Network Planning with Repeaters

In general, repeaters can resolve two network issues:

- Filling holes within a coverage area of the cell site, including extending coverage indoors.
- Expanding the service area of a cell beyond its natural boundaries, for example along a highway or road.

Both applications have the same implementation in IS-95, CDMA2000 1X and WCDMA (UMTS) networks.

Noise and Capacity
Since a repeater is not a noiseless device, it contributes additional noise into the donor sector receiver. This raises the noise floor of the base station and shrinks the reverse link coverage of the sector. IT may also affect their capacity of the donor cell.

One potential cause of decreased capacity is the removal of diversity reception at the BS for those mobiles in the repeater coverage area. These factors are covered in some detail in reference (1). The possibility of capacity decrease makes repeater use with “capacity limited” donor sectors less desirable than with “coverage” donor sectors.

Network Planning and Repeater Design Considerations
No available network planning tool has comprehensive CDMA repeater simulation capabilities, which creates challenges for the network planner. For example, this makes it impossible to automatically produce a neighbor list for a network using repeaters.

Since coverage cannot be modeled well, additional optimization efforts may be needed after deployment. The lack of simulation tools also makes it difficult for a network planner to predict the effect of a repeater introduced into an area where sufficient CDMA power already exists. Such a situation should be avoided.

In summary, although repeater solutions are often case dependent, here are several generic repeater design guidelines:

- Maintain a line-of-sight link between the repeater donor antenna and the serving donor sector if possible. Use a donor antenna with high gain, narrow beam-width, and a high front to back ratio. This type of antenna helps to avoid creating a permanent soft handoff condition in the repeater coverage area and helps establish the required isolation between repeater input and output. ***In cases where line of sight links are not possible, RepeaterOne can help mitigate the negative effects of path loss changes.***
- Install donor and server antennas so as to present a high degree of isolation between the donor and the server ports. At a minimum isolation between these ports should be at least 10dB greater than the gain of the repeater. This isolation is required to prevent the repeater from oscillating. An oscillating repeater will not function properly and may present a large interfering signal into the network.
- Make sure that the repeater has sufficient gain, in combination with the available input forward link signal, to obtain the desired output signal power. In general, the forward link input signal should be well above the input noise of the repeater, so that a good quality forward signal is broadcast. An input signal to noise ratio 20 dB is recommended. This requirement places some constraints on possible repeater locations and the required donor antenna gains.
- Establish the operating point of the repeater so that forward and reverse repeater links are balanced and the impact to the donor sector is at an acceptable level. A ***RepeaterOne repeater***

greatly enhances the establishment and maintenance of good link balance in the repeater coverage area.

- Balance the forward and reverse gains for a consistent open loop estimate between the repeater coverage areas and the direct sector coverage area.

CDMA200 Network Issues

When using repeaters in a CDMA200 network, planners should be aware of the following:

- Currently available repeaters are not designed to provide spatially separated transmit diversity signals. As a result, STS and OTD transmit diversity effectiveness is reduced. Also the 1x standard supports the use of adaptive antennas. Due to the nature of adaptive antennas, it may be very difficult to maintain the same operating point of the repeater and only one strong donor PN. ***The adaptive nature of a RepeaterOne repeater helps to compensate for any changes to the donor sector antenna coverage as result of repointing, changes in downtilt, or gain changes as a result of adaptive antenna technologies.***

- Regarding position location, currently there is no standards-based solution allowing a mobile station (MS) or Position Determination Module (PDM) to uniquely identify individual CDMA repeaters or to distinguish between a repeated signal and a non-repeated signal. This statement applies to both forward and reverse link signals.

- One result of not being able to distinguish and identify repeated signals is that delay ambiguity exists in Advanced Forward Link Trilateration (AFLT) measurements used in positioning algorithms. A second result is repeater antenna position ambiguity. Each of these affects the accuracy of AFLT measurements.

Summary

QUALCOMM has developed and is now licensing comprehensive repeater technology called RepeaterOne that makes repeaters much easier to deploy, and easier to operate within 3G wireless networks.