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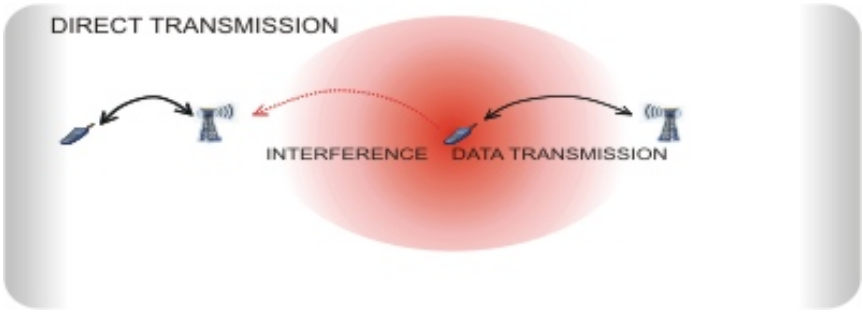
# Improving Capacity and Energy Efficiency of HiperLAN/2-based Mobile Communication Systems with Single-Hop-Relay Connections

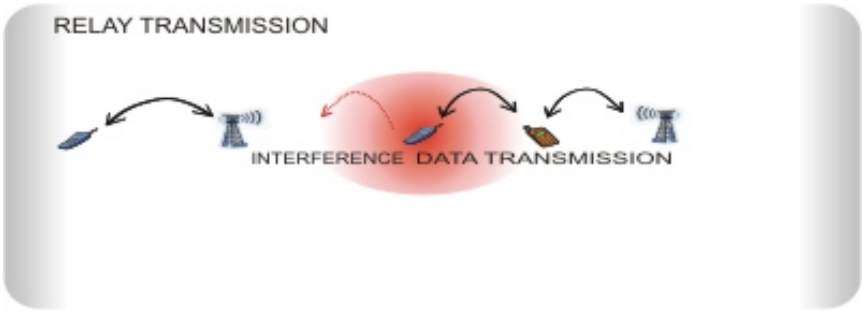
## Introduction

The TKN group is a member in the IBMS$^2$ project funded by the German Ministry of Education and Research (BMBF). The idea of this project is to use "single-hop-relay" connections within a base station controlled cell to relay traffic for remote terminals via terminals laying inbetween. The aim of this project is to investigate whether a gain in capacity and/or an increase in energy efficiency (in terms of mobile lifetime) can be achieved.

## Motivation




direct communication within a cell produces high interference in own and neighboring cell




relay communication within a cell produces less interference in own and neighboring cell

The factor limiting capacity in an infrastructure-based wireless local area network, e.g., H/2, is the dependancy of distance and transmission speed achievable. A longer distance implies either a higher radiation power or, when maximum radiation power is reached, a lower modulation (lower transmission speed). An intermediate terminal, placed in the middle, can change this behavior - a higher modulation can be used and/or the radiated power can be decreased. As the possible decrease in radiated power does not depend linearly on the distance (using half a distance reduces the necessary power radiated to a quarter or further on - this

depends on the path loss coefficient), the introduction of an intermediate terminal reduces the total power radiated by half. As this reduction of power consumption can be beneficial in terms of energy consumption, it also reduces the interference within the cell and to neighboring cells, therewith allowing a frequency reuse to increase the capcity. In the TKN part of IBMS$^2$ an overview of capacity and energy-efficiency improvements is given.

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- W. Zirwas, J. Habetha, and H. Karl, "Ziel-orientierter Entwurf von Multi-hop Medienzugriffsprotokollen", *Praxis der Informationsverarbeitung und Kommunikation*, vol. 26, no. 4, pp. 184-189, 2003.
- S. Mengesha and H. Karl, "Relay Routing and Scheduling for Capacity Improvement in Cellular WLANs", In *Proc. of Modeling and Optimization in Mobile, Ad Hoc and Wireless Networks (WiOpt'03)*, Sophia-Antipolis, France, March 2003.
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- M. Kubisch, S. Mengesha, D. Hollos, H. Karl, and A. Wolisz, "Applying ad-hoc relaying to improve capacity, energy efficiency, and immission in infrastructure-based WLANs", In K. Irmscher, editor, *Proc. of Kommunikation in Verteilten Systemen (KiVS)*, pp. 195-206, Leipzig, Germany, February 2003.
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- D. Hollos and H. Karl, "A protocol extension to HiperLAN/2 to support single-relay networks", In *Proc. of 1st German Workshop on Ad-Hoc Networks*, pp. 91-108, Ulm, Germany, March 2002.
  (PostScript) (PDF)
- H. Karl and S. Mengesha, "Analysing Capacity Improvements in Wireless Networks by Relaying", In *Proc. of IEEE Intl. Conf. on Wireless LANs and Home Networks*, pp. 339-348, Singapore, December 2001.
  (PostScript) (PDF)
- S. Mengesha, H. Karl, and A. Wolisz, "Improving Goodput by Relaying in Transmission-Power-Limited Wireless Systems", In *Proc. of Informatik 2001--31. Jahrestagung der GI, OCG*, pp. 537-544, Vienna, Austria, September 2001.
  (PostScript) (PDF)
- M. Kubisch, S. Mengesha, D. Hollos, H. Karl, and A. Wolisz, "Applying ad-hoc relaying to improve capacity, energy

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- H. Karl, "2nd International OMNeT++ Workshop", Technical Report TKN-02-001, Telecommunication Networks Group, Technische Universität Berlin, January 2002.
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- M. Kubisch and H. Karl, "Analyzing Energy Consumption in Wireless Networks by Relaying", Technical Report TKN-01-006, Telecommunication Networks Group, Technische Universität Berlin, June 2001.
(PostScript) (PDF)
- H. Karl and S. Mengesha, "Analysing Capacity Improvements in Wireless Networks by Relaying", Technical Report TKN-01-003, Telecommunication Networks Group, Technische Universität Berlin, May 2001.
(PostScript) (PDF)
- H. Karl, "Using ad-hoc extensions to cellular networks for capacity and energy-efficiency improvements --- An overview of the IBMS2 project", Inivited talk at Hasso-Plattner-Institute Potsdam, April 2003.
(PDF)
- H. Karl, "Relaying --- bad for energy, good for capacity?", Work-in-progress session of Mobicom 2001, Rome, Italy, July 2001.
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- H. Karl, "Relaying --- bad for energy, good for capacity?", Eork-in-progress session of mobicom 2001, Rome, Italy, July 2001.
(PDF)
- T. Hentschel and H. Karl, "Integriertes Bandbreiteneffizientes Mobiles Software-Radio System (IBMS2)", Zukunftsperspektiven der Mobilkommunikation, Symposium Bundesministerium für Bildung und Forschung, May 2001.
(PDF)

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