# Assessment of Mobile WiMAX Exposure in an urban environment

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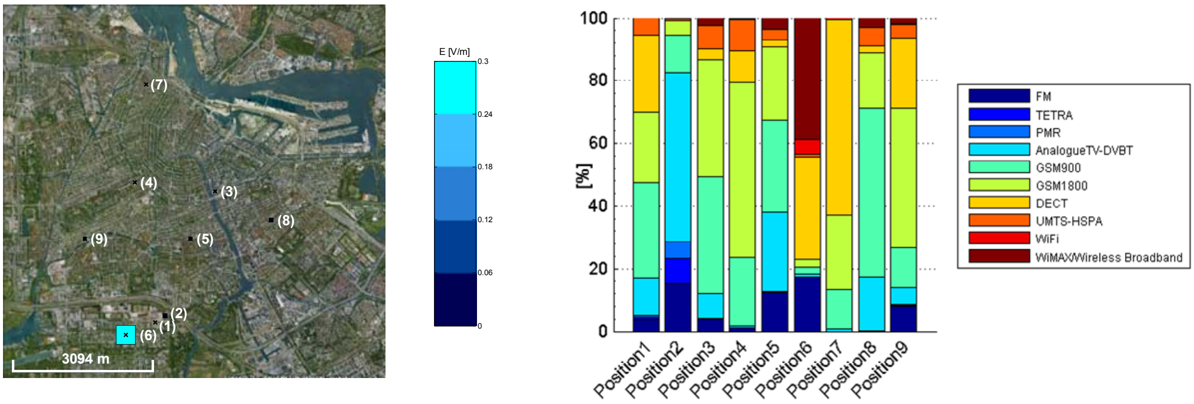
## INTRODUCTION

There is a priority in the research agenda of WHO to assess the typical range of exposures from emerging wireless network technologies such as WiMAX (Worldwide Interoperability for Microwave Access), HSPA (High Speed Packet Access), and LTE (Long Term Evolution) for common locations (outside public areas, within buildings, homes, etc.) [1].
In this paper a methodology to determine in-situ electromagnetic-field exposure of the general public to Mobile WiMAX (IEEE 802.16e [2]) will be presented. Narrowband measurements with spectrum analyser (SA) and measurement probe are performed in an urban environment in Amsterdam (the Netherlands). Optimal settings for the measurement equipment (sweep time, resolution bandwidth, etc.) are investigated and selected. Exposure contributions due to different radio-frequency (RF) sources are compared with mobile WiMAX exposure.

## MATERIALS AND METHODS

The narrowband measurements were performed in an urban environment in Amsterdam, the Netherlands, in February 2010. At each location, the frequency spectrum in the range of 80 MHz up to 6 GHz was measured. Current wireless sources are mainly operating in this frequency range. Based on this spectrum overview only the most dominant signals were measured more in detail. The main focus of this study lies on the exposure due to signals from GSM, UMTS, HSPA, LTE, and WiMAX. If present FM, DAB, DVB, etc. signals were measured. In Amsterdam, 15 mobile WiMAX channels are currently present in the frequency band 3500 – 3580 MHz. The bandwidth of these 802.16e channels was 10 MHz.
At nine different locations, narrowband SA measurements were executed. The measurement locations are indicated in Fig. 1 (a). These locations are randomly selected, spread over Amsterdam. Positions 2 – 5, 7, 8, and 9 are outdoor locations, while positions 1 and 6 are indoor locations.
The measurement setup consisted of a tri-axial R&S TS-EMF Isotropic Antenna in combination with a SA of type R&S FSL6 (frequency range of 9 kHz – 6 GHz). If SA-settings are discussed in literature, almost never all parameters (and certainly not the sweep time) are discussed or only vaguely specified. These settings have a huge influence on the measurement results and it is very important to specify these [3]. To check compliance of Mobile WiMAX signals with the ICNIRP guidelines, the method of [3] is used, After some investigations, we obtained the following optimal settings to perform exposure assessment of Mobile WiMAX: *RMS (root-mean-square) detector, resolution bandwidth RBW = 1 MHz, sweep time SWT = 0.8 s (or longer), frequency span of 100 MHz.*




(a) (b)

Figure 1: (a) indication of the measured electric-field strength due to mobile WiMAX on the map of the urban environment Amsterdam and (b) percentages of power density contributions of the different signals.

## RESULTS

The measured electric-field values in Amsterdam satisfy the ICNIRP guidelines. The maximal cumulative value was measured at position 2 and equals 1.28 V/m. This value is 25 times below the ICNIRP guidelines. The maximal value at this position was mainly due to the DVB-T signal (0.94 V/m, Fig 1 (b)), caused by a near broadcast transmitter.

The highest mean values were measured for the GSM signals (0.19 V/m for GSM900 and GSM1800). For the WiMAX signal the maximal value for the electric field was measured at position 6 and equals 0.28 V/m (Fig. 1 (a)). The mean value of the WiMAX exposure equals 0.06 V/m.

Fig. 1 (b) shows the power density contribution [%] of each signal at the nine different measurement locations. At each position the contribution is mainly due to the GSM, UMTS-HSPA, and WiMAX signals (except positions 2 and 7). The average contribution of the cumulative value of these signals equals 57.72 %. The highest average contributions are due to the GSM900 and GSM1800 signal, respectively 23.57 % and 25.83 %.

The average contribution of the WiMAX signal equals 5.52 %, the maximum contribution 38.85 % (indoor cell). This signal was measured at all the different locations except at positions 1 and 7. At these positions the WiMAX signal was below the sensitivity of the measurement system.

## CONCLUSIONS

A method to assess in-situ mobile WiMAX exposure is presented and settings for the measurement equipment are proposed. The measured electric-field values in Amsterdam satisfy the ICNIRP guidelines. At each position the contribution is mainly due to the GSM and UMTS-HSPA signals. The contribution of mobile WiMAX is 5.5 % on average.


## ACKNOWLEDGMENTS

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