Metrics For Multihop Systems

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Purpose:

To recommend performance metrics for multihop system

Introduction

- **The choice of metric can significantly alter the perceived performance of a multihop system relative to a conventional cellular system**
  - For example, a metric that is based on the total number of sites, irrespective of whether they are base station or relay sites, will underestimate the performance of a multihop system because of the additional sites required for relays in the multihop network
  - Conversely, a metric that neglects the relays will overestimate the benefits of a multihop system: a multihop network optimised according to such a metric will contain an unrealistically low number of base stations and compensate by employing large numbers of relays
- **In this contribution, we describe a metric that enables a fair comparison of multihop networks with conventional cellular networks. The proposed metric may be used for the evaluation of MMR concepts and combines coverage and spectral efficiency and includes provision for the trade-off between base stations and relays in terms of overall system performance**

Coverage

- **Coverage is the probability that a randomly placed subscriber is able to reliably communicate at a particular data rate. It may also be expressed as the fractional area of a cell within which signal quality is high enough to support a specified service. If users are distributed uniformly within the cell, it is equivalent to the proportion of users that can receive a signal of sufficient quality**
- **Coverage enhancement is a primary objective for MMR. By improving coverage, a network operator may provide service to a greater proportion of the users in a cell, and users will experience more uniform access to the service. The inclusion of coverage as part of the metric is therefore valuable from both the network operator's perspective and from the user's perspective**

System Capacity

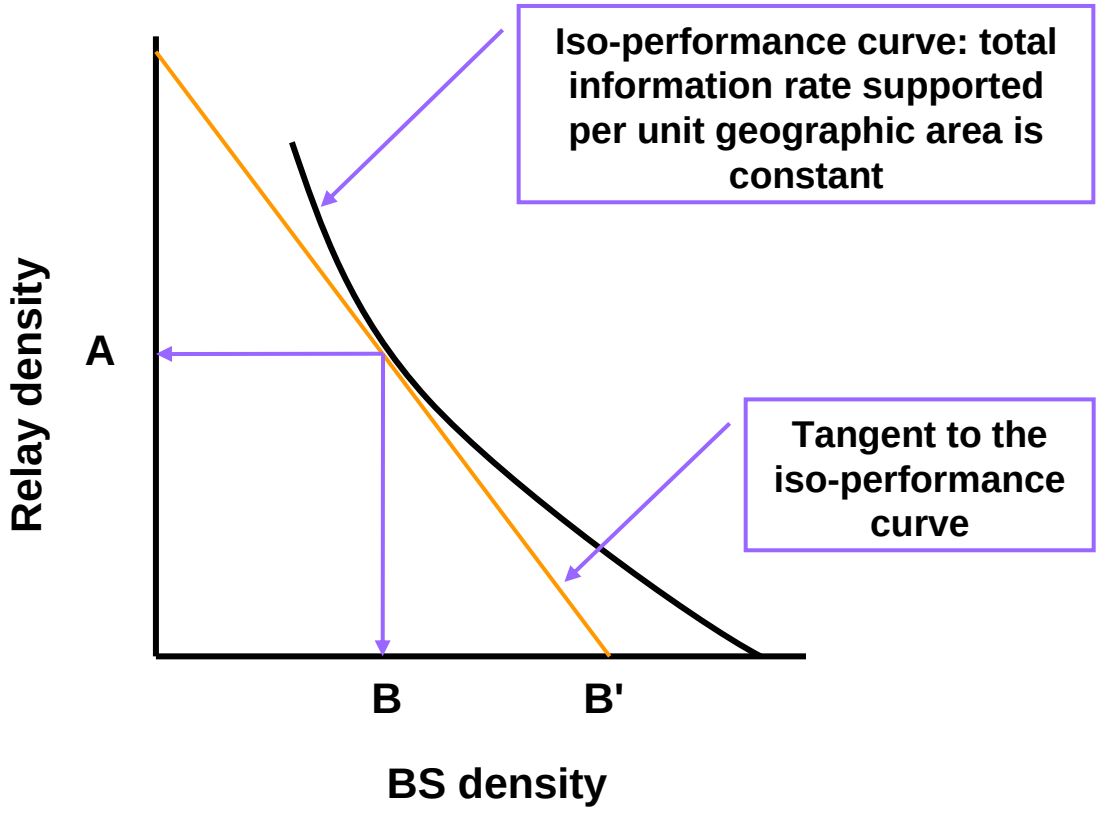
- **Whether or not a user is able to access the service also depends on the system capacity being sufficient to meet the demand for that service in his local area. System capacity enhancement is a secondary objective for MMR, as a system providing high capacity will be better able to meet the demand for a given service and hence to meet the user's requirements**
- **System capacity is a measure of the maximum total information rate supported by a base station. It is the total information rate per base station**
  - It is equivalent to the ratio of the total information rate supported per unit geographic area to the number of base stations per unit geographic area

System capacity does not take account of any relays in the network

Graphical Description of “r” and “m”

$$m = \frac{A}{B}$$

$$r = \frac{A}{B' - B}$$



Spectral Efficiency

- **For a network operator, it is also desirable to minimise the total amount of spectrum used by the system to deliver a specified service. This is equivalent to maximising the spectral efficiency of the system**
- **Spectral efficiency is the effective system capacity per unit bandwidth**
- **Spectral efficiency is a useful "network-centric" or "operator-centric" metric. It is a maximum when the total amount of spectrum required to provide the required effective system capacity is a minimum**
- **Including spectral efficiency as part of the metric therefore provides a measure of both effective system capacity and the use of spectrum**

Recommended Metric

- **The recommended metric is therefore spectrum efficiency for a specified service at a particular level of coverage. It is described mathematically as follows:**

$$\eta = \frac{C_{eff}}{S}$$

for a specified service
at a particular coverage

$$= \frac{C}{S(1+m/r)}$$

Typically r ≥ 1 i.e., the relay density increases faster than the base station density decreases

where C_{eff} = effective system capacity

S = total spectrum used by the system

C = system capacity or total information rate per base station

m = number of relays per base station

r = ratio of the increase in the density of relays to the decrease in the density of base stations to maintain constant total inforamtion rate per unit geographic area