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Implementation Aspects of RF-repeaters in Cellular Networks

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Abstract: This paper discusses the essential implementation aspects of simple amplify-and-forward type repeaters in the radio network planning. Different RF-repeater configurations are assessed through numerical analysis and field measurements in WCDMA network. The target of this paper is to show the important factors regarding the repeater deployment, which have significant impact on the overall cellular network efficiency. The paper shows the impact of repeater donor antenna beam width on the repeater deployment flexibility. Moreover, the impact of repeater on the optimum BS antenna tilt angle is presented using two macro cellular topologies. Finally, the significance of repeater placement in the repeater antenna line is emphasized through field measurements using an outdoor-to indoor repeater configuration for WCDMA.

Keywords: External antenna, Signal booster system, internal antenna, GSM, UMTS

I. INTRODUCTION

In telecommunications, a repeater is an electronic device that receives a signal and retransmits it. Repeaters are used to extend transmissions so that the signal can cover longer distances or be received on the other side of an obstruction. Some types of repeaters broadcast an identical signal, but alter its method of transmission, for example, on another frequency or baud rate. There are several different types of repeaters; a telephone repeater is an amplifier in a telephone line, an optical repeater is an optoelectronic circuit that amplifies the light beam in an optical fiber cable; and a radio repeater is a radio receiver and transmitter that retransmits a radio signal.

A repeater is an electronic device in a communication channel that increases the power of a signal and retransmits it, allowing it to travel further. Since it amplifies the signal, it requires a source of electric power. The term "repeater" originated with telegraphy in the 19th century, and referred to an electromechanical device (a relay) used to regenerate telegraph signals. Repeaters are used to connect 2 physically close buildings together that are too far apart to just extend the segment. Can be used to connect floors of a building together that would surpass the maximum allowable segment length The aim is to develop a signal booster circuit to enable even the remote areas to obtain the signal.

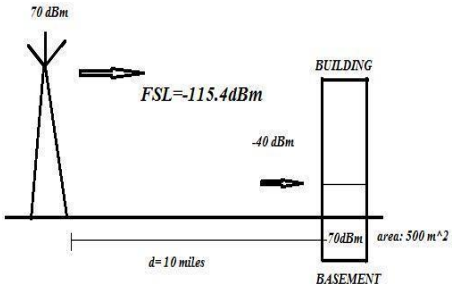


Fig1. Signal without enhancer

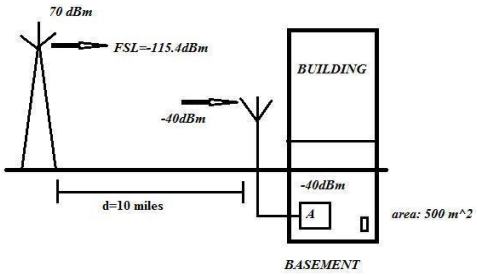


Fig2. Signal with enhancer

II. PAPER ORGANISATION

We provide relevant definitions and background information on different types of antenna in Section III and Experimental method in IV. In Section V, we give the recommendations of other antenna and we give concluding remarks in Section VI.

III. BACKGROUND AND DEFINITIONS

A. Pre Requisite:

1. Dead Zone:

A mobile phone signal (or reception) is the signal strength (measured in dBm) received by the mobile phone from the cellular network (on the down link). Depending on various factors, such as proximity to a tower, obstructions such as buildings or trees, etc., the signal strength will vary. Most mobile devices use a set of bars of increasing height to display the approximate strength of the received signal to the mobile phone user.

Areas where mobile phones cannot transmit to a nearby mobile site, base station, or repeaters are known as **dead zones**. In these areas, the mobile phone is said to be in a state of outage. Dead zones are usually areas where mobile phone service is not available because the signal between the handset and mobile site antennas is blocked or severely reduced,

usually by hilly terrain, dense foliage, or physical distance.

A number of factors can create dead zones, which may exist even in locations in which a wireless carrier offers coverage, due to limitations in cellular network architecture (the locations of antennas), limited network density, interference with other mobile sites, and topography. Since cell phones rely on radio waves, which travel though the air and are easily attenuated (particularly at higher frequencies), mobile phones may be unreliable at times. Like other radio transmissions, mobile phone calls can be interrupted by large buildings, terrain, trees, or other objects between the phone and the nearest base station.

2. Antenna:

The following antennas are most suitable for mobile communication*:*

I. Directional and Omni-directional

GSM antennas will be either directional or omni-directional. Omni-directional antennas, also known as helical antennas, can receive signals from any direction. Directional antennas usually have more gain, that is, more sensitivity to signal, than omni-directional antennas. Directional antennas accomplish

Fig3. Antennas

B. Description

Wireless (GSM/CDMA) networks enable network operators to offer users a wider range of more advanced services while achieving greater network capacity through improved spectral efficiency.

this greater sensitivity because they are able to focus their energy patterns onto a smaller area than omni-directional antennas. However, to receive signal, directional antennas must be pointed in the specific direction from which the signal is emanating.

I. Monopole Antennas

Monopole antennas consist of a small pole placed upon a planar piece of metal or a series of wires radiated out from the pole. Monopole antennas are omni-directional in nature and have equal gain in all directions so that we can use it outdoor.

II. Yagi-Uda Antennas

Yagi-Uda antennas, more often referred to simply as Yagi antennas, are directional antennas made up of a dipole element, a reflector dish and one or more director elements. Yagi antennas are much more complicated in design than most other types of GSM antennas.

III. Multiband Antennas

Multiband antennas can also be used to pick up GSM signals. They are able to pick up many sorts of different signals, including the GSM frequency, which is usually the 800 MHz or 1900 MHz bands. Multiband antennas can come in many different models. Tri-band antennas can be tuned to pick up three different bands, while duo-band antennas can pick up two different bands.

C. Table

Specifications of GSM module:

	Signal GSM-80	Signal GSM-300
Frequency range	Up Link: 890-915MHz, Down Link 935-960MHz,	Up Link: 890-915MHz, Down Link 935-960MHz,
Output power	UL: 5dBm, DL: 5dBm	UL: 15dBm, DL: 15dBm
Gain	UP: 35dB, DL: 45dB	UP: 50dB, DL: 60dB
Coverage area	80m^2	300m^2
In-band ripple	<3dB	<3dB
Maximum group delay	1.5 µs	1.5us
Out-of-band spurious emission	< -40dBm	< -40dBm
Impedance	50Ω	50Ω
Antenna connectors	out. antenna: N-f, ind. antenna SMA socket,	out. antenna: N-f,ind. antenna N-f
Power	10V DC	10V DC
Operating temperature range	-25°C to +55°C	-25°C to +55°C
Operating relative humidity	5%-95%	5%-95%
Dimensions [mm]	130x85x35	293x148x35

Services include wide-area wireless voice telephony, video calls, and broadband wireless data, all in a mobile environment. Additional features also include High Speed Packet Access (HSPA) data transmission capabilities able to deliver speeds used for GSM applications. The coverage of a mobile system depends significantly on the geographical nature of the covered area. The signal propagation can be dramatically different in downtown area with many high buildings than in a building free area. Wireless cellular (GSM/CDMA) repeater is a simple, low cost solution in extending Wireless network coverage for enhanced connectivity.

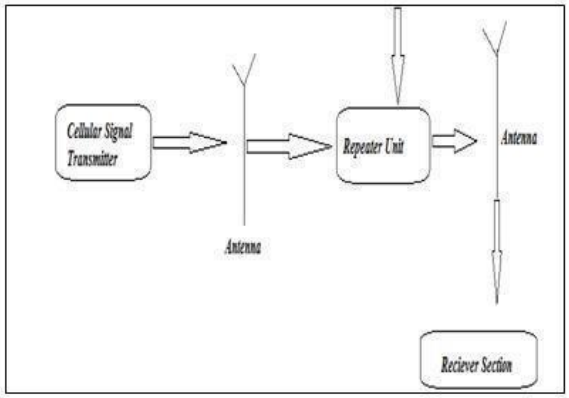


Fig. 4 Block diagram

C. Abbreviations and Acronyms

GSM is "Global System for Mobile communication". The **uplink frequency range** specified for GSM is 933 - 960 MHz..The **downlink frequency band** 890 – 915 MHz. GSM is a digital system with an over-the-air bit rate of 270 kbps.

IV. EXPERIMENTAL METHOD

Repeaters

A repeater on the other hand is simply a device that receives and retransmits the incoming and outgoing signals without adding power or amplifying the signal whatsoever. This type of device is commonly installed when a building's structure or roof is stopping a mobile phone signal from penetrating, causing reception to be strong outside the building but very weak inside.

A repeater requires a very strong signal outside, and a high gain external antenna (usually a directional yagi or high gain collinear) mounted clear of the roof. This high gain external antenna is then connected to an internal low gain antenna inside the building by a cable running through the roof or wall.

Conventional ceiling -mounted repeater systems do not work effectively. While the theory and technology works perfectly, the inverse-square law of RF propagation results in almost all signal increase is lost after the first metre. In our work, Instead of connecting a ceiling antenna, connecting up a large pad antenna that can sit on the desk and any phones placed on the pad are provided the increased signal.

Much like a regular passive repeater system, this type of setup requires the following items:
- High gain external antenna
- Low loss cable
- A large flat antenna for sitting phones on

External Antenna

For the external antenna, a high gain directional antenna, such as a 16dBi Yagi Antenna will provide a very high gain and should provide plenty of signal when installed pointing in the direction of the nearest mobile phone tower. While providing best performance often this antenna (at a whopping 2.4m in length) is a handful to mount, so 14dBi Yagi's are a good compromise between performance and ease-of-installation.

Cable

This antenna should be used with a super low loss cable like LMR400, to ensure maximum signal is transferred to the internal radiating antenna. A 10m LMR400 cable will do the trick for most households and will incur a measly 1.2dB of loss over the whole 10m (when used with Telstra Next-G), compare this to standard RG58 cable, which will lose around 4.6dB over the same distance.

Internal Antenna

A flat antenna with a large surface for placing phones. We can place as many phones as fit on the antenna (can even stack them on top of each other!). A high quality panel antenna such as the designed internal Flat panel desk antenna, is tested against a number of other panel antennas which provide the most significant improvement in mobile phone signal.

If we don't feel like customising your kit we sell a high quality House-Wide Coverage Kit containing all antennas, fittings, cabling and brackets required for this set up.

With the Total House-Wide Coverage Kit (contain antennas, fittings, cabling and brackets) we can make and receive calls from mobile phone anywhere in the house. Simply leave up to four Bluetooth enabled phones on the pad and enjoy the freedom as calls are then routed through a stylish cordless phone system.

By placing a strong antenna on the roof and running a cable inside we negate the blocking effect. The internal panel re-broadcasts the signal obtained by the roof antenna exceptionally well, but because of the 'inverse square law' of RF transmission signal improvement drops off rapidly as we move away from the panel. By placing phones on the internal panel antenna one can enjoy improved phone reception without having to connect with a cable or specially designed cradle.

The cordless phone system can then be used to route calls from up to 4 mobile phones through the cordless

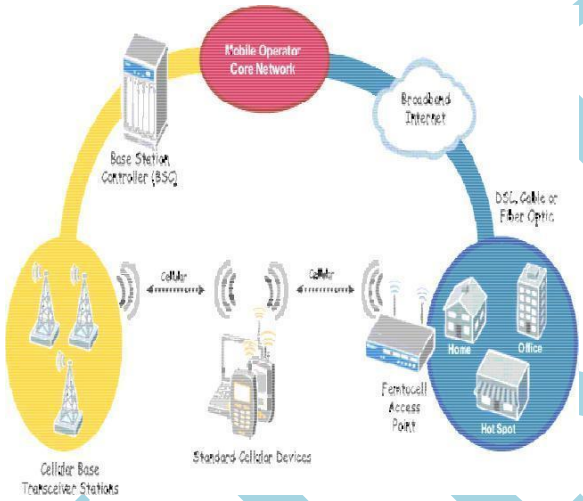
handsets, meaning you can enjoy the freedom of movement throughout your home and still make phone calls. The cordless phones only need a spare power-point and can be used even if already have an existing cordless phone system.

From experience we find most phones will pick up almost all of the signal obtained by the external antenna when placed next to the internal antenna, with signal decreasing as per the inverse-square law as the phone gets further away from the antenna. Usually even a small increase in signal will be enough to make the difference between making a call or receiving a text message.

V. OTHER RECOMMENDATIONS

1. *FEMTO CELL*

A femtocell acts like a miniaturized cell tower in your home, creating an access point for both voice and data that provides better reception than what you might be getting from the nearby cell tower. In addition to the femtocell device (available from cell providers), you need an Internet connection and a home LAN (wired or wireless network). After plugging the device into your network, your cell phone uses the femtocell's radio frequency to connect to your cellular network. When you leave the house, your phone will automatically switch over to communicating over the normal cell towers.



2. *CELL REPEATER*

A cell repeater can also help in boosting reception. Made up of a few more parts than a femto cell, a cell repeater includes an antenna, an amplifier, and a coaxial cable that connects them. The antenna is placed either outside your building or on a window and then you can string the coaxial cable to the most convenient spot to place the amplifier. Some cell repeaters include an additional indoor antenna, but many of them integrate that into the amplifier.The antenna grabs a range of supported frequencies and then retransmits them with a stronger signal from the amplifier. When you make a call or use data when within the cell repeater's range, the indoor antenna picks up the signal from your mobile phone and transmits it through the outdoor antenna.

3. *CAR ANTENNA*

The ideas discussed so far can be used for signal reception within a closed area. A car antenna may be used to enhance signal inside a moving car. That's because cars insulate cell phones from the external GSM signal, an unwanted artifact known as the "Faraday Cage." This Cage can sometimes result in

poor voice quality and even dropped calls. A well-installed external car antenna usually fixes the problem. And if you're in a rural area that's on the periphery of the GSM coverage range, or even in a building that tends to block GSM signals, there are some novel antenna solutions available.

4. *SOLAR*

To provide the power for the enhancer a solar panel (renewable source) can also be used. A **solar panel** is a set of solar photovoltaic modules electrically connected and mounted on a supporting structure
.The solar module can be used as a component of a larger photovoltaic system to generate and supply power to the enhancer circuit. The power generated by the photo voltaic cells is also used to charge a rechargeable battery which will power the circuit during night times (No light condition).

VI. CONCLUSION AND FUTURE WORK:

1) Installing repeaters are improving overall communication.
2) The possibility of use of repeaters which makes communication more reliable and error free.
3) This is used to increase the range of telephone signals in a telephone line.
4) They are most frequently used in trunk lines that carry long distance calls.

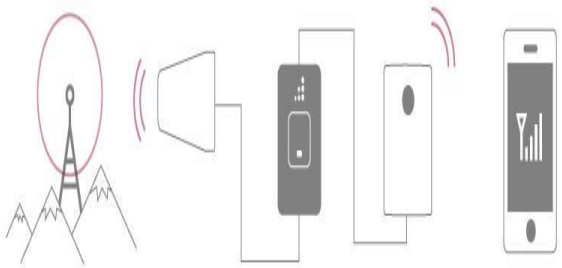


Fig.5 Basic setup of repeater installation

the wire pair carries two audio signals, one going in each direction. So telephone repeaters have to be bilateral, amplifying the signal in both directions without causing feedback, which complicates their design considerably. Telephone repeaters were the first type of repeater and were some of the first applications of amplification. Based on Customer requirement we arrange the different types of repeaters.

Fig. 6 Basic setup of Booster

Fig. 7 Basic setup of Panel Antenna

Fig. 8 Basic setup of Repeater

Fig. 9 Basic setup of Customer Coverage Normal view

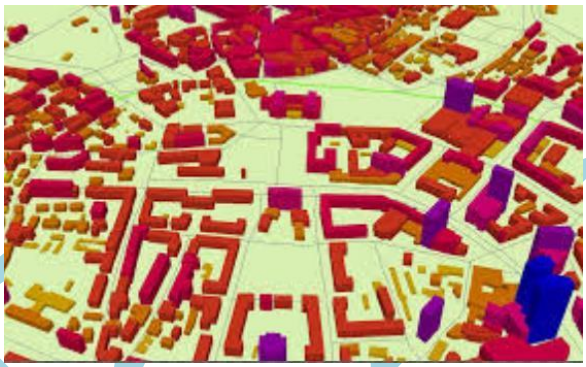


Fig. 10 Basic setup of Customer Coverage Digital view

REFERENCES

[1] J.H Wnnters, AT&T Bell Labs, in "USA Personal Communications", *IEEE* (Volume: 5, Issue: 1), Feb 1998.
[2] Rappaport, *wireless communications: principles and practice*, Pearson Education India, 2009,pp 57-97.
[3] Balanis C.A, *Antenna Theory & Analysis*, John Wiley & Sons, 2007,pp 945-995
[4] www.mobileworld.org
[5] www.clove.co.uk

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