AVAYA

WHITE PAPER

Selecting a Wireless Headset Radio Technology

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Table of Contents

Section 1: Overview

It's well known that wireless headsets make office and mobile professionals more productive. Technology advances have made wireless headsets practical and increased product choices. A manager responsible for the smooth functioning of a business needs to select wisely to get the full convenience, compatibility ,and productivity benefits of wireless headsets. Choices of radio technology, range, user density, security, cell phone and Wi-Fi compatibility can be confusing. This paper reviews the strengths and weaknesses of the technologies available today: analog, DECT™ (Digital Enhanced Cordless Technology) and *Bluetooth®*.

Section 2: Pairing

Wireless headsets are point-to-point communicators. Each headset communicates only with its base, and ignores other headsets and other bases. To do this, each headset and base must learn of each other by a process called *pairing*. Analog systems need to be set to a common frequency. *Bluetooth* and DECT headsets pair when the user presses buttons on both the headset and the base in a predefined way, chosen to be unlikely to be hit upon accidentally.

Some newer *Bluetooth* headsets have a capability called *multipoint* which allows them to be paired simultaneously with two different devices. This means the headset can be used alternately with either base without repairing. A *Bluetooth* headset with multipoint can be paired simultaneously with a cell phone and an office wireless system, allowing the user to wear the same headset with both, and conveniently switch between them.

Section 3: Range

When people ask about the performance of wireless systems, they usually ask first about range. Range is easy to understand and obviously relevant. "How far can I go?" is a simple question, demanding a simple answer. But the answers supplied are generally vague and qualified: *Bluetooth* range is "up to 30 feet"; DECT systems promise "up to 300 feet." Why the equivocation? Because radio wave propagation is affected by every nearby material, and these headsets are used indoors where there are lots of different materials. Offices are filled with cubicle walls, file cabinets, desks, bookshelves, doors, and ventilation ducts. Will the signal go through a wall? Maybe. How thick is the wall? Are wall studs wooden or metal? If it's concrete, how much steel re-bar is in it? Does the wall contain vapor-barrier insulation coated with aluminized mylar? Because there are so many variables, a general answer is necessarily inexact. Take care when comparing range claims from different manufacturers. The advertised claims may say more about the manufacturer's marketing philosophy than the equipment's performance.

DECT systems in the 900MHz band often supply the best practical range, because antennas at this frequency are larger and so pick up more signal. The much shorter range of *Bluetooth* is due mainly to technical comprises made to allow the economical production of singlechip *Bluetooth* systems.

Section 4: User Density

User density measures the number of users who can simultaneously talk on wireless links. The maximum number of analog systems that can be used within sight of each other is limited by the number of available radio channels. The limit in a single room is typically half the number of channels, since radio receivers usually don't cope well with strong signals on adjacent channels, so only every other channel is usable.

With digital systems determining the maximum practical density is more complex. Sophisticated, adaptable algorithms in digital receivers are much more tolerant of interfering signals than analog systems. As an area becomes heavily loaded with wireless signals, interactions among systems become complex.

A *Bluetooth* system, to maintain a voice conversation, needs to have its radio transmitting one-sixth of the time and listening one-sixth of the time. 1600 times a second, it hops to a new channel among 79 available, assuming there's no Wi-Fi in the area (see table, page 5). Nearby *Bluetooth* systems do the same. Every time they end up on the same channel at the same time, users of one or both *Bluetooth* systems may hear a small click. This will be several times a second. Most people begin to find this objectionable when there are more then two or three *Bluetooth* links simultaneously carrying conversations within about a 20 by 20 foot square. Cubicle walls high enough to block line-of-sight signals help this somewhat.

DECT systems need to transmit and receive only one-quarter as often as *Bluetooth* systems to maintain a conversation. Because the DECT system was designed from the beginning for voice communications, it responds better to high user density than *Bluetooth* does, which was designed first for data. As the number of simultaneous DECT conversations in an area increases, the maximum range begins to decrease. The practical limit in a large room filled with cubicles is to put a DECT system in every cubicle. So long as the cubicle walls are high enough to block the line-of-sight between radios, users should experience satisfactory operation within their cubicles. Since Avaya offers both 900MHz and 1.9GHz DECT systems, performance can be improved by alternating system types in high density applications.

Section 5: Compatibility with other Wireless Services

In a busy office, wireless headsets must be compatible with other wireless systems. Some offices may have cordless phones operating at 900MHz or 2.4GHz, microwave ovens at 2.4GHz or Wi-Fi at 2.4 or 5.8GHz. Different systems coexist best when each has its own frequency band to work in. This isn't always possible.

DECT systems have a real advantage here: the 900MHz band is generally under used in medium or large offices. Even better is the new 1.9GHz UPCS band recently allocated in North America. This band is reserved for DECT and similar services, so it's free of interfering signals.

Section 6: Wi-Fi

Most offices today use 802.11b or 802.11g Wireless Ethernet, often called Wi-Fi, to link laptop computers. Wi-Fi operates in the 2.4GHz radio band, the same band used by *Bluetooth* and some analog FM systems, so these can interfere with each other. (Some offices use the related 802.11a standard, which operates at 5.8GHz. 802.11a systems won't interfere with *Bluetooth* or other 2.4GHz systems.) 2.4GHz analog or proprietary digital systems can swamp 2.4GHz Wi-Fi networks, so they are usually poor choices for office environments. *Bluetooth*, however, works hard to get along with Wi-Fi neighbors. Newer *Bluetooth* systems, designated *Bluetooth* 1.2 or higher, use a technique called Adaptive Frequency Hopping (AFH) to avoid channels within the 2.4GHz band in active use by Wi-Fi. Individual access points in Wi-Fi systems generally operate within only one-third of the 2.4GHz band, with adjacent access points using different thirds. So a *Bluetooth* headset can usually find at least a third of the band to use. Problems can arise when the *Bluetooth* headset is within range of three Wi-Fi access points, or when several nearby *Bluetooth* systems attempt to operate in a Wi-Fi environment. When this happens it's generally *Bluetooth* voice communication, rather than Wi-Fi, which suffers. Each *Bluetooth* packet carries a tiny 1/1600-second snippet of voice. Wi-Fi interference causes some of these packets to be lost. Each lost packet is heard as a small click; at some level

of interference these clicks become so frequent that communication is impaired. Wi-Fi compatibility is not an issue for wireless DECT headsets, which operate in a completely different frequency band.

Section 7: Cell Phones and PCS

A *Bluetooth* headset can connect to a *Bluetooth*-equipped cell phone. That same headset can connect to a PC for IP telephony if the PC is equipped with an audio-enabled *Bluetooth* adapter. (But beware: not all PCs with *Bluetooth* support audio.) In North America, DECT headsets can generally connect only to their own bases. Compatibility with cell phones and PCs is the main reason to choose a *Bluetooth* headset.

Section 8: Voice Quality

Voice quality on *Bluetooth* Headsets is similar to the voice quality of cell phones. It's readily intelligible, but not as good as the voice quality delivered by a wired telephone. Wireless analog FM systems generally provide better voice quality when conditions are favorable. DECT and proprietary digital systems reliably provide voice quality comparable to wired telephones.

Section 9: Power

Wireless headsets are low-power devices. *Bluetooth* (Class 3) devices emit less than 1% of the power of a cellular phone; Avaya DECT devices emit less than 3%. Operating at such low power provides several advantages: Day-long operation on a tiny battery, multiple similar devices in the same office, little interference with older equipment, and no concern about any health effect of the radio signal.

Section 10: Security

Older wireless systems use analog FM modulation. Although their short range provides some inherent security, anyone in range with a radio receiver tuned to the frequency in use can overhear conversations. Since radio waves can pass through walls and windows, an eavesdropper might be in an adjacent building or parking lot. This low security may still be acceptable today if your business application is relaying burger orders efficiently to a fry cook. But it's inadequate for any business conversation that includes credit card numbers, product problems, orders or sales leads, unannounced financial results, or confidential plans. Luckily much better alternatives are economically available.

Modern digital systems are vastly more secure. Like analog FM, the security of both DECT and *Bluetooth* wireless systems benefits from the short range of the link. But both DECT and *Bluetooth* systems do something else which makes intercepting their transmissions exceedingly difficult: they change channels frequently. *Bluetooth* systems change channels 1600 times every second in a seemingly random pattern which repeats only about once a day. DECT systems change channels less frequently, but at unplanned, irregular intervals which depend on continuously varying local propagation conditions impossible to predict.

To make conversations even more secure, both DECT and *Bluetooth* use sophisticated mathematical algorithms to encrypt the bits in each voice packet. *Bluetooth* has a theoretical edge here, since it uses 128-bit encryption vs. DECT's 64-bit encryption. For practical business purposes, this difference is unimportant: either system provides more than adequate security. Both systems meet the requirements of Sarbanes-Oxley and HIPAA for safeguarding confidential information.

Section 11: Bottom Line

Analog systems are usually unsuitable for business use, so the choice comes down to *Bluetooth* vs. DECT. The main benefit of *Bluetooth* is its compatibility with some cell phones and PCs. If this is important for your users, *Bluetooth* may be your best choice. DECT offers superior range, user density, Wi-Fi compatibility and voice quality. If your users don't need their office headsets to work with cell phones, they'll be better served by DECT.

RF Technology Comparison

Technology	Radio Frequency	Voice Quality	Compatibility With Wi-Fi	Compatibility with Cell	Security	Range	User Density	Talk Time
Analog FM	900 MHz, some 2.4GH	Varies	Poor for 2.4GHz units	No	Poor	Up to 300 feet	Limited by available channels	Good
Bluetooth	2.4 GHz	Cell phone quality	Can be OK	Yes	Excellent	Up to 30 feet	2 to 3 users per 400 sq. ft.	Excellent
DECT	900 MHz, 1.9GHz	Desk phone quality	Excellent	No	Excellent	Up to 300 feet	Up to one per cubicle, but range reduced	Excellent

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