagnetic fields irradiated by these networks during long periods of time. Exposure assessment of WLAN using Wi-Fi is only rarely investigated. In a WLAN data packets are transmitted in bursts. According to international safety guidelines, the exposure is to be averaged over 6 min or 30 min time period. Hence, the correct assessment of the exposure requires the knowledge of the duty-cycle. The duty cycle can be measured using a spectrum analyzer (SA) in zero span. In this study, the duty cycle is measured in an office building and at a total of 151 locations in Belgium and the Netherlands.

MATERIALS AND METHODS

In an in-situ assessment of the exposure to radio-frequency electromagnetic fields, the SA often measures in max-hold mode until the signal stabilizes. In this way the maximum field level during the measurement time is determined. In a WLAN data is transmitted in bursts (packets, frames). Thus, the maximum field level measured with a SA in maximum-hold mode overestimates largely the time averaged field level. Therefore, the duty cycle must be taken into account. The following method to assess correctly Wi-Fi exposure is used [1]: first, the active WLAN channels are determined with a WLAN-packet analyzer. Secondly, a maximum-hold measurement of the electric field of the different channels is performed using a SA and a tri-axial measurement probe. Thirdly, the duty cycle of the active channels is determined. The duty cycle is also measured using the SA, but now the SA is set in zero-span mode. The different settings of the SA to correctly measure the duty cycle according to [1] are listed in Table 1. Finally, the total averaged field is determined from the duty cycle and the maximum-hold field strength as follows:

$$E_{\text{tot}}^{\text{avg}} = \sqrt{D} E_{\text{tot}}^{\text{max-hold}} \tag{1}$$

with D the measured duty cycle.

Table 1: Optimal SA settings for measuring correctly the duty cycle in a WLAN.

Parameter	**Value**
Span	0 MHz
Center frequency	Channel frequency
Detector	RMS
SWT (sweep time)	1 ms
RBW (resolution bandwidth)	1 MHz
VBW (video bandwidth)	10 MHz
Number of sweeps	2200

RESULTS

Figure 1 shows the cumulative distribution function (cdf) of the duty cycle measured at the UGent-INTEC / IBBT offices in Ghent, Belgium and the overall duty cycle measured during a large measurement campaign performed in Belgium and the Netherlands. Figure 1 shows the cumulative distribution function (cdf) of the duty-cycle. At the UGent-INTEC / IBBT offices, measurements were executed at 33 different locations spread over the whole building. The median or 50th percentile (p50) equals 2.5 % and the 95th percentile is 2.7 %. In the measurement campaign performed in Belgium and the Netherlands, the duty cycle was measured at 151 different locations. The median or 50th percentile (p50) equals 1.4 % and the 95th percentile is 11.1 %. These duty-cycles might be worst-case estimates.

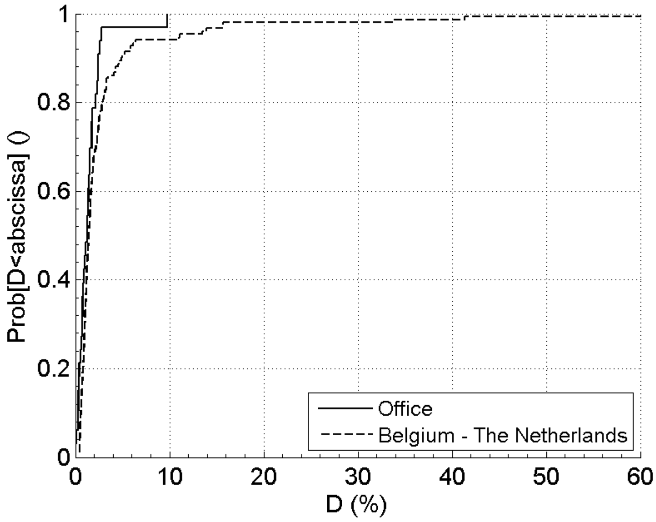

Figure 1: Cumulative distribution function (cdf) of the duty-cycle D measured at the UGent-INTEC / IBBT office building and in 151 locations spread over Belgium and the Netherlands.

CONCLUSIONS

The duty cycle has been measured in different environments using a spectrum analyzer in zero-span mode. In an office building the 50^{th} percentile of the duty cycle in a WLAN equals 2.5 %. In measurements performed in Belgium and the Netherlands the 50^{th} percentile of the overall duty cycle equaled 1.4 %.

REFERENCES

[1] Verloock L, Joseph W, Vermeeren G, and Martens L. Procedure for assessment of general public exposure from WLAN in offices and in wireless sensor network testbed. Health Physics 98:628-638, 2010.

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