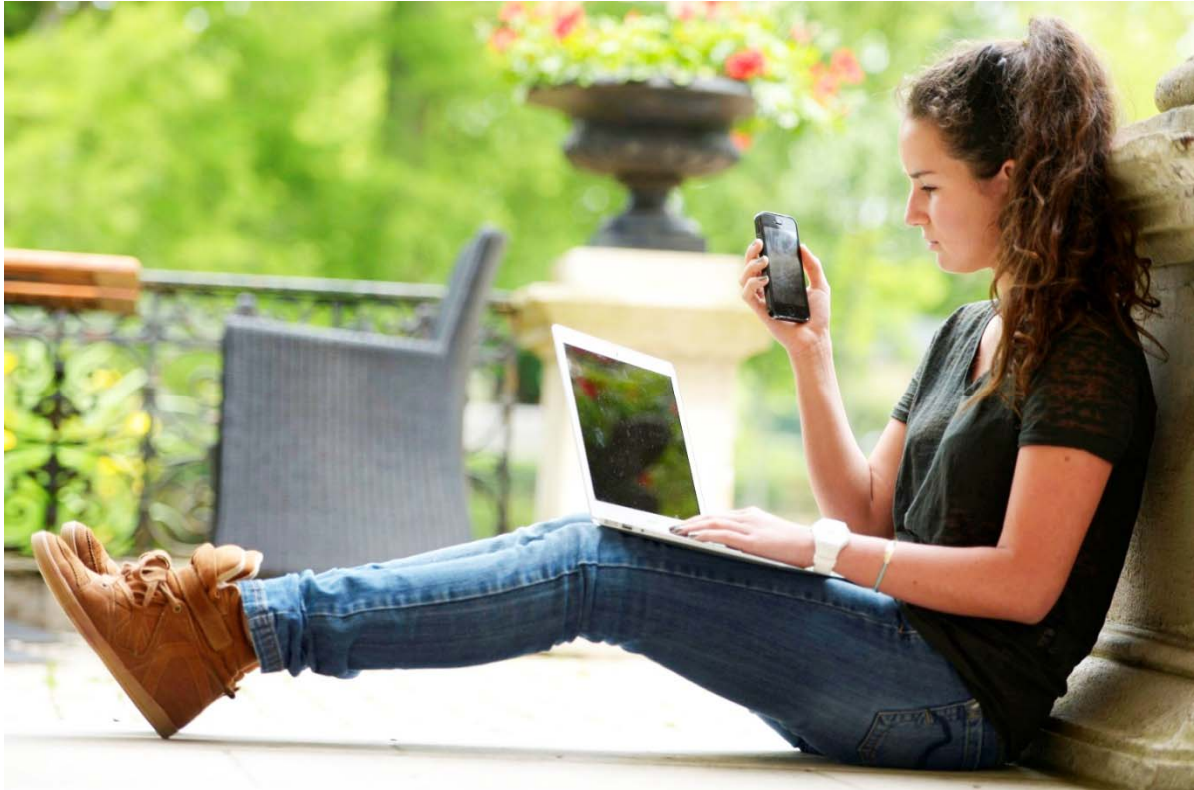


IMPROVING MOBILE SIGNAL



Introduction

The purpose of this guide is to educate consumers on ways to improve their mobile signal and also find the causes of their poor signal.

One of the biggest complaints mobile users make is having poor signal. Not being able to make a call, missing calls and having slow internet speeds is often very frustrating. For businesses not being able to receive calls can mean revenue loss and upset customers.

Never fear there is a solution to improving your signal and within this guide I will explain the many ways you can improve your signal and stay connected.

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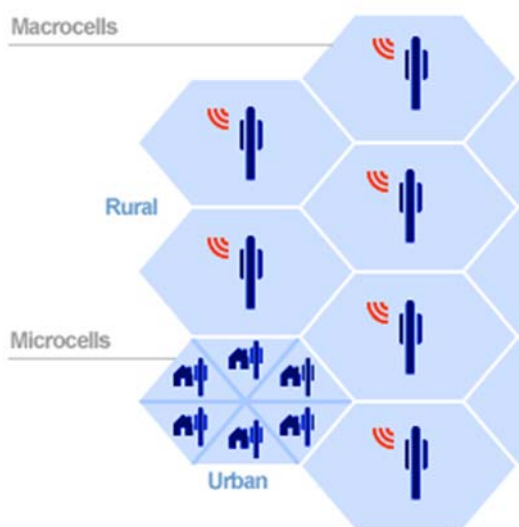
Mobile Phone Networks

How Do They Work?

A mobile phone network or cellular phone network as it is also known, is made up of a large number of signal areas called cells. These cells join or overlap each other to form a large coverage area. Users on the network can cross into different cells without losing connection.

Within each cell you will find a base station or mobile phone tower, which sends and receives the mobile transmissions. A mobile device will connect to the nearest or least congested base station. The base stations are connected to a digital exchange where the communication is sent to other telephone or data networks.

Cells will often be smaller in size throughout large towns and cities due to the number of users in the area. The higher the population density the more base stations are needed.

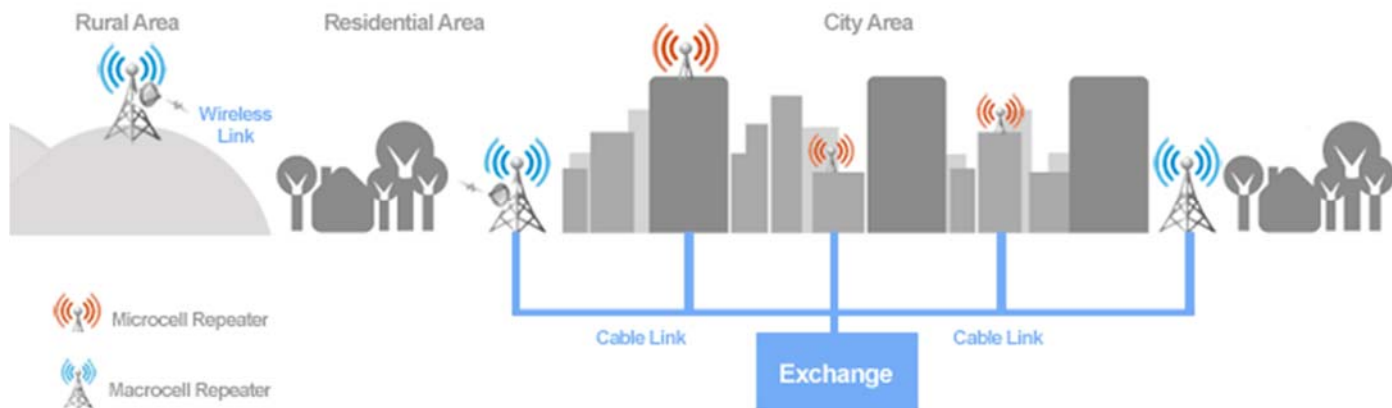


Base Station Types

Base Station Type	Typical Coverage Radius	Typical Use
Femtocell	10m	home or office use
Domestic Repeater	100m	home, office or factory use
Picocell	200m	high rise building, hotel or car park use
Microcell	1-2km	shopping centres, transport hubs, mine sites, city block, temporary events or natural disasters.
Macrocell	5-32km	suburban, city and rural use
Macrocell - Extended Reach	50-150km using extender cell technology	rural use

Cell Coverage

The cell coverage area is determined by the base station output power and the environment. Things such as trees, hills, buildings and land formations will have an effect on the coverage area.



In city areas there is generally a larger number of users and also obstructions. To help compensate you will find a lot more base stations to cover demand, and the cell sizes will have a 2-5km radius. In country areas where there are large open spaces the base stations will be further apart and the cell radius will be around 10-32km. Using extender cell technology like that used by Telstra's NextG™ network, a radius of 80-200km can be reached.

Mobile Black Spots

Found in both city and rural areas, a black spot is an area that has a lack of mobile signal. There could be no signal at all in the location or not enough signal to place a phone call.

Black spots are often caused by the base station not being able to transmit into a particular area. This could be due to buildings, mountains, vegetation, terrain or simply the distance is too far away.

The Australian Government has announced the [Mobile Black Spot Programme](#) to extend mobile coverage and competition in regional Australia.

How Signal Effects Calls, SMS and Data

When your mobile device has poor signal its ability to effectively communicate with the base station diminishes. Sometimes your phone will be connected to the network, but will not have enough signal to place a call or send an SMS.

Voice

Often voice is the first thing to go when you get down to one bar of signal or less. When you place a voice call it is converted into data. A constant stream of data is required to be maintained in order for the call to stay open. If not continuous the call can cut in and out, or even drop the connection all together.

Data

Data will usually become unreliable, with requests to the base station either not being sent or received back. You may have to send multiple requests before a response is received back. Data is sent in

packets, instead of being a continuous connection like voice, making it a more reliable form of communication in low signal areas.

SMS

SMS will often be the last to stop functioning. This is because like mobile data, SMS is sent using small packets. An SMS will try for quite some time to send before it times out, usually allowing the message to eventually be sent. At the other end, the network will store the reply SMS until you are able to successfully receive. This form of communicating is often the most effective when your phone has very poor signal.

Your phone will use a lot more power when the signal is low, this is because the phone's amplifier is operating at full power to try and get a signal. As a result the battery will drain quicker.

Lower Mobile Frequencies Offer the Best Range

The carriers have chosen to utilise the lower frequency such as 700, 850 and 900 for their primary bands because they offer much better range and building penetration than the higher bands. As a result you will find that these lower bands are widely used in country areas.

The higher 1800/2100 bands are very useful to the carriers in highly populated areas due to the increased user capacity that they offer.

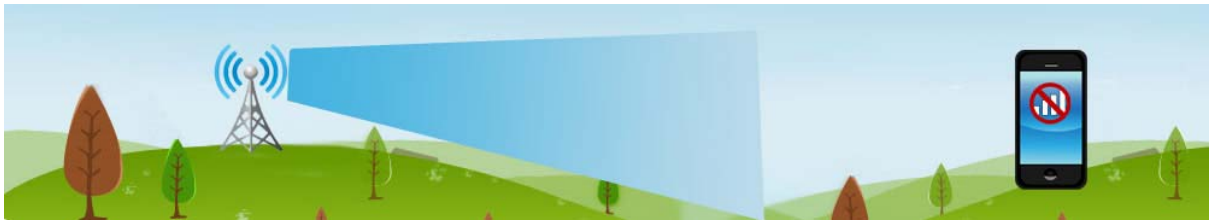
The 700 band is due to go live in January 2015 and will be the primary band for 4G in rural areas for Telstra and Optus.

These will be the future bands used in rural areas from 2015:

Mobile Carrier	3G Band	LTE Band
	850 (Rural) 2100 (City)	900 (Rural) 700 (Rural) 1800 (City) 2500 (City)
	900 (Rural) 2100 (City)	700 (Rural) 1800 (City) 2500 (City)
	900 (Rural) 2100 (City)	850 (Rural) 1800 (City)

Causes of Poor Mobile Signal

Distance from the Tower



Mobile base stations have a set coverage area that they can broadcast a signal. This distance is dictated by the hardware used on the base station, the output power, it's location in regards to terrain and the frequency being used to broadcast.

One of the most critical factors in determining signal reach is the towers search window area. In order for the mobile network to work efficiently, the towers need to supply the majority of customer within that cell area with the best quality service and ignore those on the edge that use up valuable resources. They do this by limiting the reach at which a customer's phone can see the tower. A tower's search window might typically be set to 30, 60 or 160km, so only users within that range would be able to connect to the tower.

If you are on the outer footprint of the coverage area, you may experience an unreliable level of service with call drop outs and slow data speeds.

If we look at Telstra for example typical 4G signals on 1800MHz travel up to 5km from a base station. 3G signals on 850MHz typically extend out to 60-120km, with a record of 200km being achieved during testing by Ericsson and Telstra using extended range technology.

Physical Obstructions



One of the most common causes of poor mobile signal is when the radio waves are degraded by obstacles between the base station and the user. This includes buildings, terrain such as hills, vegetation, weather and other structures.

Building Structures



Poor indoor coverage is usually caused by building materials that assist in shielding the signal from entering the building:

- Brick, concrete and tiles are great at shielding the signal.
- Double glazed or tinted windows
- Metal roofs
- Reinforced steel concrete walls.
- Retaining walls

Interference

If the base station is experiencing interference from a radio emitting device, it can cause the tower to lower its output power. An example of this is illegal mobile phone repeaters and boosters. Other objects known to cause interference are solar panels and large stadium viewing screens.

Network Issues

On occasions the base station you are connected to may experience a reduction in performance. This could be due to a hardware issue or a tower upgrade. Sometimes when a 3G tower is upgraded to 4G some customers may experience a reduction in signal levels. Contact your service provider if you ever experience this to report the issue.

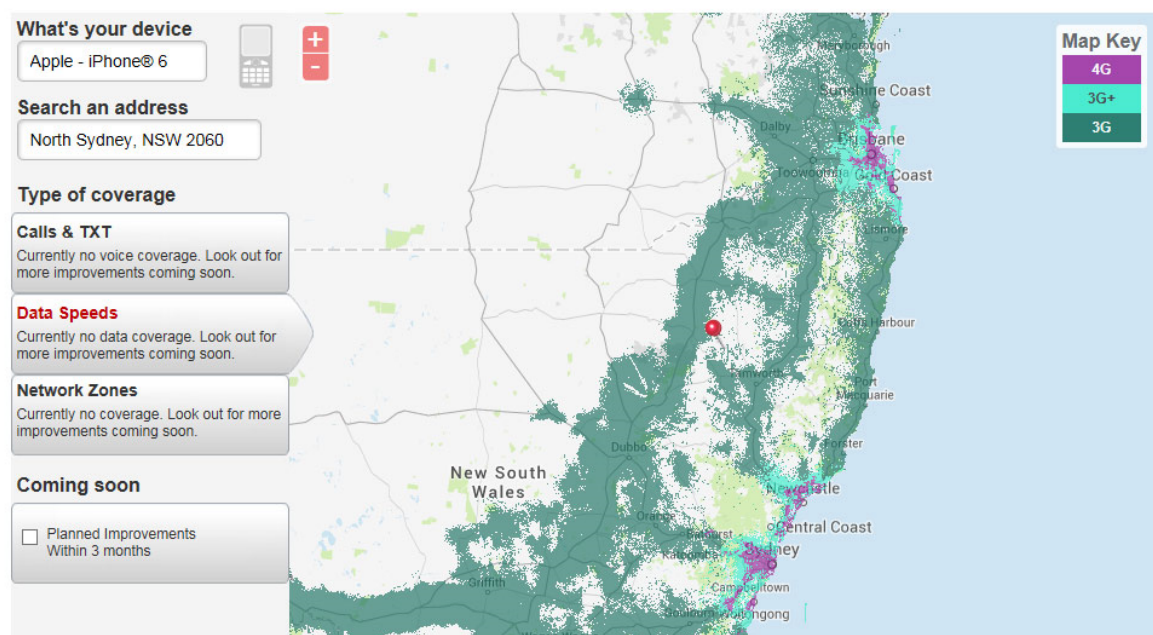
Network Congestion

Believe it or not the number of users on the tower can also affect your signal level. During times of peak use, customers may experience lower signal than normal. This is due to an effect called 'cell breathing' where a tower decreases its coverage area so users can be offloaded to a neighbouring tower. Cell breathing will affect 3G networks, but not LTE networks.

Coverage Checkers

Each of the mobile service providers in Australia offer coverage checkers using interactive maps. They use intelligent software to predict the area on the map that will have signal. As these maps are only a prediction, they may not be exact, but come very close. The prediction is based on the location of towers, the tower hardware being used and the surrounding terrain.

Coverage Checker



Telstra

<http://www.telstra.com.au/mobile-phones/coverage-networks/our-coverage/>

Telstra's coverage checker provides the ability to switch between voice and data, 3G/4G or 2G, and also predict your data speed.

Optus

<http://www.optus.com.au/network/mobile/coverage>

Optus offer the ability for customers to enter their device and then display the coverage based on the bands their device supports. GSM, 3G and 4G coverage is represented by different colours on the map. Extra features they offer are an indoor and outdoor coverage rating, outages in the area and future coverage options for 3 or 6 months' time.

Vodafone

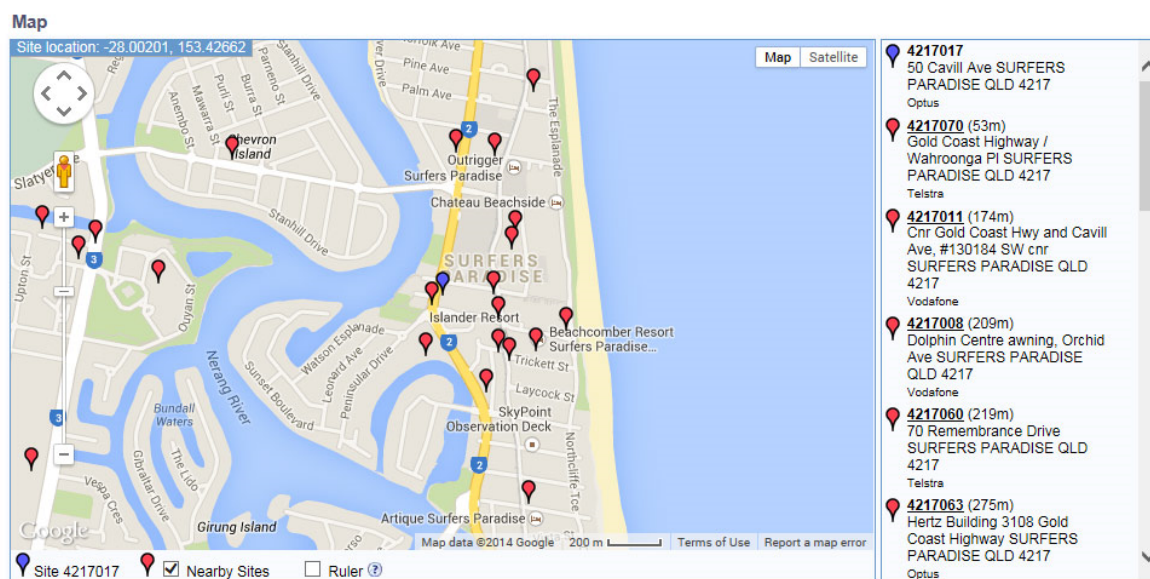
<http://www.vodafone.com.au/aboutvodafone/network/checker>

Vodafone also have the ability for customers to enter their phone model and tailor the map to their supported bands. A colour overlay on the map represents the indoor and outdoor coverage areas, as well as the different data speeds. There is also a map overlay showing the 3G and 4G coverage with the different frequency bands.

How to Locate a Mobile Base Station

Knowing the location of the nearest mobile base station or tower can be extremely useful in helping improving your signal. Knowing which way to point a directional antenna, which side of the building to mount an antenna, or which tree to trim can go a long way to getting the best possible signal.

Radio Frequency National Site Archive



The Australian Mobile Telecommunications Association (AMTA) is the peak industry body representing Australia's mobile telecommunications industry. They also keep an up to date list of mobile base stations with information on the frequencies used by these sites.

Step 1

Go to <http://www.rfnsa.com.au/nsa/index.cgi>

Step 2

Enter your address

Step 3

Tick the 'Nearby Site' checkbox

Step 4

Hover over the sites on the map to see the carriers using that site.

Step 5

To identify the frequency being used, click on the site and under reports, open the Environmental EME Report. This report will list the existing frequencies being used and may mention future plans.

How to Measure Mobile Signal

Measuring mobile signal is done in two ways, using the signal bars on your mobile device or obtaining exact readings.

Signal Bars



The signal bars on your mobile device will offer a very basic interpretation of the mobile signal and also the signal quality. Each phone manufacturer calculates how many bars to display differently, resulting in different readings between phones in the same location. It is important to stress that signal bars do not always mean you can make a call. Users will sometimes have signal bars, but cannot place a call due to network congestion.

The bars on your phone are a representation of both signal strength and the quality of the signal. As we have progressed from GSM, 3G and now 4G, the quality of the signal has become just as important as the signal strength level in determining your quality of service. Users with five bars may have a low signal strength reading, but have excellent signal quality.

iPhone – iOS 7 takes into account the signal strength, signal quality and also the number of people using the base station to determine how many bars are displayed. This helps to prevent a user thinking they can place a call when they have several bars.

Other Phones – only takes into account the signal strength in dBm and the signal quality in determining how many bars to display.

Exact Readings



The other way to measure signal is using exact readings from your phone. To access these readings you need either to put your phone into service mode or download a signal App. There are several measurements that determine the quality of your mobile signal:

Signal Strength – GSM & 3G/HSPA (RSSI)

Applicable to GSM and 3G networks. The exact signal strength, often called Received Signal Strength Indication (RSSI), is measured in dBm. The dBm scale is roughly between -50 and -120dBm, with -50 being perfect signal and -120 being when you fall off the network. RSSI measures both the usable signal and the noise in a single figure.

-50 to -75 dBm – High Signal

-76 to -90 dBm – Medium Signal

-91 to -100 dBm – Low Signal

-101db to -120 dBm – Poor Signal

Signal Strength – 4G/LTE (RSRP)

LTE signal strength is measured on a different scale than 3G/HSPA, it is measured in Reference Signal Received Power (RSRP). This often ends up being around -20dBm lower than RSSI, so -100dBm (RSSI) would equate to around -120dbm (RSRP).

$$RSCP = RSSI + Ec/Io$$

RSRP does a much more accurate job of measuring signal strength than RSSI, as it excludes noise and interference on the network, measuring just the usable portion of the signal. Just because RSRP signals appear lower, it will not mean your signal is worse.

-75dBm and -88dBm is a strong signal

-89dBm and -96dBm is a very good signal

-97dBm and -105dBm is good

-106dBm and -112dBm is fair

-113dBm and -125dBm is poor

Signal Quality

SNR

The "Signal to Noise Ratio" is a measurement that compares the signal strength to the level of background noise. The higher the SNR the better your signal quality will be. The SNR reading will be automatically calculated by the base station in dB. On the SNR scale 4 is poor and 25 is great.

ASU

"Arbitrary Strength Unit" is a value that is proportional to your RSRP. The higher the number the better your signal quality. $ASU = RSRP + 140$, so if you have a RSRP of -100dBm, then the ASU will be 40.

Ec/Io

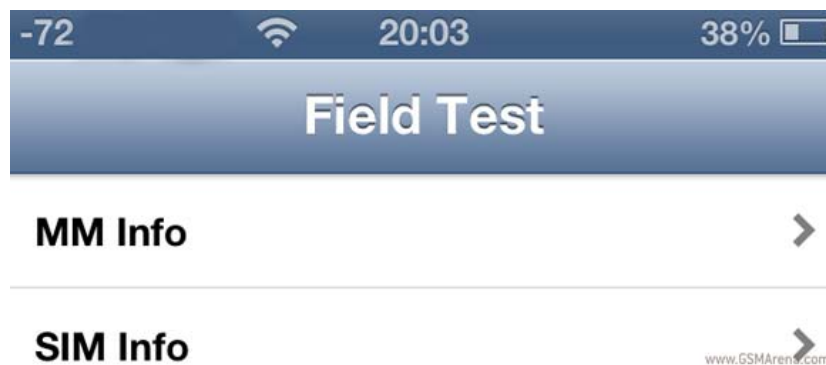
Very similar to SNR above, this measurement is the ratio of signal to interference. With the best being around -10 and the worst quality being around -40.

RSRQ

Reference Signal Received Quality is the ratio of usable signal to noise and interference measured in dBm. $RSRQ = RSRP - RSSI$

Field Test, Service & Engineering Modes

To access the exact readings you need to go into your phones field test mode or into the phones settings to get the current network status.



Field test mode is entered by typing a code into the phones keypad, with each phone model having it's own unique code.

iPhone

dial *3001#12345#* into the keypad and press call.

Android

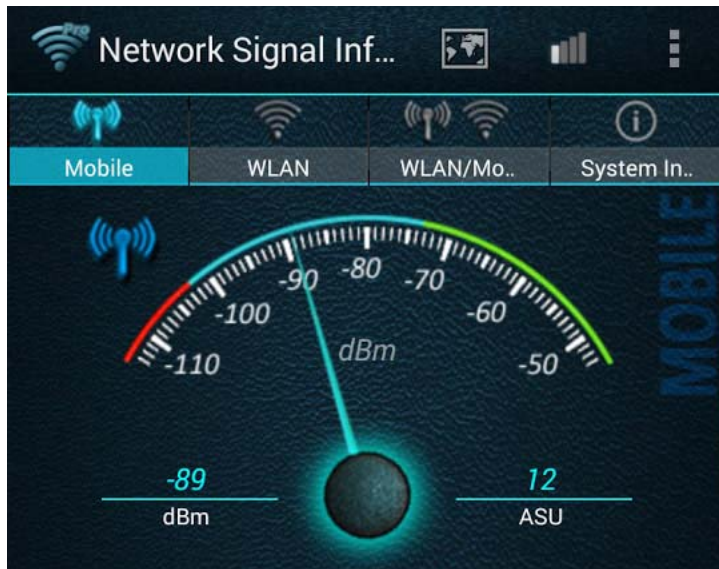
You can view the db reading by going into Settings > About Phone.
For service mode enter *#0011# into the keypad.

ZTE/Telstra Phones

For service mode enter *983*3641# into the keypad. To exit service mode enter *983*3640#

Apps that Measure Signal Strength

One of the best ways to display this information in an easy to understand manner is by using Apps. Android has the best Apps available for measuring signal, some just display the measurements in a table, whilst others have great graphical representations. Apple unfortunately does not approve Apps that measure the phones signal strength.



Android Apps

- Advanced Signal Status
- G-NetTrack
- Network Signal Info
- RF Signal Tracker
- Network Signal Strength
- Phone Signal Notifier
- Phone Signal

Solutions to Improve Mobile Signal

If you are one of the many people that suffer from poor mobile signal the following section is designed to help find the ideal solution.

For the sake of overloading you with information I will be leaving out illegal products that are either banned or do not have permission to be used on the networks. These include mobile phone boosters and mobile phone repeaters. There are large fines associated with using these devices and even imprisonment, due to the fact that they can seriously interfere with the mobile network.

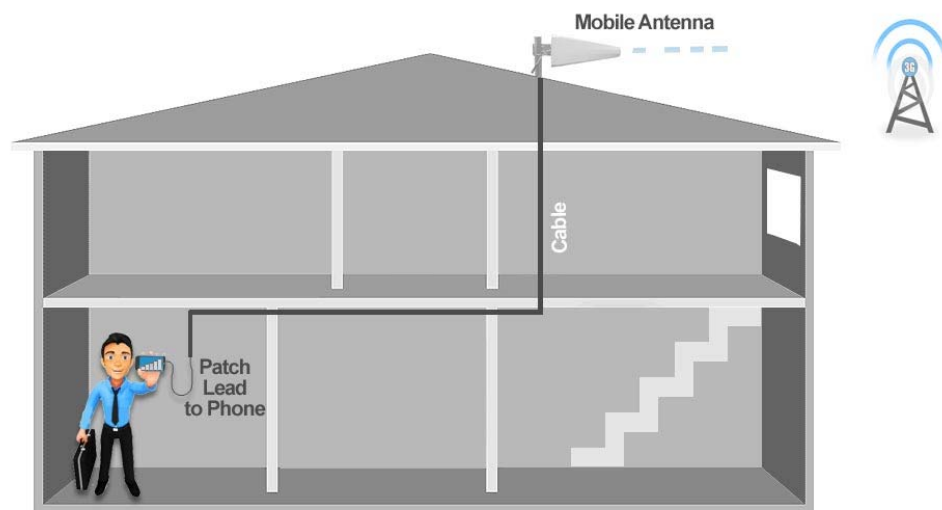
Legal ways to improve signal include:

- Antennas
- Passive Repeater
- Smart Repeaters
- Femtocells
- Changing Mobile Providers
- Purchase a New Mobile Device
- Contact your Mobile Provider
- Carrier Solutions

Antennas

The most common and cheapest way to improve your mobile signal is by using an external antenna connected to your mobile device. A majority of mobile devices have an external antenna port, and by using a 'mobile patch lead' you can connect an external antenna. For those smart phones without an external antenna port a cradle style patch lead is usually available to transfer the signal.

Antennas come in all shapes and sizes, from vehicle whip style antennas, marine grade, vandal proof, desktop, wallmount, ceiling mount and even antennas shaped like lamp posts



Antennas can be divided into two categories:



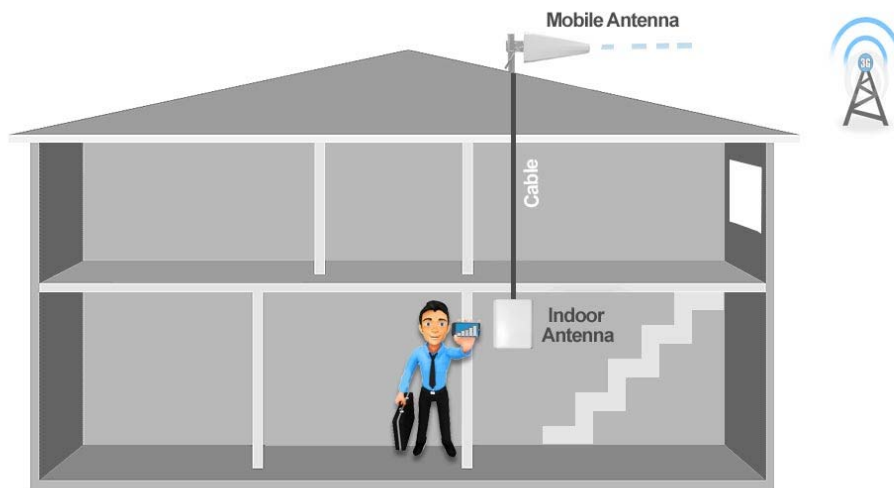
i) Omni-Directional Antennas - These antennas will receive a signal from all directions and are often called a whip antenna. They are useful in situations where the mobile device is constantly moving such as on a vehicle, where the location of the nearest mobile tower is not known or when there is not a clear line of site to the tower and the signal is bouncing off nearby objects.

ii) Directional Antennas - As the name suggest these antennas are designed to receive a signal from a particular direction. Sometimes called a panel or yagi antenna, they are often much higher gain. They are ideal in low to medium signal areas where there is line of site to the tower.



The **gain** of an antenna is its effectiveness in focusing radio frequency energy in a particular direction. The higher the gain the more focused the antenna is and the narrower the field of reception. Antenna gain is measured in dBi or dBd and the greater the gain the better your signal should be.

Passive Repeater

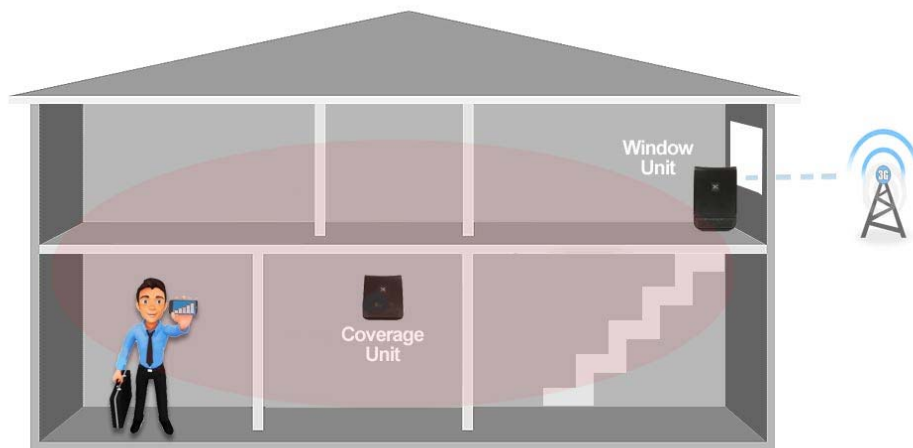


Very similar in principle to the active repeater, but without any amplification or powered repeater. A passive repeater would usually consist of a directional antenna outside the building connected by cable to a directional antenna inside the building to disburse the signal.

This type of repeater needs to be setup correctly and relies on the signal at the outdoor antenna being close to perfect. There is therefore no guarantee this type of installation will work adequately.

An adaption of this system that is commonly used is for the indoor antenna to be a flat panel antenna that a mobile phone can sit on. The mobile is left on the panel antenna and a blue tooth enabled cordless phone is used to receive and make calls.

Smart Repeater



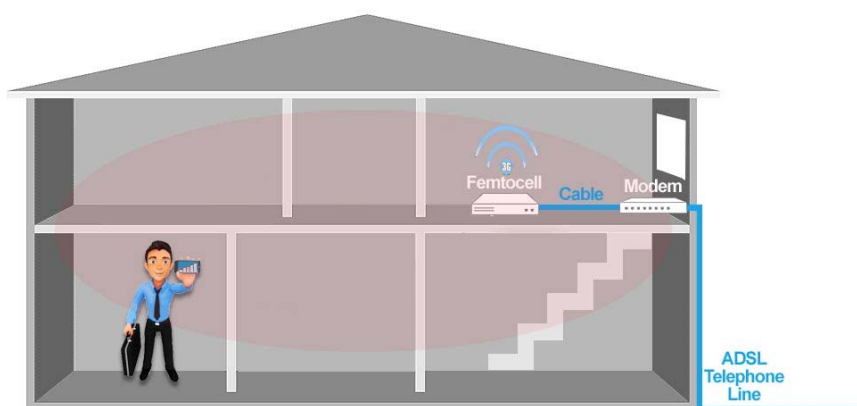
Smart Repeaters are very similar to a mobile phone repeater, but have built in smarts to help protect the mobile network. This repeater will amplify and then disburse a mobile signal in a defined area, but will also monitor the gain to ensure it is not overpowering or interfering with the external mobile network. A typical setup includes a window unit placed near a window inside the building, and an indoor unit to disburse the signal within the building.

Smart repeaters will generally have a 50-100dB gain signal amplifier, providing a 10-50m coverage area from the indoor unit.

At this point in time US manufacturer Nextivity are the only company making smart repeaters. Smart Repeaters are recommended for use in Australia by the ACMA.

The **Cel-Fi Repeater** by Nextivity was released in June 2012 and has been approved for use on the Telstra NextG Network, Optus and Vodafone 3G networks. **Powertec Telecommunications** are the Australian distributors.

Femtocell





A femtocell is like a mini base station that provides mobile coverage inside a home or office. It connects to the mobile carrier via the customer's broadband internet connection, such as cable or DSL and provides reception for up to four mobile devices. There can be some limitations with Femtocells including the number of devices that can be used and the ability to hand off to the mobile network when you leave home.

Examples of Femtocells are [Optus's Home Zone](#) and [Vodafone's Xpand for Enterprise](#) products.

Changing Mobile Providers

Sometimes changing to a different provider can be the only option for those with poor or no signal. They have either tried all the signal boosting options or are happy to switch to a new provider. A carrier will often let customers out of a contract if they cannot get adequate signal at their home address, as long as they listed that address on the contract.

Just because a carrier claims to have the best coverage in Australia does not mean they will offer the best coverage at your home. It is best to try mobiles from all three carriers on GSM, 3G and 4G.

Purchase a New Mobile Device

If your mobile device is several years old or is a low end model, it may not support the bands that offer the best signal in your area. The mobile providers may change bands every few years and it's only the newer devices that usually support these bands.

As a typical rule of thumb, make sure your device supports these bands on 3G:

Telstra 850Mhz
Optus 900Mhz
Vodafone 900Mhz

The carriers may also provide phones more suited to low signal areas. If you plan to add an external antenna to your device make sure it has an external antenna port.

Contact your Mobile Provider

Contacting your mobile provider and logging a complaint for poor signal in your area can be to your advantage in the long run. For a carrier to spend money and improve services, they must be able to justify that expense by having customers in that area to bring in revenue. The more customers that log a complaint the higher the chances services will be upgraded in your area.

If your mobile signal used to be fine, but has become poor then it is best to report this to your mobile provider. Carriers like to ensure that their mobile network operates at full capacity and by reporting you have the best chance of getting that signal back.

Carrier Solutions

For large corporates, body corporates, construction companies and businesses that rely heavily on mobile signal, the carriers offer several solutions to assist. This could include multi-story inbuilding coverage solutions using a DAS (Distributed Antenna System) or a Microcell for an outdoor area such as a mining camp or shopping centre. Expect to pay \$20k + for this solution.

Further Information

If you require further information on increasing your mobile signal please visit our website at www.mobilenetworkguide.com.au or contact us at the address below.

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