Maximum Throughput Calculations for 802.11b WLAN

Table I-1 lists the packet fields for voice traffic (both G.711 and G.729), and Table I-2 shows the theoretical maximum throughput for voice packets on an 802.11b WLAN network.

Table I-1 Voice Packet Fields

Field	Long Form	Short Form
Preamble (microseconds)	144	72
Header (microseconds)	48	24
Short Inter-Frame Space (SIFS) (microseconds)	10	10
Distributed Inter-Frame Space (DIFS) (microseconds)	50	50
Acknowledgement (ACK) (bytes)	14	14
Backoff (bytes)	32	32
Slot (microseconds)	20	20

Table I-2 Theoretical Maximum Throughput in Bits per Second (bps)

Header Type	Packet Length (bytes)	Transmission Rate			
		11 Mbps	5.5 Mbps	2 Mbps	1 Mbps
Long header	128	1,153,625	1,012,585	709,141	482,109
	256	2,088,246	1,710,294	1,047,034	650,571
Short header	128	1,472,033	1,249,889	817,891	Not Applicable
	256	2,596,588	2,036,889	1,160,997	Not Applicable

Note Throughput is based on a single client in disengage-confirmed (DCF) mode using Differentiated Services (DS) 802.11 with zero retries, no WEP, no request to send (RTS) or clear to send (CTS), and no fragmentation.

The throughput values in Table I-2 were calculated as follows:

Theoretical Maximum Throughput =
(Packet Length * 8 * 1000000) / (Preamble + Header + ((Packet Length + 28) * 8 / Rate) + SIFS + Preamble + Header + (ACK * 8 / Rate) + DIFS + ((Backoff / 2) * Slot))

One of the key aspects to remember when calculating network capacity for 802.11b networks is that it is a shared medium, so you must consider radio contention among the various devices. This contention means that the overall throughput is affected by the backoff algorithms in 802.11b that allow multiple devices to access the medium.

For the VoIP calculations in this section, a call has the following characteristics:

- The packets consist of a 20-byte IP header, an 8-byte UDP header, a 12-byte RTP header, and the RTP data.
- The RTP data is a 20-ms voice sample. For G.729 the data is 20 bytes; for G.711 it is 160 bytes.
- The total VoIP packet is 200 bytes of (IP+UDP+RTP) headers plus RTP data. The 802.11 header (Layer 2 MAC address) is 24 bytes long and the packet frame check sequence (FCS) is 4 bytes long, so the total packet size is 228 bytes.
- RTP traffic is transmitted at 50 packets per second (pps) in each direction, or 100 pps for a full-duplex conversation.

Using the 11 Mbps column from Table I-2, we can make the following calculations for G.711:

- Theoretical packet rate for 256-byte packet size = 2,596,588 bps = 324,573 bytes per second
- Bandwidth of G.711 VoIP call = 100 pps * 228 bytes per packet = 22,800 bytes per second
- Theoretical maximum VoIP capacity per 802.11b channel = 324,573 / 22,800 = 14.235 calls
- Theoretical maximum number of VoIP calls at 60% of bandwidth = 14.235 * 0.6 = 8.54 calls

Note Use only 60% of the available bandwidth to calculate the number of VoIP calls because this limit leaves some bandwidth for data traffic as well as for 802.11b management traffic and acknowledgements.