Design Space Exploration of Wireless Multihop Networks

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The Licentiate seminar will be held in Wigforssalen at Halmstad University
on Tuesday the 7th of June, 2005, at 13:15.

The discussion will be conducted by Ph.D. Jan Nilsson from Swedish Defence Research Agency.

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Abstract

This thesis explores the feasible design space of wireless multihop networks and identifies fundamental design parameters. In the process of exploring it is important to ignore all details and instead take a holistic view. This means that all protocol details are overseen, all details of radio wave propagation models are overseen and the system is modelled strictly on an architectural level. From a theoretical information perspective, there is a limit to the capacity that a certain bandwidth and a certain signal-to-noise ratio at the receiver can provide. This limit is approximated as a volume in the time-frequency-space domain. A single transmission is represented as an occupied volume in this domain. A wireless multihop network covers a spatial area, and the question is how multiple numbers of transmission volumes can be fit into a given limited spatial area. This volume fitting should be done in order to maximize the overall performance or to trade available resources to favour a specific characteristic in the wireless multihop network. The volume model is used for the design space exploration of a wireless multihop network. It is argued that the fault tolerance and the energy gain achieved in a multihop topology are its strength as compared to a single-hop architecture. It is further shown that the energy gain is achieved at the expense of delay and a greater end-to-end error probability. This indicates that these parameters must be very carefully balanced in order to gain in the global overall performance perspective. It can further be concluded that the overall spatial capacity is increased as a result of the spatial channel reuse in a multihop topology. On the other hand, it is also shown that the multihop topology introduces a rather stringent geometrical capacity limitation when the number of nodes of a wireless multihop network is increased. The dynamics (e.g. node mobility, changing radio channels etc.) of a large scale wireless multihop network is also a limiting factor. The nodes' mobility creates a knowledge horizon beyond which very little can be known about the present network topology.

Keywords: Wireless multihop networks, wireless sensor networks, ad hoc networks, design space, wireless embedded networks, packet radio networks.