

Performance Impact of More than 2-Hop Relay

Document Number:

IEEE C802.16j-06/082

Date Submitted:

2006-07-03

Source:

Mark Naden, Dean Kitchener
Nortel
London Road
Harlow, Essex, CM17 9NA

Voice: +44 1279 402715

Fax: +44 1279 402100

E-mail: jmn@nortel.com

Wen Tong, Peiyong Zhu, Gamini Senarnath
Hang Zhang, David Steer, Derek Yu, Wang G-Q
Nortel, 3500 Carling Avenue
Ottawa, On K2H 8E9 Canada

Voice: 613 7658089

Email: pyzhu@nortel.com

613 7631315

wentong@nortel.com

Venue:

IEEE 802.16 Session #xx, xxx, xxx

Base Document: C80216j-06_040:” Multi-hop System Evaluation Methodology (Channel Model and Performance Metric)”

Purpose:

To recommend performance metrics for multihop systems

Notice:

This document has been prepared to assist IEEE 802.16. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein.

Release:

The contributor grants a free, irrevocable license to the IEEE to incorporate material contained in this contribution, and any modifications thereof, in the creation of an IEEE Standards publication; to copyright in the IEEE's name any IEEE Standards publication even though it may include portions of this contribution; and at the IEEE's sole discretion to permit others to reproduce in whole or in part the resulting IEEE Standards publication. The contributor also acknowledges and accepts that this contribution may be made public by IEEE 802.16.

IEEE 802.16 Patent Policy:

The contributor is familiar with the IEEE 802.16 Patent Policy and Procedures <<http://ieee802.org/16/ipr/patents/policy.html>>, including the statement "IEEE standards may include the known use of patent(s), including patent applications, provided the IEEE receives assurance from the patent holder or applicant with respect to patents essential for compliance with both mandatory and optional portions of the standard." Early disclosure to the Working Group of patent information that might be relevant to the standard is essential to reduce the possibility for delays in the development process and increase the likelihood that the draft publication will be approved for publication. Please notify the Chair <<mailto:chair@wirelessman.org>> as early as possible, in written or electronic form, if patented technology (or technology under patent application) might be incorporated into a draft standard being developed within the IEEE 802.16 Working Group. The Chair will disclose this notification via the IEEE 802.16 web site <<http://ieee802.org/16/ipr/patents/notices>>.

Introduction and Background

- In this contribution we present the simulation study on the impact of multi-hop in particular for the case of more than 2 Hops
- This usage model is the in-cell coverage hole improvement, to demonstrated trade effectiveness of multi-hop relay, the coverage data rate is defined as 384kbps

Simplified System Model (1)

- We model the downlink of a macro-cellular wireless network in which the source is a BS and the destination is a MS. The path between the BS and the MS may be direct, comprising a single hop, or may be indirect via a RS. Initially we restrict an indirect or multihop path to a single RS and thus to two hops
- For a particular 2-hop multihop path, the RS chosen for inclusion in the path is the one which provides the best signal quality of those available. Only those RSs included in multihop paths are assumed to transmit signals; therefore, the density of active RSs (wanted plus interfering) will be in general lower than the density of RSs
- The BSs are assumed to be deployed in a **tri-cellular** arrangement with various BS separations between **1000m** and **400m** in both the multihop and the conventional cellular networks.
- We do not restrict a MS to be served by the BS in the same geographic cell but assume that the MS will be served by the BS providing the best signal irrespective of its location

Simplified System Model (2)

- The density of RSs is an input variable and thus the number to be deployed in a given area is determined. This number of RSs is randomly deployed within this area
- We assume that the system is partitioned into one group of orthogonal channels that are used for direct paths and a second group of orthogonal channels that are used for multihop paths
- Furthermore, we assume that the timeslots are synchronised between cells, so that the BS transmission on a multihop path coincides with all other BS transmissions on other multihop paths and similarly the RS transmission on a multihop path coincides with all other RS transmissions on other multihop paths
- Consequently, interference to a signal from a BS, whether intended for a RS or a MS, arises only from other BSs; and interference with a signal from a RS arises only from other RSs

RF Parameters

- Carrier bandwidth 5MHz
- Bit rate 128kbps
- MS receiver noise figure 7dB
- RS receiver noise figure 7dB
- E_b/N_0 7.5dB
 - An SINR greater than this value is assumed necessary for successful reception i.e. to be in coverage
- RS transmit power 21dBm
- BS transmit power 21dBm
- BS antenna gain 18dB
- RS antenna gain 0dB
- MS antenna gain 0dB
- BS to MS/RS system losses 4dB
- RS to MS system losses 2dB
- Interference margin 1dB

Path Selection Algorithm – Direct / 2-hop

- The algorithm compares the SINR on each hop of each potential multihop path and sets the SINR of the path to be the minimum of the SINRs of the two hops
- The multihop path with the highest SINR is selected if this is greater than the SINR of the direct path between the BS and the MS, otherwise the direct path is chosen

$$snir = \max_i \min(BStoRS_i, RStoMS_i), BStoMS$$

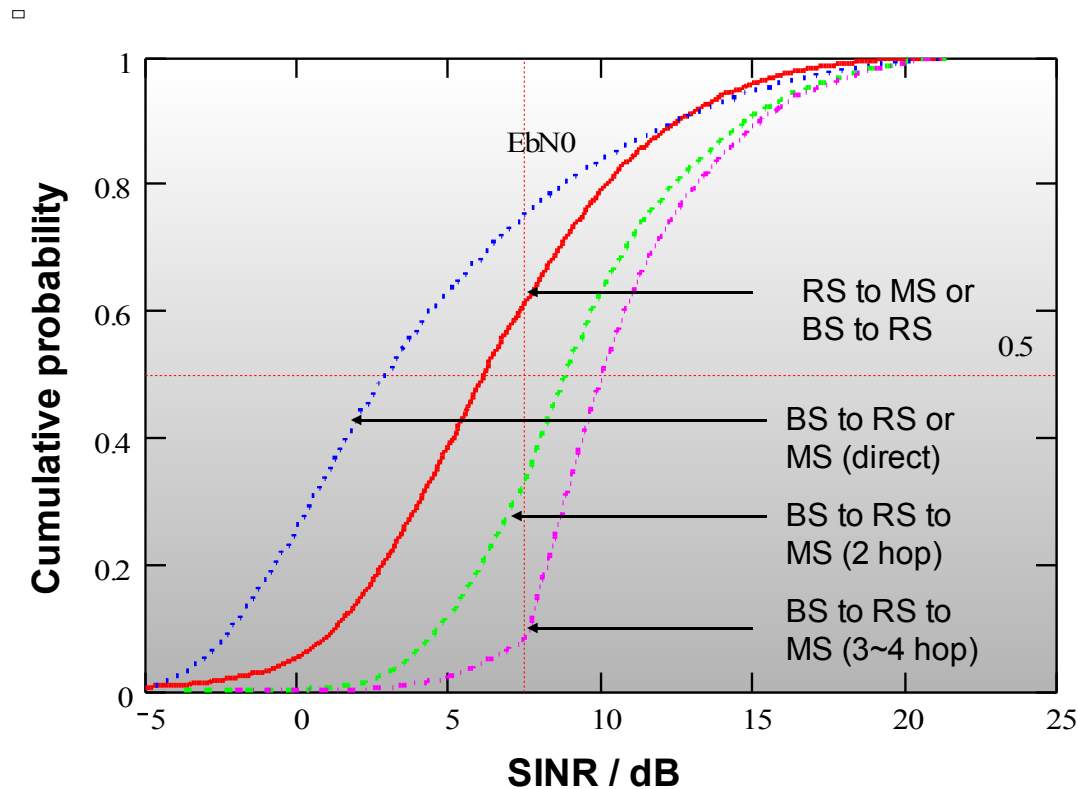
- All possible paths can be included because the number of RSs visible to a given MS is restricted by the propagation environment

Simulation Assumptions

- RS density 32 per km²
- Active RS density 6 per km²
 - ~1 per sector
- BS separation 750m
- RS and MS outdoors
- Urban propagation environment
- Uncorrelated lognormal fading
- Load factor variable between 2 and 20 simultaneous users per sector
- Path selection criterion is improved path SINR
 - SINR of the multihop path must be greater than the SINR of the direct path it replaces and the SINR of the direct path must be less than E_b/N_0

SINR Cumulative Density

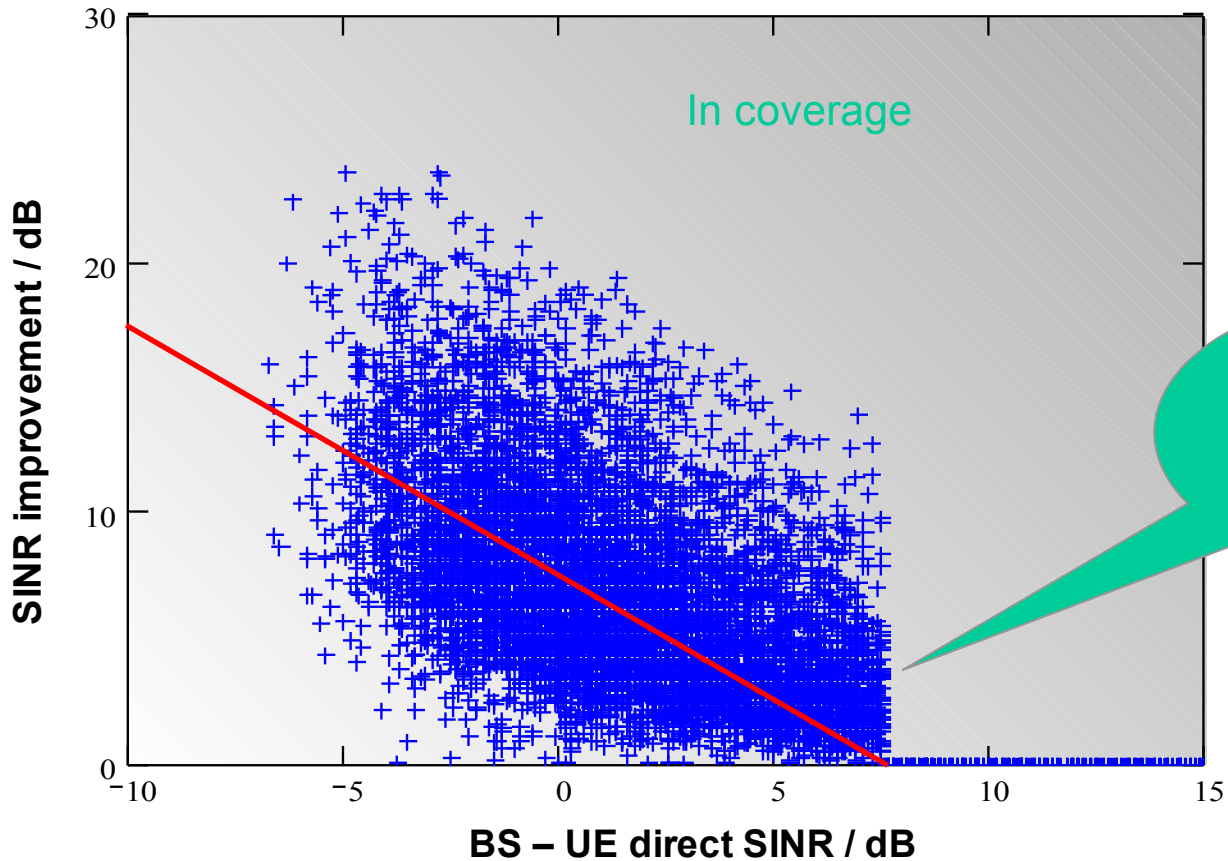
Example of multihop system performance with multihop diversity for a load factor of 20 simultaneous users per cell



SINR Improvement

the improvement in SINR of the multihop path compared to the direct path

□



Use of multihop paths is not allowed for MSs which are in coverage of the direct path