

# High-rise Office Buildings Commonly Suffer from Poor GSM Coverage

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GSM telephony is nowadays seen as a basic necessity for doing business. In general, outdoor GSM antennas provide a reasonable coverage into buildings. However, high-rise office buildings commonly suffer from poor GSM coverage. In this chapter we explain the reasons behind this problem by discussing three sources of the problem. In practice, this issue is not solved by changes in the outdoor GSM network, nor by changes in the building construction. A solution for the problem is often found in installing an indoor network inside the office building.



## Operators are Not Obligated to Provide Indoor Coverage

Operators do not guarantee indoor coverage. The reason behind the operators position is that 100% coverage is technically and economically impossible due to inherent radio propagation phenomena such as fading. Fading implies a quick and nearly random increase and decrease in signal strength due to reflections and shadowing of the radio signal by its environment. Also, indoor coverage is often hindered by the characteristics of a building, which is clearly outside the control of an operator. Consequently, the license does not oblige the operators to provide indoor coverage. The regulations of the Dutch Ministry of Economic Affairs regarding GSM900/1800 licences only specify outdoor coverage requirements. Moreover, these coverage requirements are formulated in terms of area percentage. E.g. for GSM1800 holds that in cities with more than 25,000 inhabitants, 95% of the area has to be covered by the operators network.

## Coverage Problems often Arise in High-rise Buildings due to Interference

Coverage problems are often experienced in high-rise buildings. The main reason for this is that the concept of *frequency reuse*, a fundamental GSM network property, causes too much interference at high levels, e.g. from the 10<sup>th</sup> floor up. The GSM network is a *cellular network* consisting of many small cells (antennas). In urban areas up to 10 cells per square kilometre can be found. *Frequency reuse* implies that frequency channels are re-used at a certain distance. In other words, at some distance, generally a few kilometres away, the same spectrum is being used by another network cell (antenna) to transmit another voice call. See Figure 1 for an illustration of the *cellular network* layout and the concept of *frequency reuse*. The reuse of spectrum is normally not a problem since obstacles such as buildings in between the serving cell and the other interfering cell are blocking the interfering voice call. However, at higher floors, other buildings are no longer blocking the interfering voice calls of other cells, resulting in a poor voice quality or even dropped calls. This effect is illustrated in Figure 2.

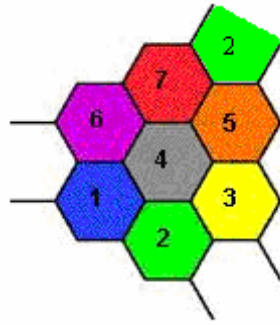


Figure 1: GSM network footprint showing the cellular network layout, each cell with one antenna, and the frequency channel being used. Frequency reuse is always used and implies that frequency channels are being re-used at a certain distance. In this figure we have 7 channels available and channel 2 is being reused at few cells distance.

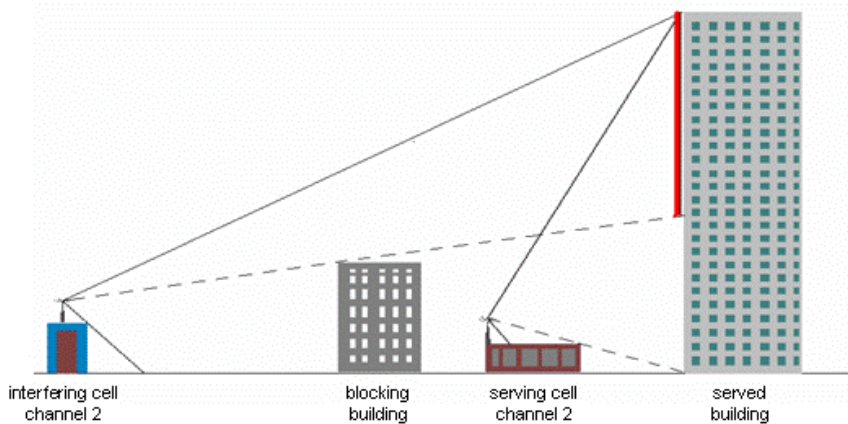


Figure 2: The building on the right side is covered by the serving cell using frequency channel 2 directly left from the building. The most left network cell is reusing the same frequency channel. On the lower floors of the building this is not a problem since the building in between is blocking the interfering cell. However, at higher floors (often the 10<sup>th</sup> and above) the building in between is no longer blocking the interfering network cell resulting in a bad experienced signal quality or even dropped calls

## Alternatively coverage problems may arise due to materials often used in office buildings

The materials used in the construction of the office buildings can also cause coverage problems. In modern architecture, the construction of office buildings often incorporates steel. Besides this, the windows are normally equipped with a metallic coating to dim the sunlight penetrating into the building. This metal coating is also responsible for attenuating the GSM radio signal when penetrating from outdoor antennas into the building. As a result, indoor GSM signal levels may be too weak, leading to poor voice quality, dropped calls, or no network coverage at all. This phenomenon can be experienced at all floors of the building, and can be especially pronounced in elevators, garages and deep inside the building.

It should be noted that the problem of too low signal levels may exist in conjunction with interference problems caused by frequency reuse. In this case both phenomena contribute to and enlarge the indoor coverage problem.

## Further questions?

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