An Indoor Resource Optimisation using Ray-Tracing Techniques and Signal-To-Interference Object Function to Obtain Best Capacity

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***Abstract*—The purpose of this work is to produce a method that calculates the best locations of a multiple transmitters in an indoor environment whilst meeting the required user capacity. The method uses a non-standard building discretisation[1] and a signal-to-interference ratio with quasi-convex space optimisation to produce the best positioning of transmitters.**

***Index Terms*—Indoor Scattering, Resource Optimisation, Signal-to-Interference.**

I. Introduction

The optimisation of the antenna locations to produce the best mobile receiver capacity is discussed in Kenny[2]. This work requires at its core the fast ray-tracing technique described in another paper in this conference[1]. Using the techniques described in Boyd[3] and a number of handover principles employed by Nokia[4] it is possible to produce an optimisation method in which the transmitters are placed apriori in a building, and move according to a quasi-convex optimisation algorithm along paths to the best location to a sufficient quality of service (QoS) given a prescribed user capacity map.

II. Architecture

A general descent method based on the implementation of Boyd[3] was employed to produce a descent direction for transmitters located in a building. The algorithm uses a modified and improved version of that of Rappaport[5] to give a better starting point for the transmitters. A centre of gravity approach using the user capacity requirement formed the basis of this start point guess. The object function of Rappaport was replaced by a new signal-to-interference function since this better describes the interaction with the user. An alternative stopping algorithm is presented which includes a measure of user capacity reached by the system. Annealing is used to exit any local maxima if the required capacity is not achieved.

III. Implementation and Results

A foyer problem with 3 large areas of high capacity links marked in brown (1.25Mb) and low capacity in blue (12.2kB) is depicted in Fig. 1. 60% of the capacity is data whilst 30% is assumed to be non-real time data and 10% is voice data. For this simple configuration with a total capacity of 5Mb, the splitting algorithm of Rappaport will split across the centre of the x-axis first, to give two hyper-rectangles each containing approximately 2.5Mb of capacity. Applying the algorithm again leads to 4 rectangles. With the improved algorithm there is a clear distinction of the 3 areas. It turns out that the algorithm cannot reach a high number of connects at the high data rates, if the SIR is to be met. The main reason for this is that there are no barrier for interference due to working in a foyer. If we lower the capacity requirement slightly in each timeslot to 256kB per user with 24 users we found that 90% of the users obtain their slightly lower capacity requirement and 75% reach their full capacity requirement.

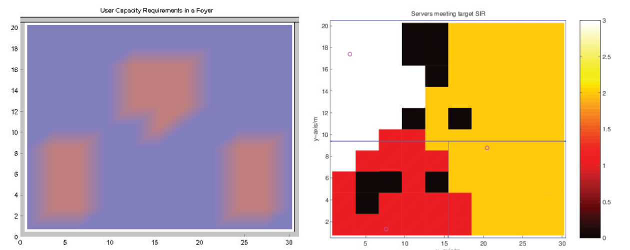

Fig. 1. 5Mb user capacity requirements in a building and the best transmitter locations

A hard handover algorithm was applied to avoid overflow of a server. The original method was applied to a TDD system, but soft-handover can also be applied. This handover is only implemented at the end of an optimisation procedure, otherwise it was found that the non-linear optimisation technique becomes unstable. The mean of a random phase is applied to the ray-tracing so as to smooth out the effects of fast-fading.

IV. Conclusions

Obstacles such as walls/partitions assist us in producing a more optimal configuration of the transmitter locations, since they reduce the direct SIR in indoor environments. The method of Rappaport[5] was improved at every step of the process to produce a method with evolves into the best server location solution. In most experiments the antenna locations meet a stopping criteria where 90-95% of the capacity was achieved, with a starting user capacity requirement of 60-70% for the non-optimised positions.

References

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