

GSM<sup>®</sup>

# The **GSM** **S**ystem for **M**obile Communications



Michel MOULY  
Marie-Bernadette PAUTET

This book is published by the authors. Correspondence, in particular for orders, but also for comments, should be mailed to:

M. MOULY et Marie-B. PAUTET  
49, rue Louise Bruneau  
F-91120 PALAISEAU  
FRANCE

Telephone : +33 1 69 31 03 18  
Facsimile : +33 1 69 31 03 38

Copyright © 1992, **Michel MOULY and Marie-Bernadette PAUTET**

All rights reserved. No part of this book may be reproduced, translated, or utilised in any form or any means, electronic or mechanical, including photocopying, recording, or any information storage or retrieval system, without permission in writing from the authors.

All drawings are original, and all corresponding rights reserved.

The name and logo GSM (and "Global System for Mobile communications") are registered.

**International Standard Book Number: 2-9507190-0-7**

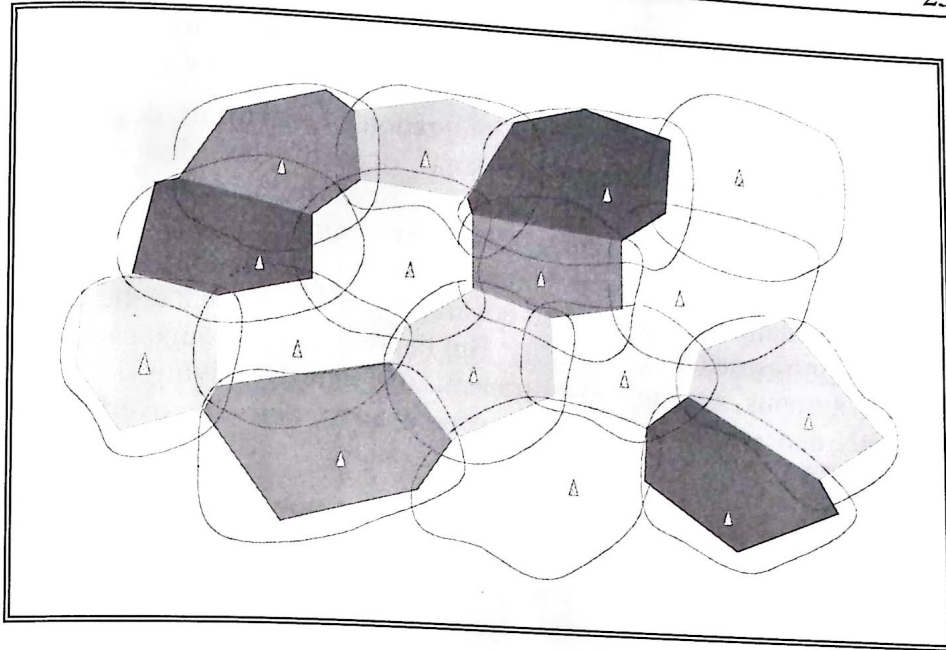


Figure 1.1 – The concept of cellular coverage

Numerous omnidirectional or sectorised antenna sites allow wide coverage, by splitting the geographical area into overlapping coverage areas. The lines show the limits of the overlapping coverage of the cells, whereas the polygons represent the more usual non-overlapping representation.

electronic techniques such as the vacuum valve enabled the implementation of a real-scale telephony service for cars. The first true mobile telephone service was officially born in St Louis (Missouri, USA) in 1946. Europe, recovering from war, followed a few years later.

The first mobile telephone networks were manually operated (that is to say that the intervention of an operator was required to connect the call to the wireline network) and the terminals were heavy, bulky and expensive. The service area was restricted to the coverage of a single emission and reception site (single-cell systems). Little radio spectrum was available for this kind of services, since it was allocated with priority to military systems (this has not changed much!) and broadcasting (in particular television). As a consequence, the capacity of the early systems was small and saturation came quickly despite the high cost of terminals which deterred many a potential customer. Quality of service decreased rapidly with congestion, and the throughput sometimes fell drastically due to near-deadlock situations.

Between 1950 and 1980, mobile radio systems evolved to become automatic and the costs decreased due to the introduction of semiconductor technology. Capacity increased a little but remained too

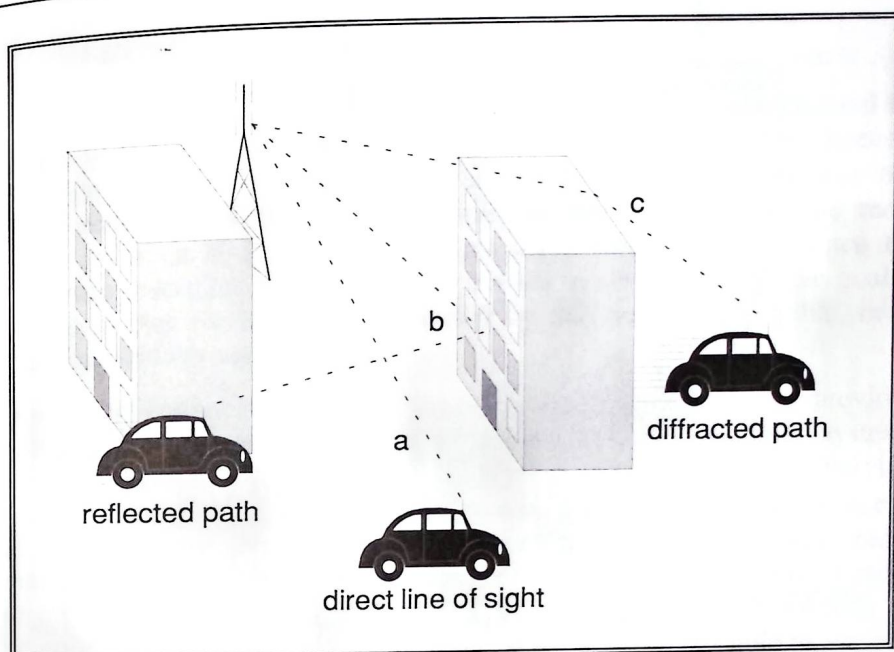


Figure 9.8 - Propagation paths

In most cases, propagation for land mobile radio systems does not follow a direct line of sight (a), but encounters many obstacles which reflect the radio waves (b) or diffract them (c), leading in both cases to losses much higher than with direct line transmission.

customers are likely to want service. As a result, an operator must take into account an important margin from the mean propagation loss.

The spread of the propagation loss around its median value depends on geography, on the height of the base station antenna and on the places where customers are expecting traffic. This last point is very tricky, since it depends on the subjective point of view of the users, influenced in particular by the indications provided by the operator or the service provider. If it is clear for users that they cannot expect coverage in underground trains, these places can be taken out from statistics; if users know that they may have to move by a few meters when using their terminal indoor, the indoor part of the statistics has to be corrected accordingly. A few years ago, with only vehicle-mounted mobile equipment, things were simpler, and measurements in the streets were sufficient to have an idea of the propagation loss statistics. From this period we inherited the classical log-normal model, where the distribution of the propagation loss for a given distance is modelled as a Gaussian distribution when expressed in decibel. This is the model assumed in