Optimisation of Base Station Placement for Indoor Wireless Communications

Liza Pujji

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Abstract

The development of wireless communication systems has enabled 'anywhere, anytime' communication and significantly influenced the working habits of the people in modern society. Engineers responsible for deploying base stations in wireless systems face opposing constraints of maximising the quality and capacity of the system while minimising the interference and cost. In addition, indoor wireless systems must cope with three-dimensional variations in signal strength and limitations in site selection. Consequently, the indoor Base Station Placement (BSP) problem becomes a multi-objective, multi-dimensional optimisation problem. This thesis investigates the BSP problem for indoor wireless communication systems by using mathematical models and optimisation algorithms and considering the effect of several factors on BSP.

Researchers have proposed a number of algorithms to find the optimal solution for the BSP problem. In this thesis, some proposed algorithms are compared to identify the most appropriate algorithm to solve the indoor BSP problem. Based on the advantages and disadvantages of the existing algorithms, a novel hybrid algorithm is developed and its performance is compared to the existing algorithms. It is seen that the proposed hybrid algorithm provides optimal deployments, without significantly compromising accuracy and efficiency.

Although there are several factors that can affect BSP in indoor wireless systems, the effects of three factors, namely call traffic variability, user mobility and call switching technologies on BSP are investigated. Two options are considered for each factor — call traffic can be static or dynamic, users can be fixed or moving and call switching technology can be circuit or packet switched. It is seen that dynamic call traffic, user mobility and circuit switched traffic must be considered in order to identify the optimal BSP. In addition, the BSP problem is extended to multi-floored buildings by considering internal and external potential base station sites. It is seen that the vertically aligned internal base station sites achieve the least call failure rate.

The results obtained from this thesis are intended to provide a practical and useful framework for solving the BSP problem of indoor wireless communication systems.

Dedication

To my grandparents, parents and brother,
who have always encouraged me and given me unfailing love, support and guidance.

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Glossary

Abbreviations and Acronyms

BFS	Brute Force Search
CAC	Call Admission Control
CBR	Constant-Bit-Rate
CDMA	Code Division Multiple Access
CIR	Carrier-to-Interference Ratio
D/F/C	Dynamic traffic/ Fixed users/ Circuit switched calls
D/M/C	Dynamic traffic/ Moving users/ Circuit switched calls
D/M/P	Dynamic traffic/ Moving users/ Packet switched calls
FDMA	Frequency Division Multiple Access
GEN	Genetic Algorithm
GoS	Grade of Service
GRE	Greedy Algorithm
LTE	Long Term Evolution
NGA	Ngadiman's Algorithm
OFDMA	Orthogonal Frequency Division Multiple Access
RCR	Reduction Estimation - Combinatorial Optimisation - Reduction Approximation
S/F/C	Static traffic/ Fixed users/ Circuit switched calls
SIR	Signal-to-Interference Ratio

TDMA	Time Division Multiple Access
VBR	Variable-Bit-Rate
WiMAX	Worldwide Interoperability for Microwave Access

Symbols

G_p	Processing gain
N_{bs}	Number of potential base station sites
N_u	Number of potential user locations
N_{u_o}	Number of office bearers
N_{u_v}	Number of visitors
P_{max}	Maximum signal power transmitted by a user
P_{min}	Minimum required signal power received by a user
P_{ru}	Received signal power of user u
P_{tu}	Transmitted signal power of user u
Q_f	Forward link SIR threshold
Q_r	Reverse link SIR threshold