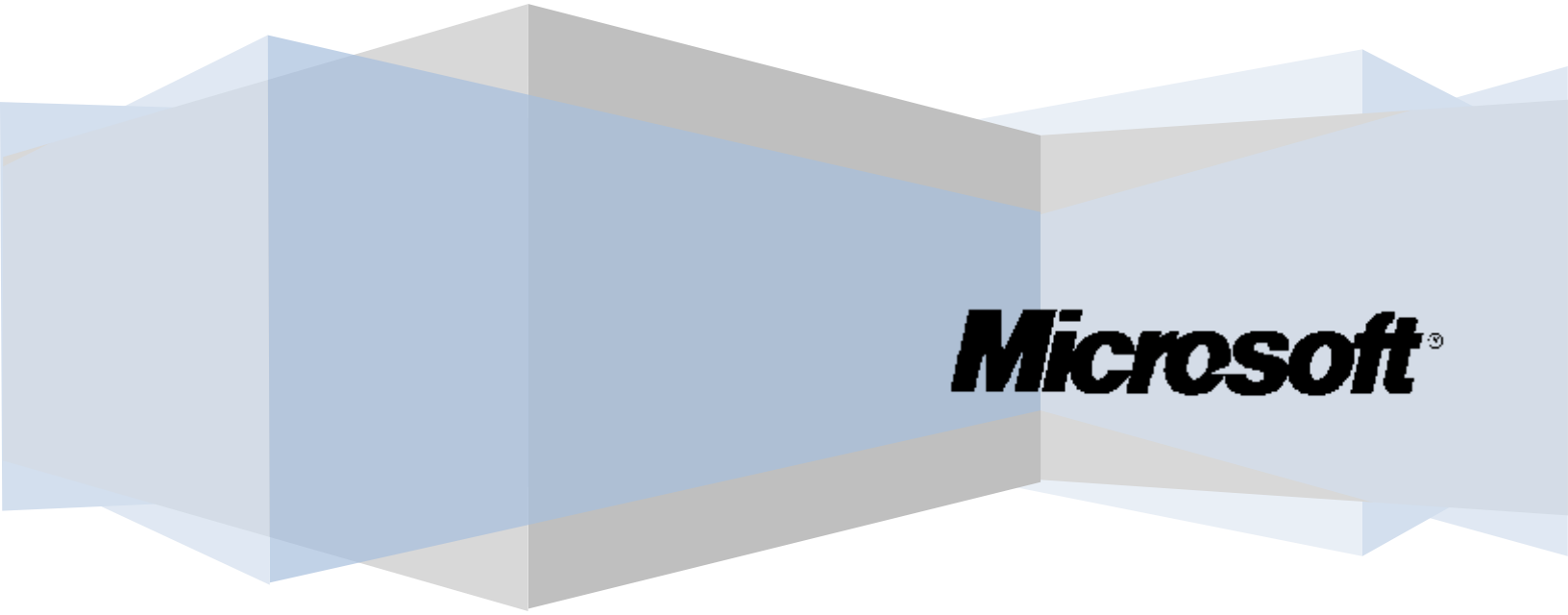
Microsoft 2.4GHz Wireless Protocol

White Paper

May 2009



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Published by:

Microsoft Hardware

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Summary

Wireless connectivity has become the preferred standard for PC peripherals. In addition, businesses all over the world are realizing the benefits of wireless peripherals when creating work environments for their employees. Wireless mice and keyboards allow users to unclutter their desktops and enhance the way they interact with their computers.

Microsoft Corp.'s latest generation of 2.4GHz wireless mice and keyboards offers significant improvements over legacy 27MHz devices. These improvements include the following:

- **Virtually no interference.** Users will experience virtually no interference when multiple devices are operating in the same work area.
- **True plug-and-play connectivity.**[1] Each device and its transceiver are paired at the factory, making connect buttons a thing of the past.
- **Longer range.** The devices have a working range of up to 30 feet.
- **Acknowledgement.** Two-way communications provides feedback that the data has been received by the host computer.

This white paper compares 27MHz mouse and keyboard wireless technology with the benefits of using Microsoft's 2.4GHz wireless technology.

Built for Business

If you enjoy the convenience of a wireless mouse and keyboard at home, you will likely want them at the office as well. But products that work well at home might not work as well in a commercial environment, where there can be considerably more radio frequency interference. When multiple 27MHz wireless devices are operating in the same environment, they can interfere with each other. This can result in data loss and decreased worker productivity.

Microsoft's 2.4GHz wireless mice and keyboards are built to work in an office environment. Their enhanced performance makes them suitable for use in a commercial setting where 27MHz devices may experience interference. In addition, Microsoft's 2.4GHz wireless devices are easy to install, reducing or eliminating the need for installation support.

Microsoft 2.4GHz Enhancements

Many wireless mice and keyboards operate in the 27MHz band. However, 27MHz technology is recommended for home use only, where it is unusual to have multiple devices operating within close proximity to each other. This recommendation is primarily due to the limited number of operating channels that are available. These devices rarely support more than two channels. Workers in adjacent cubicles or offices sometimes find that their 27MHz keyboards and mice interfere with one another, causing data loss or dropped connections. Microsoft's 2.4GHz wireless technology solves these problems.

Technology Comparison

27MHz Wireless Technology	Microsoft's 2.4GHz Wireless Technology
Range: 3 to 6 feet	Range: up to 30 feet (10 meters)
Interference possible when more than two devices are co-located within a 2-meter range.	Virtually no interference
Larger receiver	Smaller transceiver
Setup sometimes required	Plug and play
Connect button required to manually select another channel	Automatic channel selection

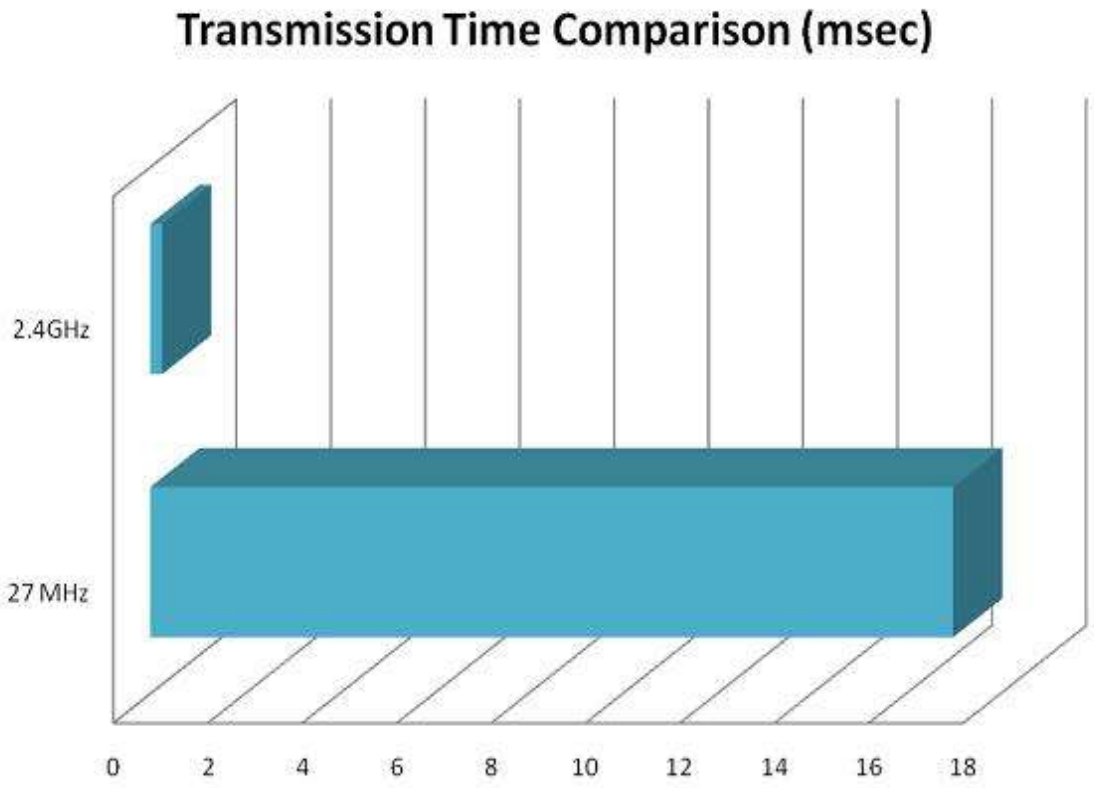
More Channels

Use of the 2.4GHz wireless band opens up more bandwidth compared with what is available in the 27MHz space. Microsoft 2.4GHz wireless mice and keyboards can be assigned to a subset of the available 24 channels spread across the band. This reduces the interference between devices assigned to different subsets. The selection of the 24 channels was made to avoid common interference sources such as Wi-Fi networks.

Rapid Data Transfer

A wide choice of operating frequencies significantly improves performance, but does not automatically guarantee reliable operation. Microsoft has improved reliability even further by taking advantage of the rapid data transfer the 2.4GHz band allows. The Microsoft channels are 2 MHz wide, permitting each keystroke (key transmission and key acknowledgment) to be sent many times faster than the fastest typist.[2] Each data packet takes so little time to transmit that the probability of interference from other devices is significantly reduced.

This rapid communication also offers a power-saving benefit because the peripheral's transmitter does not have to be turned on as long, and its batteries will last longer.



User Perception: Latency and Data Loss

As effective as multiple transmission channels and high-speed data transfer are in reducing interference-related issues, they do not fully resolve two major problems — latency and data loss. Latency and data loss are the two most common user complaints about wireless devices.

The time it takes the computer to respond to a keystroke or mouse movement is called latency. The time required to send keyboard and mouse data through a radio link naturally increases latency. Latency becomes a problem only when it lengthens to the point where the user becomes aware of the delay between pressing a key or moving the mouse and the computer's response.

Data loss occurs when data is blocked outright by interference. In this case the computer is not just slow to respond, it doesn't respond at all.

27MHz peripherals are prone to both increased latency and uncorrectable data loss in noisy environments because they cannot recover from interference-induced transmission errors. The receiver simply ignores corrupt data and the peripheral does not know the data was lost. All the user knows is that the mouse did not move or the keystroke was not displayed.

Data Integrity

Microsoft's proprietary 2.4GHz wireless technology is designed to fix the data integrity problem. Mice and keyboards using Microsoft's new 2.4GHz wireless technology wait for their transceivers to acknowledge accurate reception. If there is no acknowledgement, the peripheral transmits again, up to 10 times, until a confirmation is received. If no confirmation is received, then the frequency channel will be changed and the transmission will be retried. This send-listen-respond cycle works so rapidly that even 10 attempts take less time than the interval between the keystrokes of the fastest typist. If transmission is blocked or garbled for any reason, these devices retry until they get it right. The correction occurs so quickly that the user is unlikely to notice it.

This two-way communication also makes it possible for a computer to alter the peripheral's configuration. For example, a user could use a program to turn on the light-emitting diode in the keyboard's Caps Lock, or change the functions of the mouse's buttons.

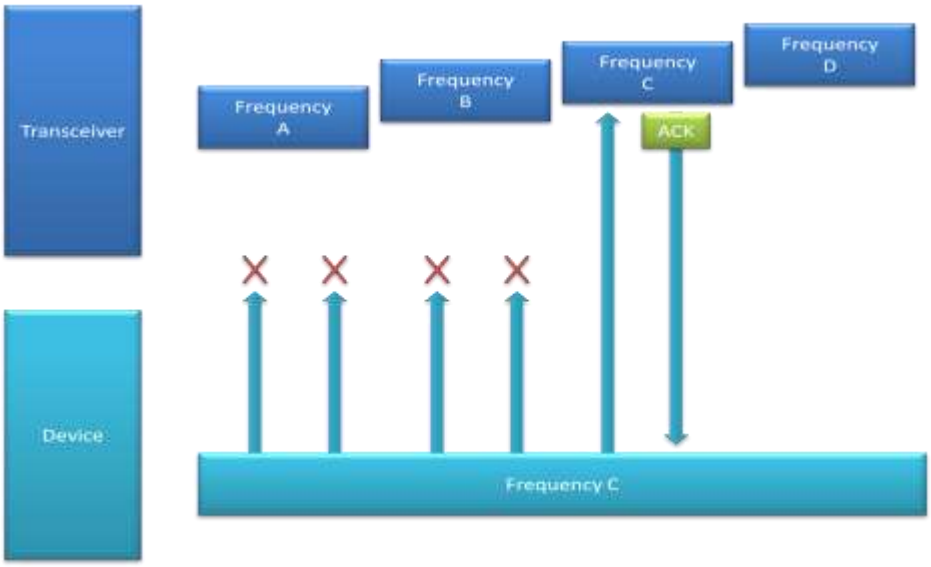
It is quite possible for two or more devices in the same office to be operating on the same channel. Assuming two devices are close enough that their receivers can "overhear" each other, how does a receiver know it is communicating with the correct peripheral? Microsoft devices provide verification by a 32-bit identifier programmed into each device at the factory. These hardware IDs must match, or the receiver and peripheral ignore each other. No two devices will be shipped that contain the same ID. What user A types will not be seen on user B's screen.

Avoiding Interference: Frequency Agility

The innovative design features described above reduce the likelihood of interference and correct data loss due to interference when it does occur. But they still do not eliminate problems. The ideal solution would be to move from a channel bothered by interference to a channel where there is none. This is called frequency agility.

With Microsoft's proprietary 2.4GHz wireless technology, the peripheral stops sending data over the current channel if it has not been acknowledged after 10 attempts. It then randomly selects one of the frequencies in its subset and retransmits the data packet.

The transceiver does not sit idle. Whenever it is not receiving data or acknowledging its receipt, it listens at each of its four assigned frequencies. If the channel the peripheral is retransmitting on is free of interference, the receiver will quickly cycle to it and re-link. If not, the peripheral moves to another channel and tries again.



The transceiver and peripheral connect the same way when they are initially installed and the user first presses a key or moves the mouse. The transceiver locks on to the peripheral almost immediately, with no need for human intervention.

The ability of the peripheral and transceiver to automatically locate each other when the connection has been lost makes the Microsoft 2.4GHz system self-initializing, self-correcting and self-maintaining, even when many devices are competing for radio space in a crowded environment. The only thing users are aware of is that their cordless peripherals work efficiently and correctly.

Conclusion

Microsoft's proprietary 2.4GHz wireless technology provides solutions to the most common and troublesome problems with wireless mice and keyboards. It uses error-detection and channel-switching technology to significantly improve performance, meeting the highest user expectations.

Microsoft 2.4GHz cordless peripherals work the way users expect them to:

- Users will experience virtually no interference when multiple devices are operating in the same work area.
- They are easy to install. With true plug-and-play operation, they start working within seconds.
- They require no manual configuration. Each transceiver/peripheral pair links up and stays linked, automatically.
- Once they are installed, you can forget them. They just work!

[1] Advanced features not natively supported by the operating system require a simple driver installation.
[2] http://www.owled.com/typing.html