In CDMA, since all the mobiles transmit at the same frequency, the internal interference of the network plays a critical role in determining network capacity. Further, each mobile transmitter power must be controlled to limit the interference.

Power control is essentially needed to solve the near-far problem. The main idea to reduce the near-far problem, is to achieve the same power level received by all mobiles to the base station. Each received power must be at least level, so that it allows the link to meet the requirements of the system such that $\text{Eb/N0}$. To receive the same power level at the base station, the mobiles those are closer to the base station should transmit less power than the mobiles which are far away from the mobile base station.

In the figure given below, there are two mobile cells A and B. A is closer to the base station and B is far from the base station. $P_{\text{R}}$ is the minimum signal level for the performance of the required system. Therefore, the mobile B should transmit more power to achieve the same $P_{\text{R}}$ to the base station $P_B > P_A$. If there is no power control, in other words, the transmission power are the same from both the mobile cells, the signal received from A is much stronger than the signals received from mobile cell B.

When all mobile stations transmit the signals at the same power $M_S$, the received levels at the base station are different from each other, which depend on the distances between BS and MSs. The received level fluctuates quickly due to fading. In order to maintain the received level at BS, a suitable power control technique must be employed in CDMA systems.

We need to control the transmission power of each user. This control is called the transmission power control $\text{ControlPower}$. There are two ways to control the transmission power. First is the open-loop $\text{OpenLoop}$ control and second is closed-loop $\text{ClosedLoop}$ control.
Reverse Link Power Control

In addition to the near-far effect described above, the immediate problem is to determine the transmit power of the mobile when it first establishes a connection. Until the mobile does not come in contact with the base station, it has no idea of the amount of interference in the system. If it attempts to transmit high power to ensure contact, then it can introduce too much interference. On the other hand, if the mobile transmits less power not to disturb other mobile connections, the power cannot meet the $E_b/N_0$ as required.

As specified in the IS-95 standards, mobile acts when it wants to get into the system, it sends a signal called *access*. In CDMA, each user's transmission power is allocated by the control power to achieve the same power $P_r$ which is received by the base station/BTS with access probe with low power. The mobile sends its first access probe, then waits for a response from the base station. If it receives no response, then the second access probe is sent with a higher power.

The process is repeated until the base station responds. If the signal answered by the base station is high, then the mobile gets connected with the base station which is closer to the mobile cell with low transmission power. Similarly, if the signal is weak, the mobile knows the path loss is greater and transmits high power.

The process described above is called **open loop power control** since it is controlled only by the mobile itself. Open loop power control starts when the first mobile attempts to communicate with the base station.

This power control is used to compensate for the slow variables shading effects. However, since the rear and forward links are on different frequencies, the estimate transmit power does not give accurate solution for the power control because of the path loss to the front of the base station. This power control fails or too slow for fast Rayleigh fading channels.

The power of closed loop control is used to compensate for the rapid Rayleigh discoloration. This time, the mobile transmit power is controlled by the base station. For this purpose, the base station continuously monitors the reverse link signal quality. If the quality of the connection is low, it tells the mobile to increase its power; and if the quality of the connection is very high, the mobile base station controller reduces its power.

Forward Link Power Control

Similar to reverse link power control, forward link power control is also necessary to maintain the forward link quality to a specified level. This time, the mobile monitors the forward link quality and indicates to the base station to turn on or off. This power control has no effect on the near-far problem. All the signals are blurred together at the same level of power when they get to the mobile. In short, there is no near-far problem in the forward link.

Effect of Power Control

By transmission power control, the user can obtain a constant communication environment regardless of the location. The user who is far from the base station sends a higher transmission power than the user who is nearer to the base station. Also by this transmission power control, you can reduce the effects of fading. This means that the variation of the received power due to fading can be suppressed by the transmission power control.
• Power control is capable of compensating the fading fluctuation.
• Received power from all MS are controlled to be equal.
• Near-Far problem is mitigated by the power control.