

# Indoor localization with UMTS compared to WLAN

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## ABSTRACT

RF-Fingerprinting for indoor localisation has frequently been investigated in wireless IEEE802.x based systems such as WLAN. RF-Fingerprinting in cellular systems such as UMTS have rather been analysed in outdoor environments to support poor GPS signals.

With the availability of FEMTO-NodeBs for indoor coverage, UMTS based RF-Fingerprinting could be an alternative or complementary to a WLAN based solution using smartphones to display location information.

The objective of this research is to compare the accuracy in location estimation which can be achieved in an indoor-scenario for WLAN and UMTS using various metrics and distance criteria.

The research was done in a 20mx15m office environment, using 4 FEMTO-NodeBs and 4 WLAN-APs. To create the radio map, fingerprints were taken with a 1m resolution. For location estimation a deterministic approach using Euclidean Distance norm with a WKNN algorithm was used based on RSSI and AP-visibility as metrics. As a probabilistic approach a histogram comparison method has been applied using Kullback-Leibler-Divergence as a distance norm with an exponential kernel.

The accuracy based on the metric visibility was 8m for WLAN and 6m for UMTS at 80% confidence level. In both cases a visibility threshold needed to be calibrated in order to optimise the performance. Using RSSI as a metric the accuracy in the WLAN environment turned out to be 7m with Euclidean distance and 4.5m using KL-Divergence, while we achieved with UMTS 5.5m and 7.5m under identical circumstances.

It is shown, that the accuracy in Indoor-RF-Fingerprinting in UMTS is comparable to the accuracy in a WLAN-Testbed. Signal visibility is an alternative metric to RSSI for interference limited systems, such as UMTS. For UMTS Euclidean distance is outperforming KL-Divergence due to its signal characteristics. For WLAN KL-Divergence is outperforming an WKNN approach with Euclidean Distance in case of slow moving users with a sufficient sampling rate.

**KEYWORDS:** RF Fingerprinting, UMTS, Femto Cells, Indoor Localisation, KL-Divergence, WKNN