

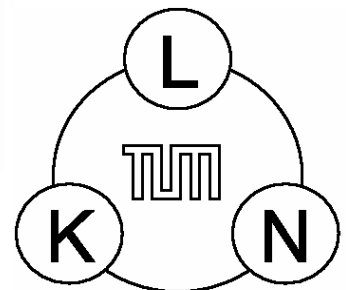
Multi-Hop Networks with Fixed Relay Stations

ITG Fachgruppentagung 5.2.4

München, 10/11. Februar 2005

Hans-Martin Zimmermann,

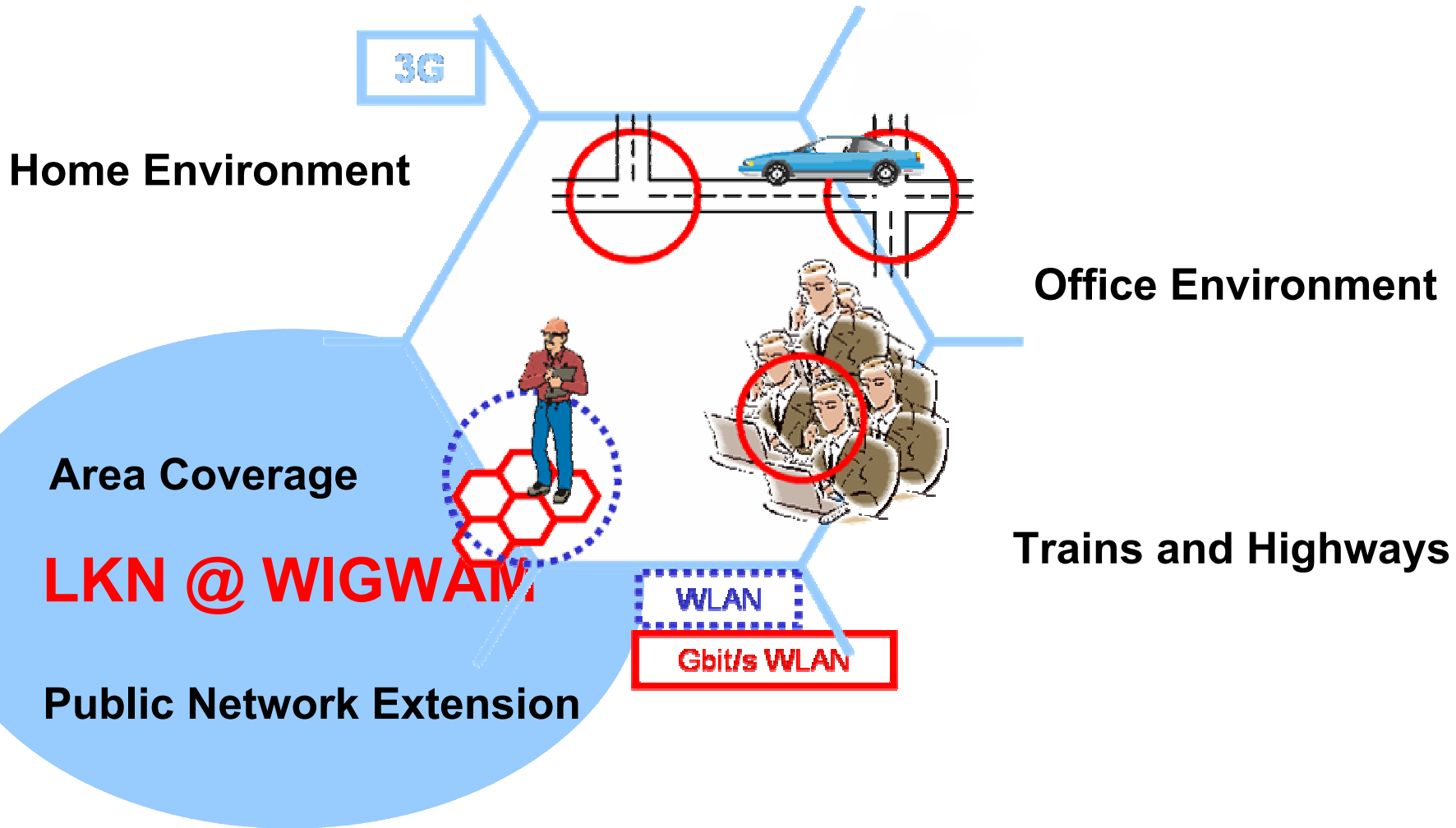
TU München



- △ „Wireless Gigabit with Advanced Multimedia Support“ (WIGWAM) - A BMBF Research Project
- △ Multi-Hop Networks
- △ The Scenario
- △ Performance Analysis of Multi-Hop Networks
- △ A Short Illustration



The WIGWAM vision - A Universal 4G Mobile Communication Network



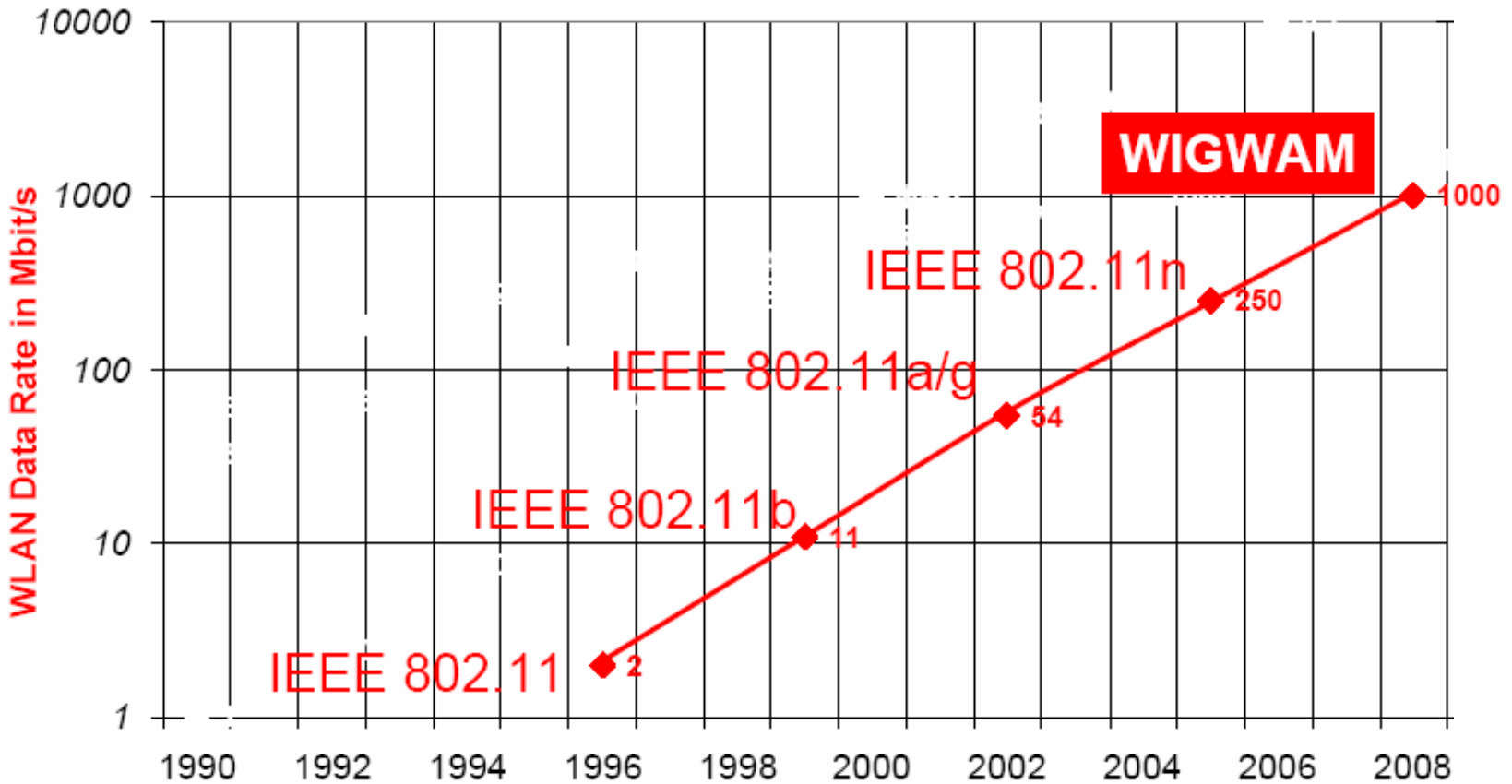
▲ design of a universal wireless communication network;

▲ targeted spectrum: 5 GHz band and extension bands at 17, 24, and 60 GHz;

▲ main application area: transmission of multimedia content;

▲ design desired maximum transmission data rate: 1 Gbit/s;


WIGWAM

[source: G. Fettweis, R. Irmer WBF@Cambridge]

Mobile communication speed record: One gigabit per second over the air

Munich, Dec 7, 2004



A world record was set at the research laboratories of the Siemens Communications Group. For the first time, data were transferred in real time via mobile communication at a speed of one gigabit per second (Gbit/s); that equates to 1,000 megabits per second (Mbit/s) . By comparison: WLAN networks presently offer the fastest wireless links to mobile devices at speeds of around 50 MBit/s . In order to achieve its record-setting high speed, Siemens combined an “intelligent antenna system” consisting of three transmitting and four receiving antennas with Orthogonal Frequency Division Multiplexing (OFDM) . Researchers consider these technologies, which are especially efficient at using the frequently band, to be highly promising modules for the mobile communication generation beyond W-CDMA.

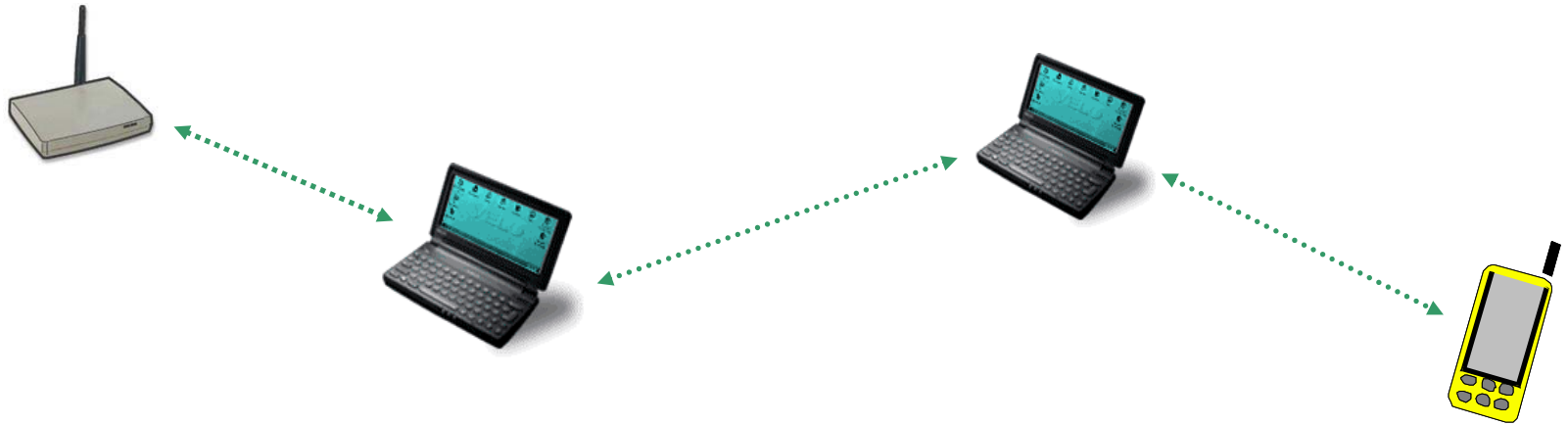
[source: Siemens Mobile, Press Release]

- △ The Situation:
 - Short Range Transmission Stations (5GHz)
 - High Data Rate Demand
 - OFDM(A) Technology

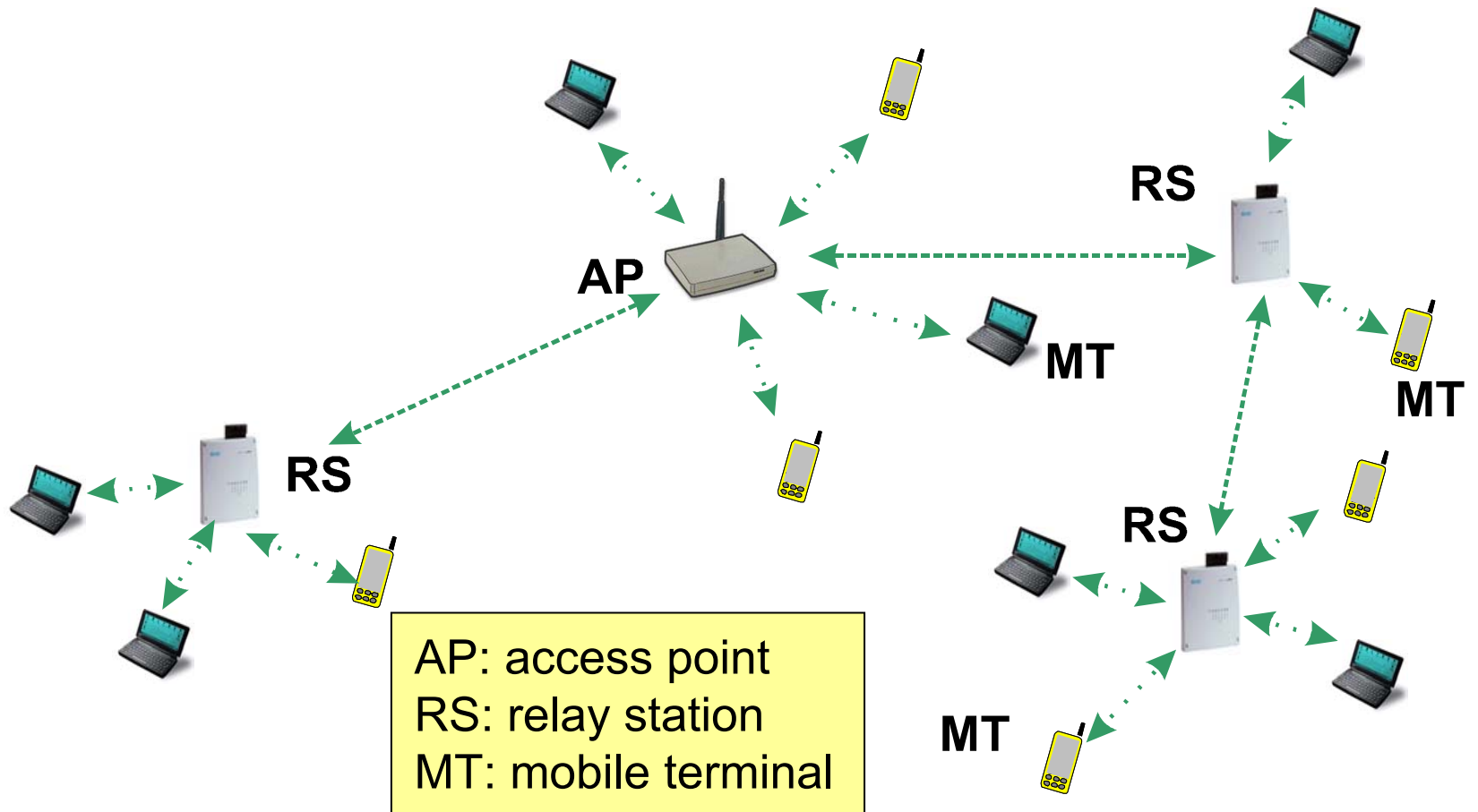
- △ The Challenge:
 - Coverage for a Public Mobile Network
 - Low Cost

- △ The Solution:
Multi-Hop Networks with
Fixed Relay Stations?!?





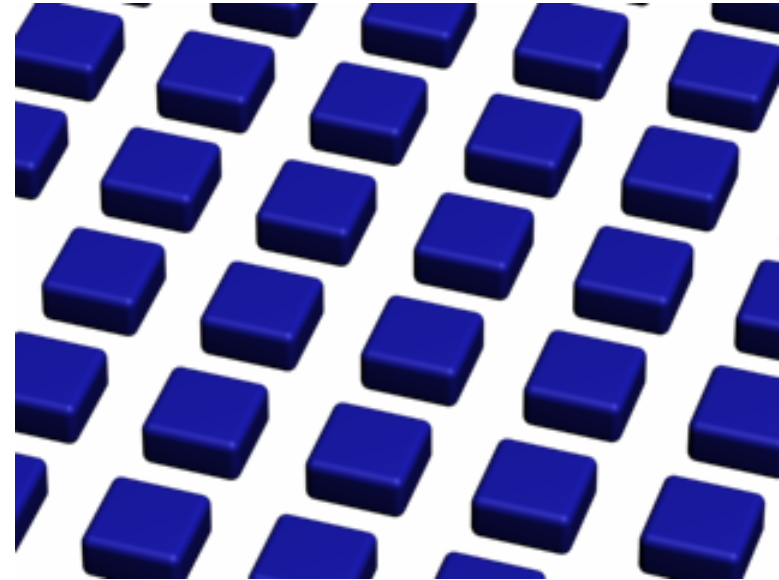
„Multi-Hop“: the ability of a network to transport data or signaling information over several independent devices to a final destination;



our focus: public multi-hop networks with fixed relay stations in urban environments

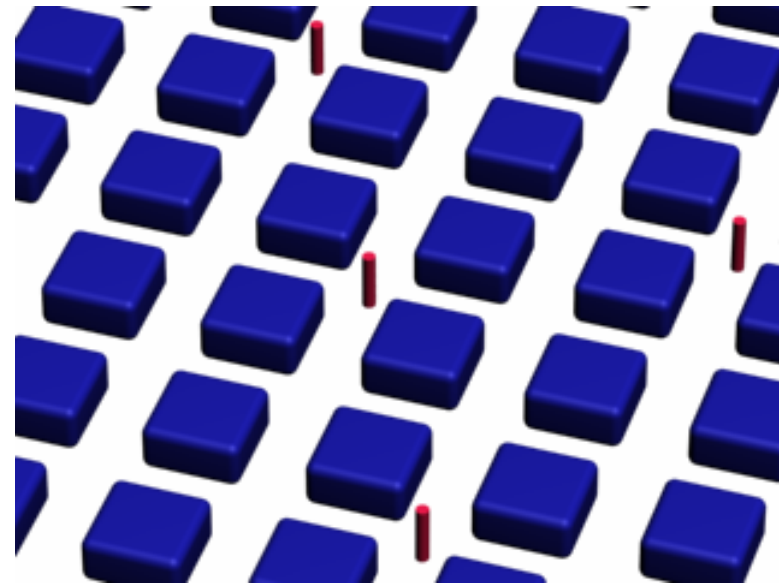
Basic Assumptions:

- ▲ Manhattan Scenario;
- ▲ Fixed Relay Stations;
- ▲ Free Space Channel Model ($\gamma=2$ for LOS, $\gamma=4$ for NLOS);
- ▲ HiperLAN/2 Link Adaptation;
- ▲ Slotted OFDMA/TDMA system;



Basic Assumptions:

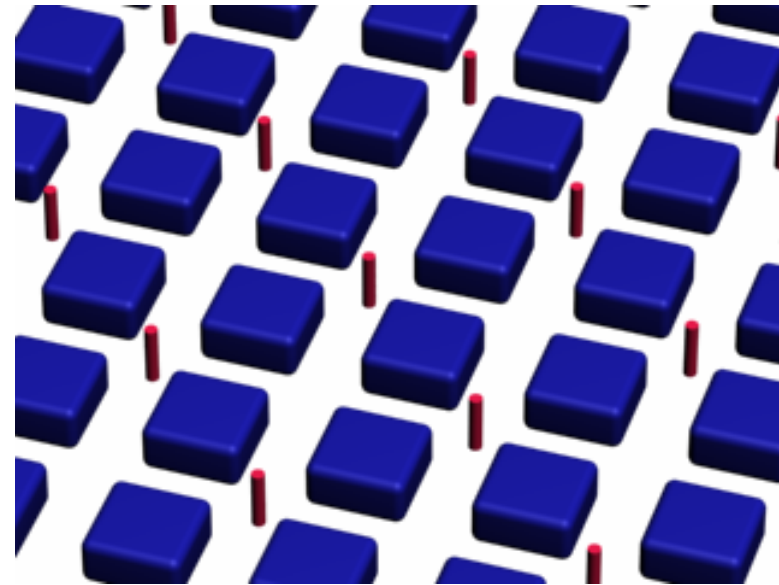
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Expansion Stage „5“

Basic Assumptions:

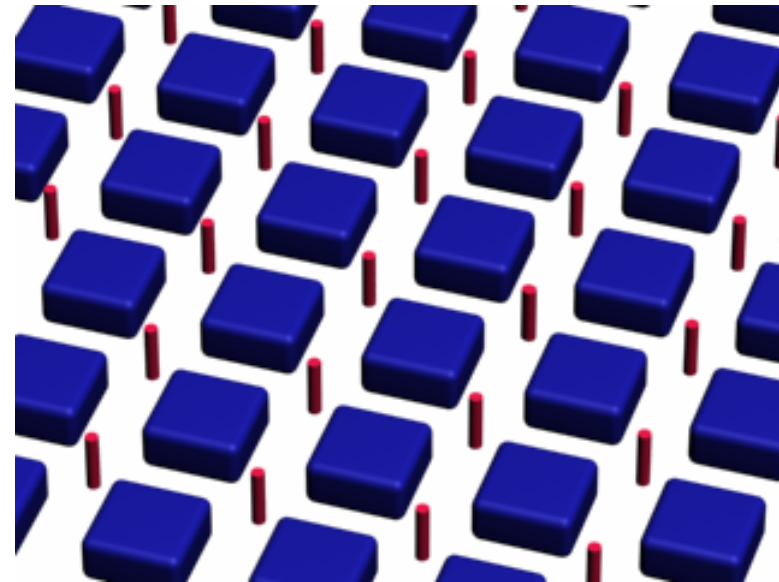
- ▲ Manhattan Scenario;
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Expansion Stage „2“

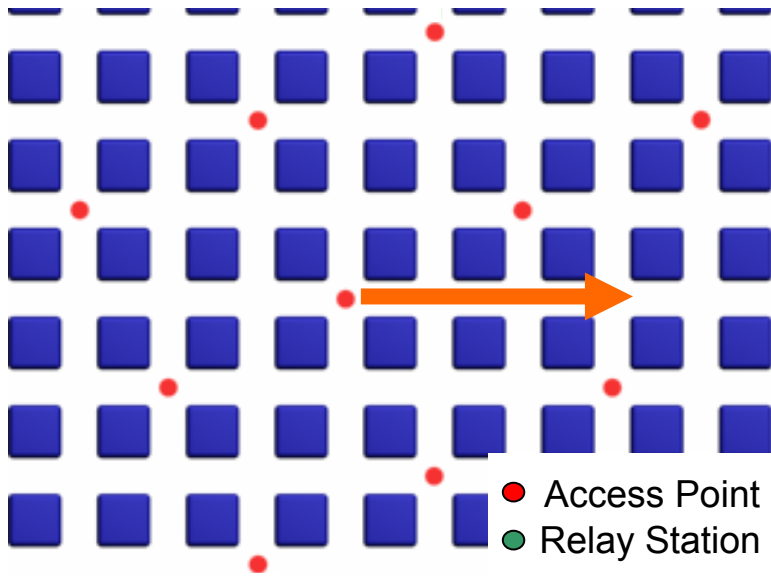
Basic Assumptions:

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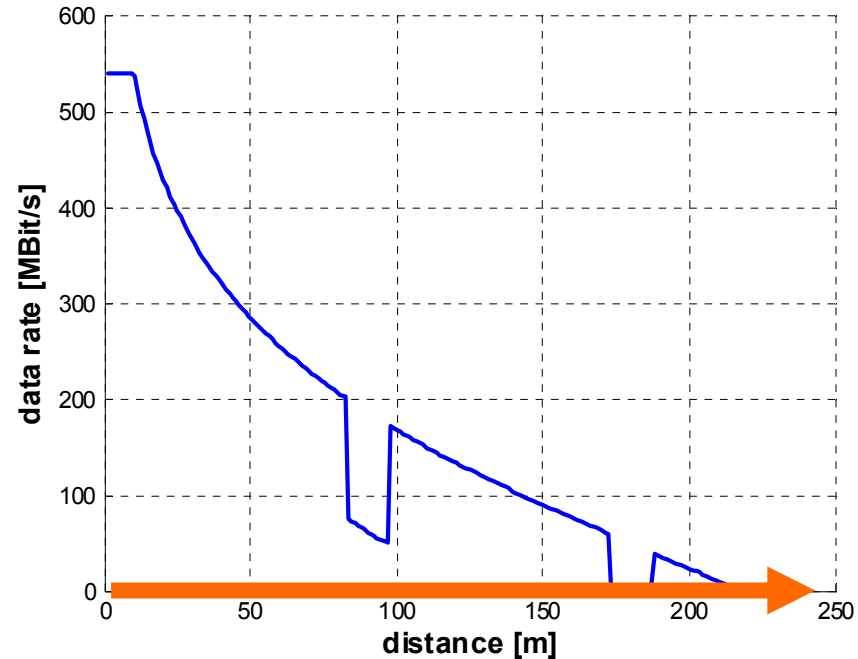


Expansion Stage „1“

Network Topology

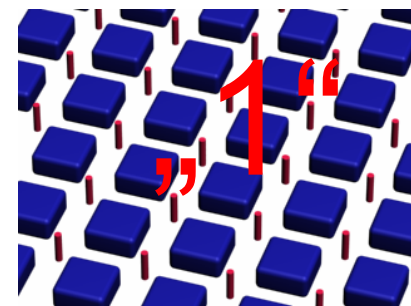
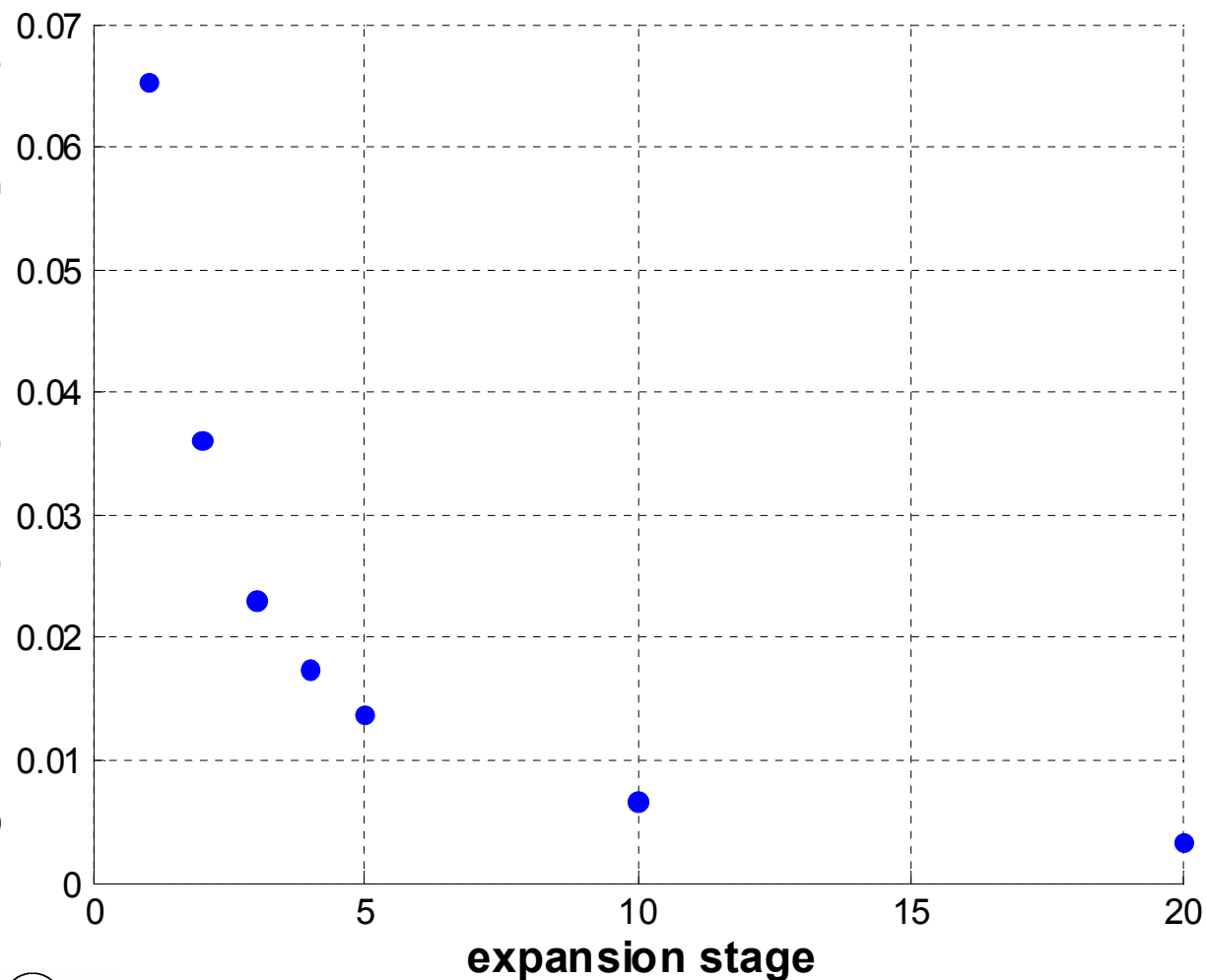


Maximum Data Rate

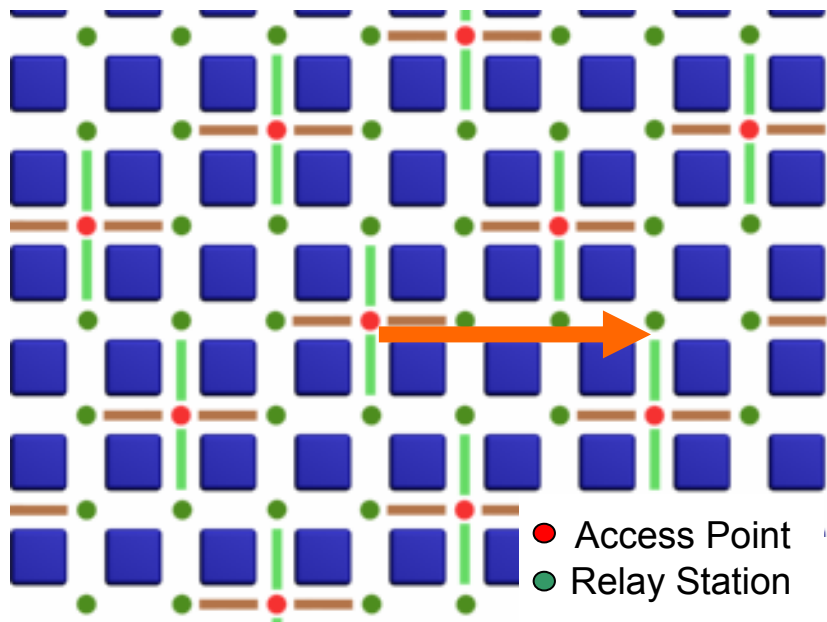


- ▲ significant notches at crossways;
- ▲ data rate by far not equally distributed;

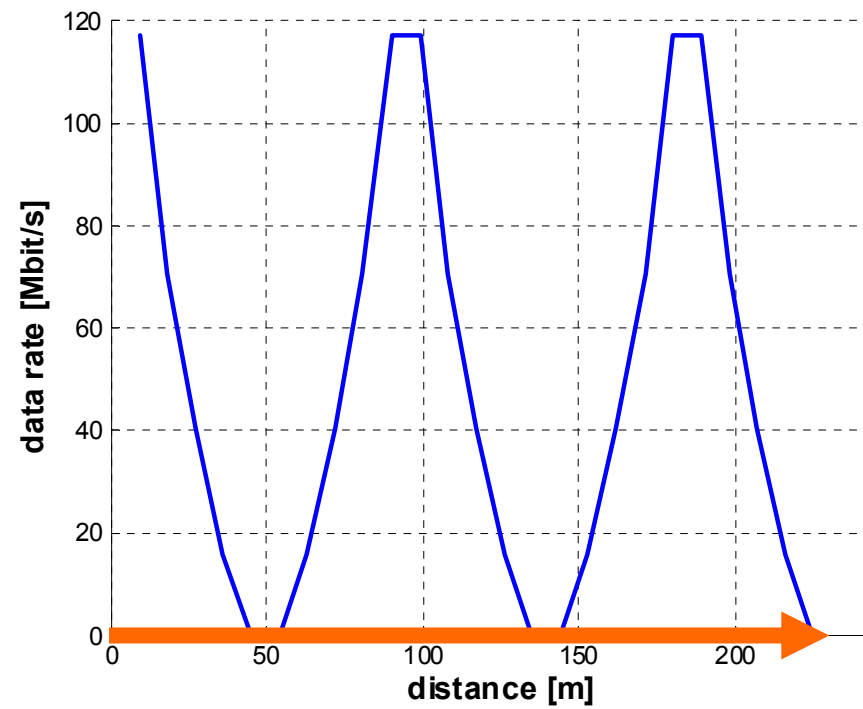
Network Capacity



Network Topology

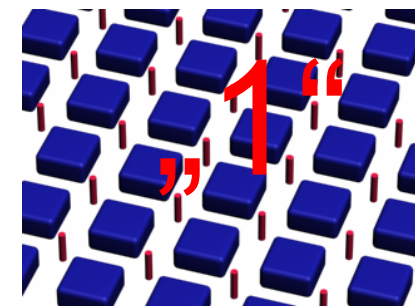
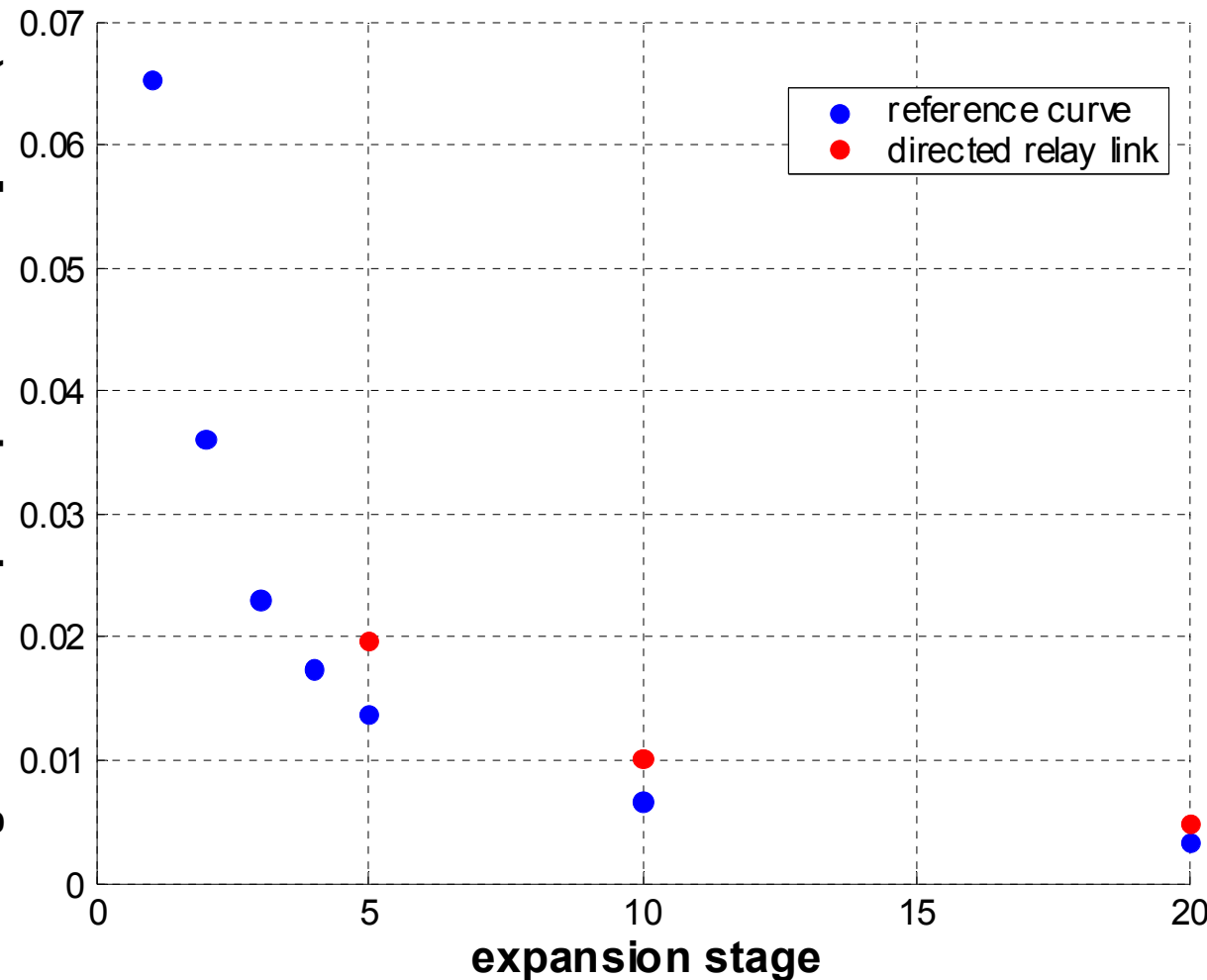


Maximum Data Rate

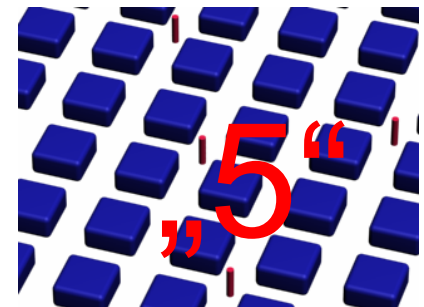
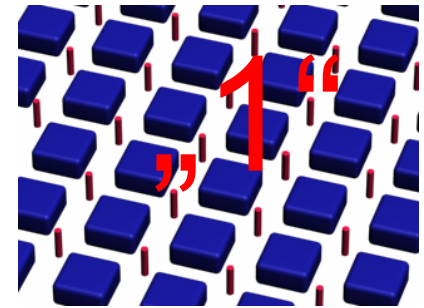
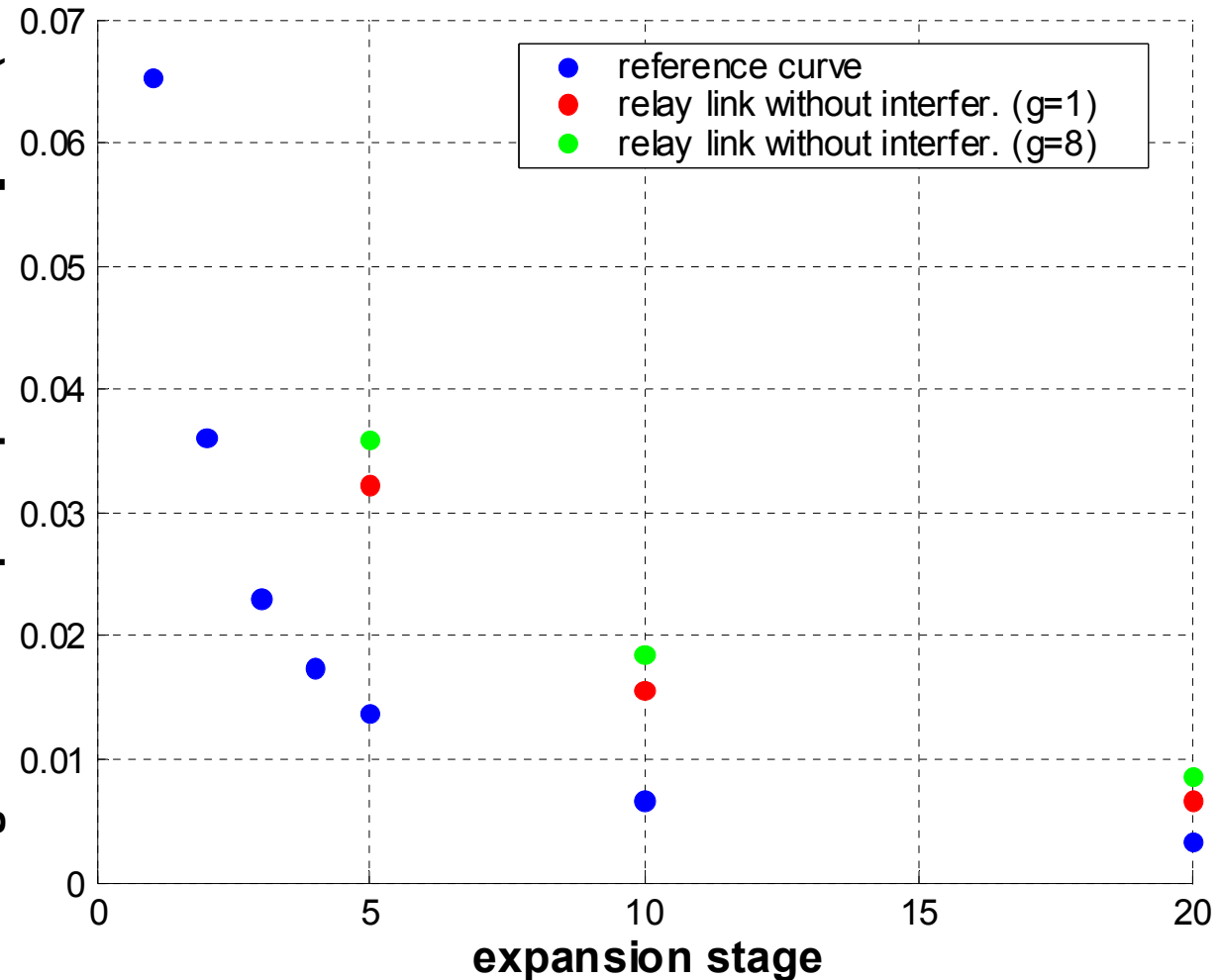


- ▲ notches removed by use of directed antennas;
- ▲ performance gains by multi-hop network;

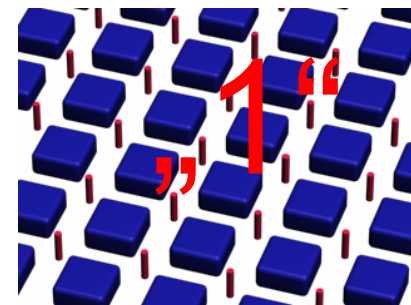
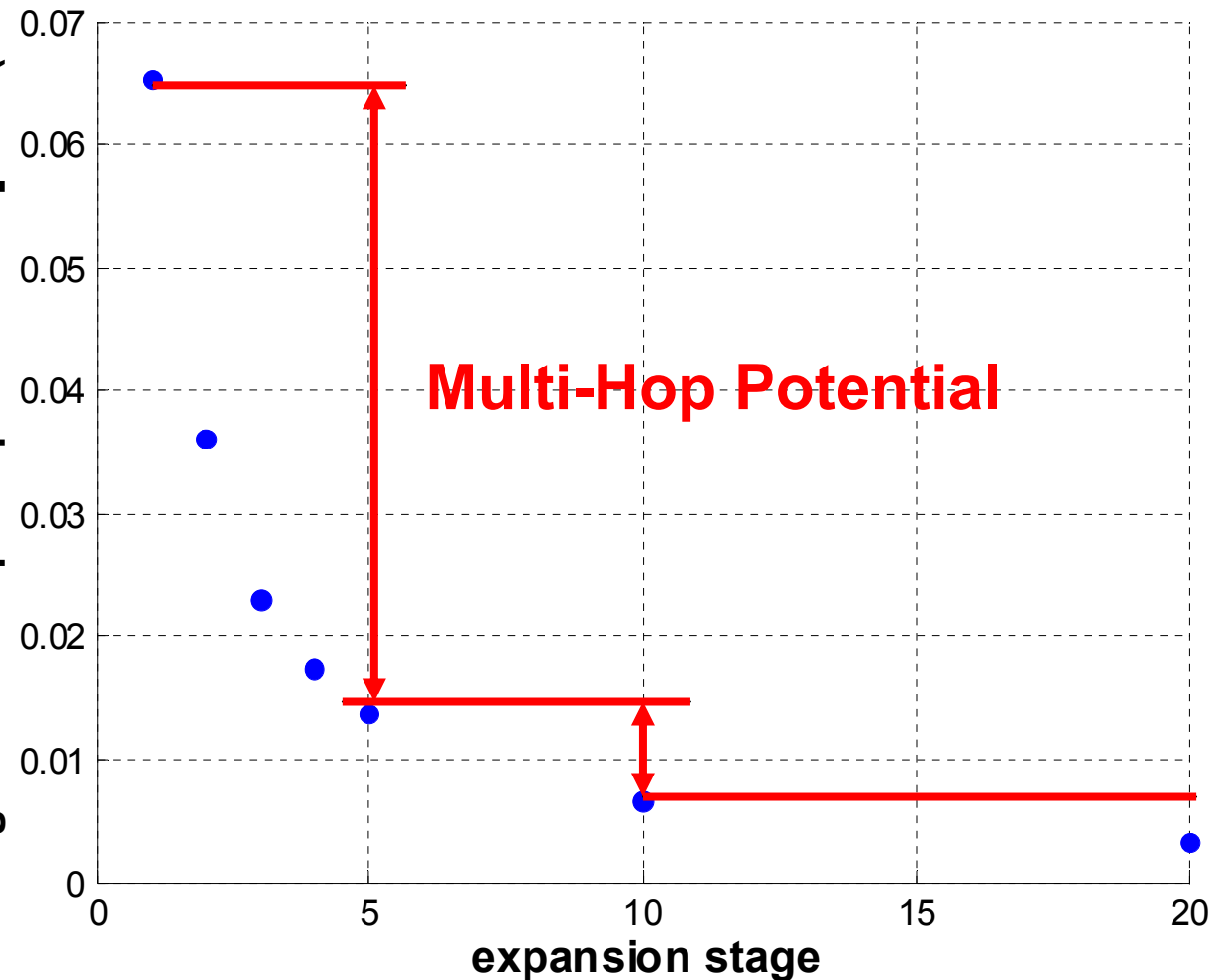
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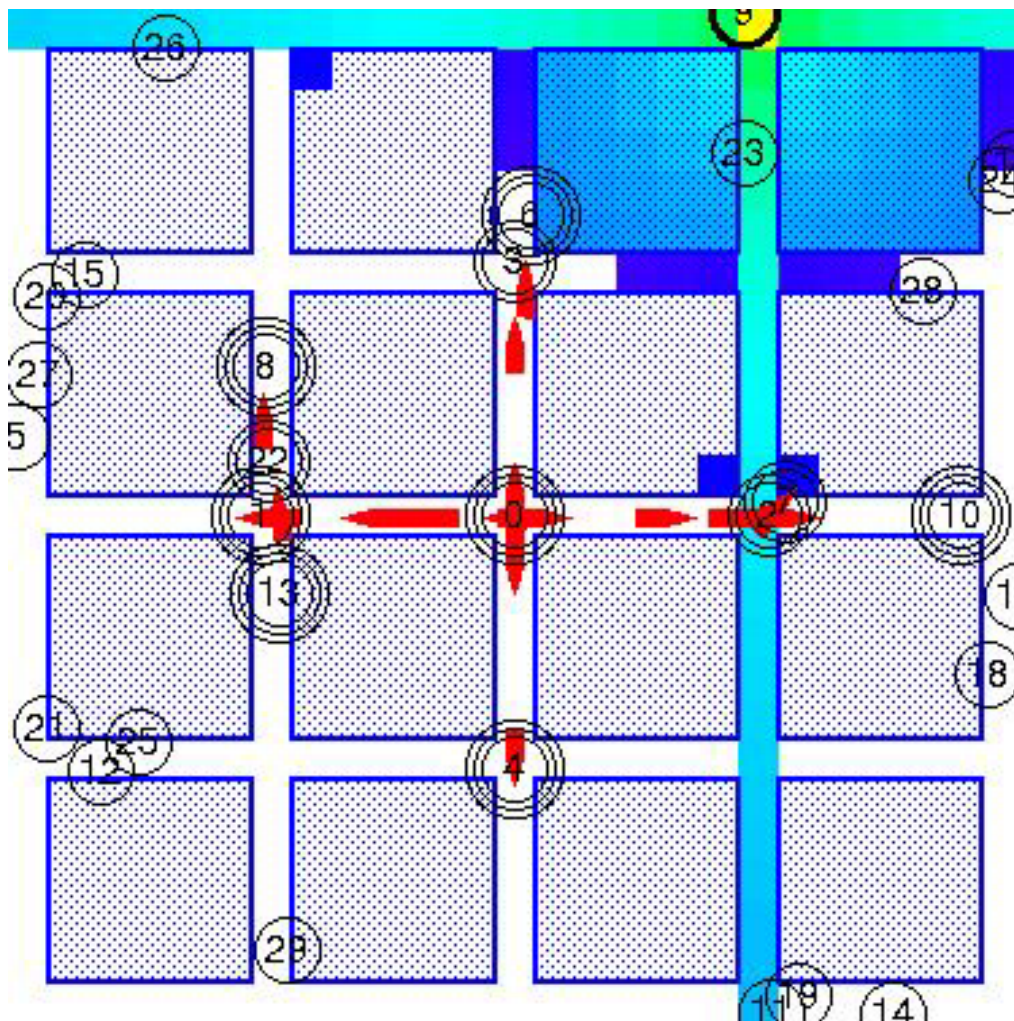


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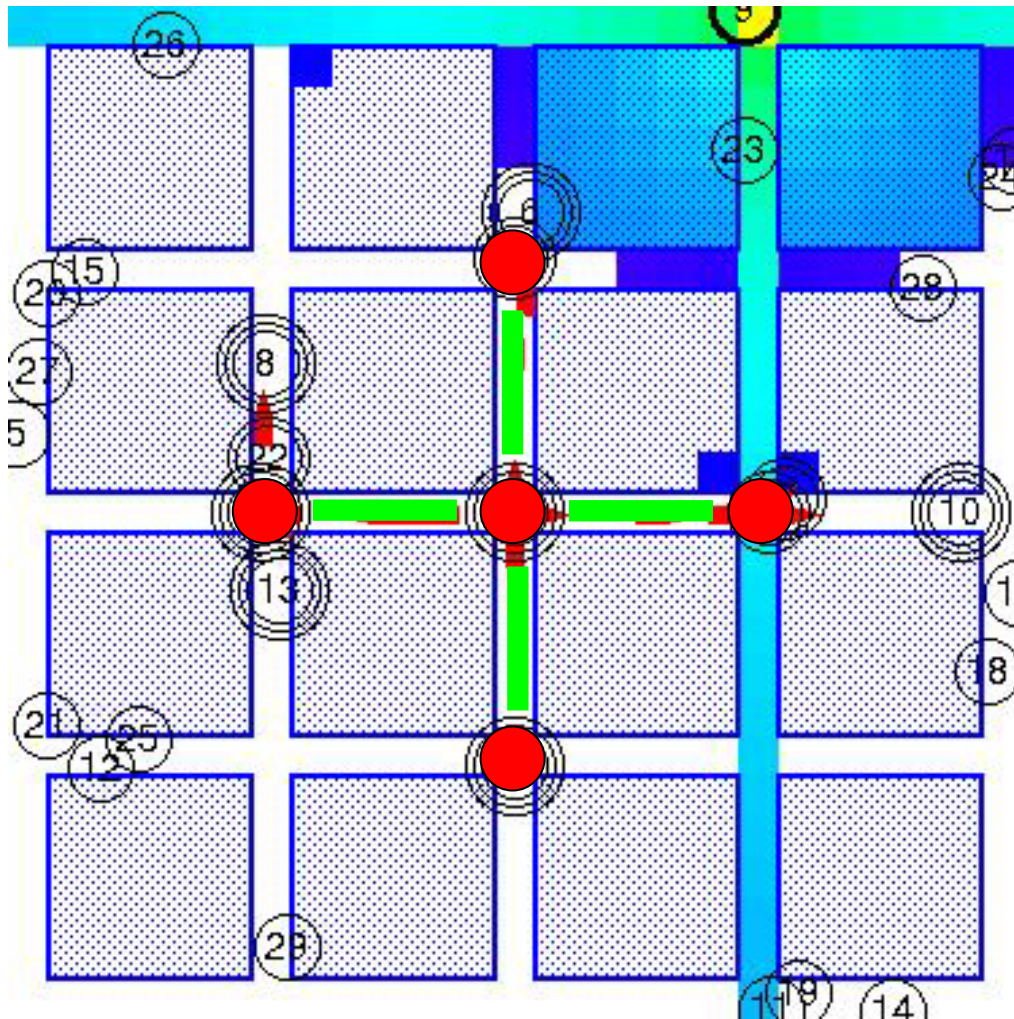
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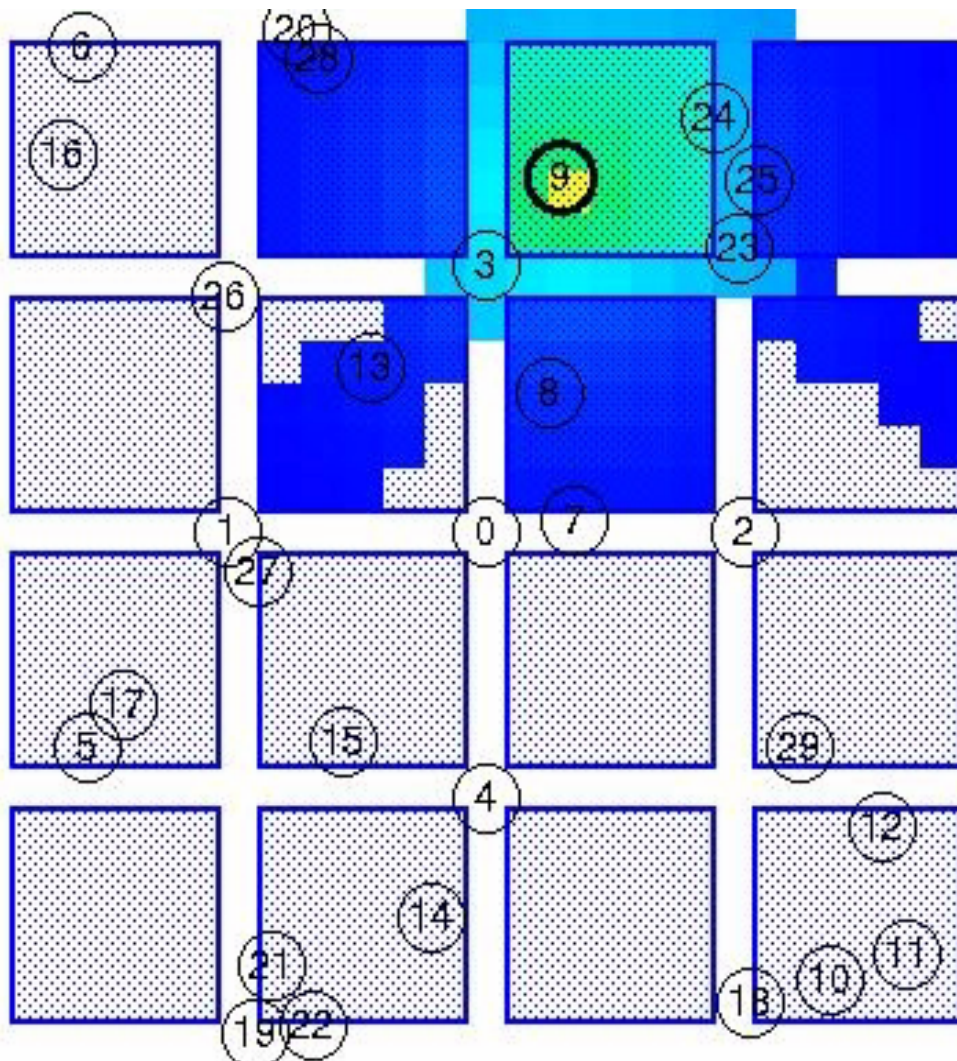


- ▲ Scenario:
 - access point with four fixed relay stations on a Manhattan grid;

- ▲ Channel Model:
 - adapted FreeSpace at 5 GHz ($\gamma=2$ for LOS, $\gamma=4$ for NLOS);



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adapted FreeSpace at 5 GHz ($\gamma=2$ for LOS, $\gamma=4$ for NLOS);

- ▲ multi-hop networks are a promising approach to realize future cellular networks with high data rates
- ▲ multi-hop networks require advanced transmission technologies in order to be efficient
- ▲ multi-hop networks are a cost-efficient way to extend network coverage step by step

