Improving Cellular Signal Reception in IoT Applications

Many design engineers are wishing to improve signal performance when designing, testing or rolling out telemetry products fitted with 2G / GSM, 3G / UMTS or 4G / LTE wireless systems and maximising the working range of thier cellular solution. To do this we first select a suitable antenna and cable configuration for the soluiton which has already been selected and qualified for the end application.

When concentrating on the improvements in cellular signal transmission and reception in embedded design applications, similar transmission and reception rules are valid for the majority of today's wireless systems. These include ISM bands such as 433, 868 and 2400MHz and other technologies such as WiFi, Sigfox and Zigbee / IEEE802.15.4 standards.

A cellular antenna can propagate on 700, 800, 850, 900, 1700, 1800, 1900, 2100 & 2600 frequencies. The propagation of these signal radiate in a straight line, operating in a line of sight basis. Although radio signals do bounce off and travel through certain materials, using the line of sight practice should be the first observation to make to improve signla integrity. There needs to be particular emphasis on the fact that the antenna receives or transmits the signal and not the wireless module.

Obstructions

Obstructions placed between the base station and antenna will absorb or bounce the signal to varying degrees. For instance a sheet of paper between a transmitting cell tower and a receiving antenna in a cellular environment would have virtually no effect, however if an antenna was inside a building or metallic enclosure, it would have a more dramatic effect. Likewise, geographic obstacles such as a hill or building between a cell tower and receiving station could block a cellular radio signal entirely.

One simple way of overcoming obstructions in a line of sight communications environment is to elevate the radiating antenna. Many of Siretta's Wall/Mount Outdoor antennas are supplied with different lengths of cable and using a loss loss cable solution it is possible to accommodate cable runs of up to 20 metres. This will give the installer a greater scope for installing the antenna as high above the ground as possible and preferably outside of a building focussing towards an area with the best cell site coverage. It is worth noting that less cable length equals less RF loss so this should be considered when specifying cable lengths for antennas.

When specifying an office or base station antenna, the engineer needs to ensure that the antenna, cable and connector configuration is of 50 Ohm impedance and the cable length is optimised for the site. Co-axial cable has differing levels of RF loss depending on the type of cable selected so it is advisable to have enough for the installation without too much surplus. Although installations vary from site to site, this can be overcome in the field by ensuring installers have carried out site surveys and have extension leads to allow for routing. These can be added or taken off at the discretion of the installing engineer. Similarly, care should be taken when fitting inter series RF adapters or link cables in line. Each adapter fitted inline to a cable increases the RF losses and reduces the overall system performance.

Losses

Regarding RF loss, the higher the operating frequency, the greater the loss per metre. In the United Kingdom, there are a number of bands available for use in cellular communication and as a result it can be possible to improve the enitre system performance by simply moving to a lower frequency. On the 2G / GSM network operating on the 900MHz band it is possible to transmit at 2 Watts whilst on the 1800MHz frequency it is possible to operate at 1 Watt. With a 2 Watt 900MHz system operating on twice the power, the working range will be significantly enhanced over an 1800MHz operating at 1 Watt.

Lower frequencies have longer wavelengths and as such distances between sequential crests of a sine wave are further apart, which mean that they are able to travel further. Therefore network operators who transmit on low frequcnies benefit the end user by being able to transmit over a greater distance and provide network coverage to more rural areas with less infrastructure. Higher frequency cellular bands are good in an urban environment with multiple cell sites as they are able to offer a higher transmission bandwidth to the connected devices within the same environment.

Network Operator

With most businesses designing and installing cellular equipment in to the field, the last factor to be considered is the cost of airtime and this is usually selected based on a commercial decision largely influenced by price. It is at this point where careful consideration should be given to the network operator and their service offering. Depending on the end application it may be necessary to consider looking at an alternative airtime provider which operates on a lower frequency band if reliable communication is required in remote rural areas.

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Whilst each of these individual criteria is an important factor on its own, to ensure a reliable communication platform that operates effectively, you must consider all of these factors together and ensure that each element is chosen for the end application. This will ensure that you have a system which out performs expectations and operates reliably in the field with reduced downtime and costs whilst improving system performance.

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