Wireless LAN Concepts

Wireless LAN technology is becoming increasingly popular for a wide variety of applications. After evaluating the technology, most users are convinced of its reliability, satisfied with its performance and are ready to use it for large-scale and complex wireless networks.

Originally designed for indoor office applications, today’s Wireless LANs can be used for both indoor peer-to-peer networks as well as for outdoor point-to-point and point-to-multipoint remote bridging applications.

Wireless LANs can be designed to be modular and very flexible. They can also be optimized for different environments. For example, point-to-point outdoor links are less susceptible to interference and can have higher performance if designers increase the “dwell time” and disable the “collision avoidance” and “fragmentation” mechanisms described later in this section.

Topology

*Wired LAN Topology*

Traditional LANs (Local Area Networks) link PCs and other computers to one another and to file servers, printers and other network equipment using cables or optic fibers as the transmission medium.

![Wired LAN Topology](image)

*Figure 1: Wired LAN Topology*
Wireless LANs allow workstations to communicate and to access the network using radio propagation as the transmission medium. The wireless LAN can be connected to an existing wired LAN as an extension, or can form the basis of a new network. While adaptable to both indoor and outdoor environments, wireless LANs are especially suited to indoor locations such as office buildings, manufacturing floors, hospitals and universities.

The basic building block of the wireless LAN is the *Cell*. This is the area in which the wireless communication takes place. The coverage area of a cell depends on the strength of the propagated radio signal and the type and construction of walls, partitions and other physical characteristics of the indoor environment. PC-based workstations, notebook and pen-based computers can move freely in the cell.

*Figure 2: The Basic Wireless LAN Cell*
Each Wireless LAN cell requires some communications and traffic management. This is coordinated by an Access Point (AP) which communicates with each wireless station in its coverage area.

Stations also communicate with each other via the AP, so communicating stations can be hidden from one another. In this way, the AP functions as a relay, extending the range of the system.

The AP also functions as a bridge between the wireless stations and the wired network and the other wireless cells. Connecting the AP to the backbone or other wireless cells can be done by wire or by a separate wireless link, using wireless bridges. The range of the system can be extended by cascading several wireless links, one after the other.

![Wireless LAN Connectivity Diagram](image-url)
Roaming
When any area in the building is within reception range of more than one Access Point, the cells’ coverage is said to overlap. Each wireless station automatically establishes the best possible connection with one of the Access Points. Overlapping coverage areas are an important attribute of the wireless LAN setup, because it enables seamless roaming between overlapping cells.

![Roaming Through Overlapping Cells](image)

Roaming allows mobile users with portable stations to move freely between overlapping cells, constantly maintaining their network connection. Roaming is seamless, a work session can be maintained while moving from one cell to another. Multiple access points can provide wireless coverage for an entire building or campus. When the coverage area of two or more APs overlap, the stations in the overlapping area can establish the best possible connection with one of the APs, continuously searching for the best AP. In order to minimize packet loss during switchover, the “old” and “new” APs communicate to coordinate the process.

Load Balancing
Congested areas with many users and heavy traffic load per unit may require a multi-cell structure. In a multi-cell structure, several co-located APs “illuminate” the same area creating a common coverage area which increases aggregate throughput. Stations inside the common coverage area automatically associate with the AP that is less loaded and provides the best signal quality. The stations are equally divided between the APs in order to equally share the load between all APs. Efficiency is maximized because all APs are working at the same low level load. Load balancing is also known as load sharing.
Dynamic Rate Switching
The data rate of each station is automatically adjusted according to the received signal quality. Performance (throughput) is maximized by increasing the data rate and decreasing re-transmissions. This is very important for mobile applications where the signal quality fluctuates rapidly, but less important for fixed outdoor installations where signal quality is stable.

Media Access
When many users are located in the same area, performance becomes an issue. To address this issue, Wireless LANs use the Carrier Sense Multiple Access (CSMA) algorithm with a Collision Avoidance (CA) mechanism in which each unit senses the media before it starts to transmit. If the media is free for several microseconds, the unit can transmit for a limited time. If the media is busy, the unit will back off for a random time before it senses again. Since transmitting units compete for air time, the protocol should ensure equal fairness between the stations.

Fragmentation
Fragmentation of packets into shorter fragments add protocol overhead and reduce protocol efficiency when no errors are expected, but reduce the time spent on re-transmissions if errors are likely to occur. No fragmentation or longer fragment length add overhead and reduce efficiency in case of errors and re-transmissions (multi-path).
Collision Avoidance
To avoid collisions with other incoming calls, each station transmits a short RTS (Request To Send) frame before the data frame. The Access Point sends back a CTS (Clear To Send) frame with permission to start the data transmission. This frame includes the time that this station is going to transmit. This frame is received by all the stations in the cell, notifying them that another unit will transmit during the following Xmsec, so they can not transmit even if the media seems to be free (the transmitting unit is out of range).

Channelization
Using Frequency Hopping Spread Spectrum (FHSS), different hopping sequences are assigned to different co-located cells. Hopping sequences are designed so different cells can work simultaneously using different channels. Since hopping sequences and hopping timing of different cells cannot be synchronized (according to FCC regulations), different cells might try to use the same channel occasionally. Then, one cell uses the channel while the other cell backs off and waits for the next hop. In the case of a very noisy environment (multiples and interference), the system must hop quickly. If the link is quiet and clean, it is better to hop slowly, reducing overhead and increasing efficiency.