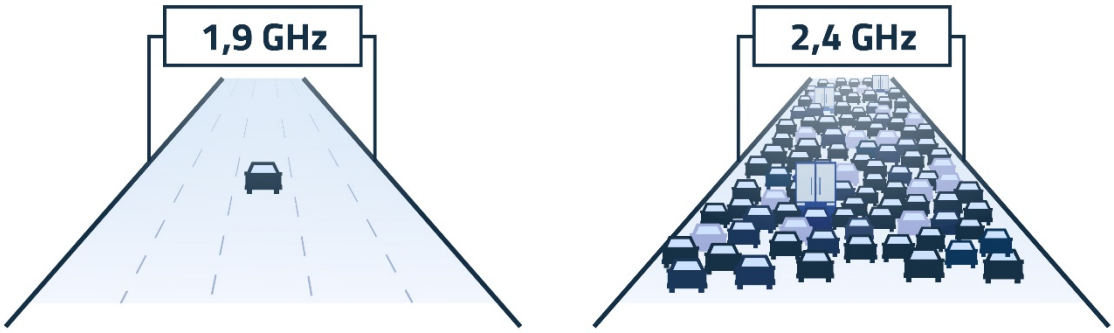
Visit our blog for more articles: www.streamit.eu/blog

Abstract:

This white paper aims to provide an in-depth analysis of important wireless communication technologies, Wi-Fi, Bluetooth and DECT, and their performance on audio transmission. The paper explores the concept of Bluetooth Coexistence with Wi-Fi services, along with the challenges and benefits associated with it, vs Digital Enhanced Cordless Transmission (DECT).

Streamit uses DECT technology, making the connection extremely stable. This technology operates on a separate 1.9 GHz band, exclusively for DECT. This is different from Bluetooth, which uses the same 2.4 GHz band as Wi-Fi, which is vulnerable to interference caused by congestion when many devices. Bluetooth and Wi-Fi signals operate in a similar physical area and are often on the same device, causing transmission interference.



Before we get into it. A very brief overview of the two most used methods of streaming music wirelessly:

Streaming via Wi-Fi

Wired and wireless ethernet were designed for data transport. Originally designed for much lower speeds than we now take for granted, the use case was document and text transmission vastly different than some of the uses today. Typical of this is the package-based model, where packets can arrive in different order and can be retransmitted if needed/requested. Wi-Fi is not designed for real-time audio or video transmission, as it was developed for non-synchronous data transfer. This means that if reliable transmission is desired, latency must be accepted. Streaming video content can have a latency of up to 30 seconds, which is fine for watching movies or even live sports events if there is enough distance, but not for synchronized sound. For local connections 1 or 2 second latency is considered low latency. Now there are ways to reduce latency dramatically, but this always comes at the price of lower reliability. If a packet is lost, an educated guess can be made on what has been lost. Add to this the vulnerability of Wi-fi to congestion as highlighted below. In contrast, DECT can go as low as 16.5 ms.

What is Bluetooth?

Bluetooth is a wireless technology that was designed especially for short-range wireless connections between two devices within an area called Wireless Personal Area Network (WPAN). A bit of trivia is that Bluetooth was created as a replacement for the RS-232 cable.

Bluetooth and Wi-Fi are quite similar. They might transmit in different ways, however, the protocols they use to do it are quite different. Whenever Wi-Fi is operating in the 2.4 GHz band, the transmission for Wi-Fi signals easily interferes with Bluetooth transmissions. The case is vice versa with the Bluetooth transmissions; they transmit to interfere with Wi-Fi transmissions similarly. Why so? It is because Bluetooth and Wi-Fi radio transmissions are often operated in a similar physical area and most of the time, in the same device. This is why the existence of both of these technologies have a profound effect on each other.

This is compounded by the fact that multiple devices will operate in the same physical space. This degrades speed and reliability as the number of devices on the same frequency rises. When it comes to compatibility, Bluetooth, and Wi-Fi both tend to perform transmissions using distinct ways and multiple protocols. Why? Because Bluetooth and 802.11b, 802.11g, and 802.11n-compliant devices are capable to operate in the typical 2.4 GHz frequency band, and they always interfere mutually.

Bluetooth is very popular for consumer level short distance point to point audio transport. Typically connecting a portable loudspeaker connected a mobile source. Pairing is simple and straightforward. Many users are familiar with this. The problem arises when it is used professionally. Like in a busy restaurant or bar. As more people arrive, they all have their Wi-Fi and Bluetooth enabled phones on them. Those phones will constantly emit Wi-Fi and Bluetooth signals when enabled. They will broadcast their name even when not actively used. This will degrade the original connection. And it happens at the worst time, leading to audible dropout just as the venue is at its busiest.

Let’s take an in depth look at DECT; What is DECT?

DECT technology, or Digital Enhanced Cordless Telecommunications, is a wireless communication technology that is widely used in a variety of applications, including cordless phones, baby monitors, and audio equipment. Here are some benefits of DECT technology.

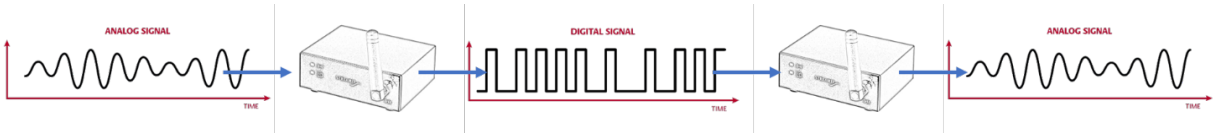
DECT was designed for audio. It was designed from the ground up for this purpose. It is a standard, at first used primarily for cordless phone systems. DECT was designed to provide secure, high-quality audio transmission for voice calls, making it well-suited for critical audio transport.

The military played a role in the development of DECT. In the early 1980s, the European Conference of Postal and Telecommunications Administrations (CEPT) initiated the development of DECT as a standardized wireless communication system for personal communication. The initial focus was on providing a cordless phone system for home and office use.

However, as the development of DECT progressed, it became apparent that the technology could also have military applications. As a result, the CEPT invited military representatives to participate in the development process, and DECT was subsequently adapted for military use.

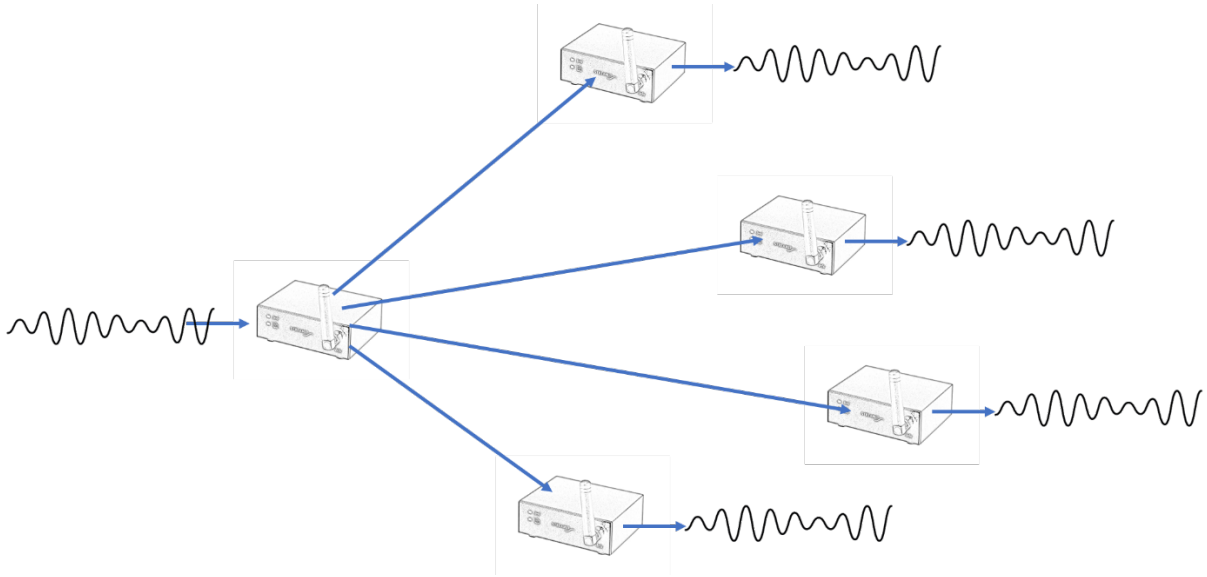
In particular, DECT was used as the basis for the TETRA (Terrestrial Trunked Radio) standard, which was developed specifically for professional mobile radio systems used by public safety organizations and the military. TETRA is based on DECT's air interface and uses many of the same technical features, including adaptive frequency hopping, which helps to ensure reliable and secure communication in challenging environments.

So while DECT was primarily developed for civilian use, its adaptability and technical features made it an attractive option for military use as well, and the military played a role in its development for these applications.



In the context of DECT, "critical audio transport" refers to applications where audio quality and reliability are essential, such as in professional communication systems like wireless headsets used by emergency services, or conference systems used by businesses. These types of systems require a high level of audio clarity, low latency, and minimal interference to ensure that communication is efficient, effective, and reliable.

DECT's design includes a number of features that make it well-suited for critical audio transport. For example, DECT uses a frequency band that is reserved specifically for its use, which minimizes interference from other wireless devices.



Streamit chose DECT as its underlying method to transport audio wirelessly. From that point of view these USP's stand out:

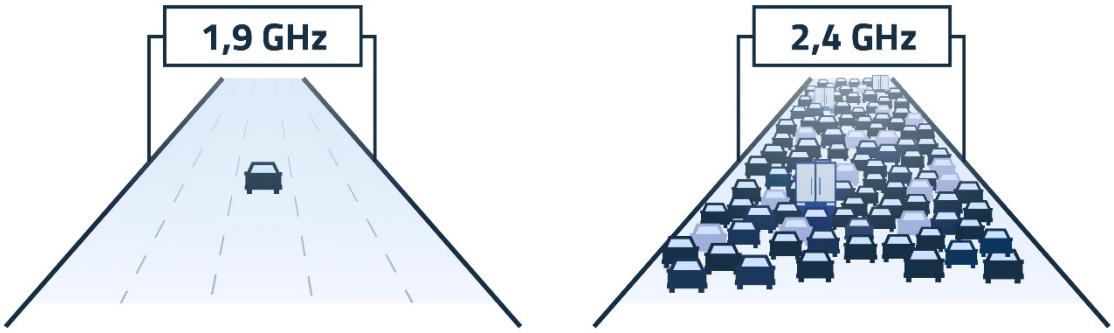
Reliable Connectivity:

DECT devices have the advantage of using their own spectrum. DECT runs on 1880 MHz-1900. This means that there is no competition for the use of airwaves between computers and Wi-Fi devices.

On the used frequency: DECT can in principle be used worldwide, but the available frequency bands differ per region. In Europe, the frequency band 1880-1900 MHz is allocated to DECT, while in North America the frequency band 1920-1930 MHz is used. India and China have additional demands that must be met. Streamit products are capable of being configured for the region it is used in. There are some hurdles.

The DECT standard has 10 channels available creating the space for multichannel of neighbouring systems with interference.

From standpoint of reliability this alone already ensures that the DECT reliability is very high and not dependent on the presence of mobile devices in range.



Long Range

DECT technology has a longer range than other wireless technologies, both outdoor and indoor: The range of wireless audio transmission depends on various factors, such as the frequency used, the transmission power and the environment in which the signal is transmitted.

Bluetooth was designed for 10 meters. It was designed to be a low-power technology that operates over short distances. The Bluetooth protocol is somewhat inefficient, although Bluetooth 5 extends the range up to 100 meters albeit at lower speeds. As this means new hardware and more interference, time will tell what the real-world performance will be.

On the other hand, Wi-Fi is designed for high-speed data transfer over longer distances, typically up to 100 meters or more. Wi-Fi uses higher power and more complex modulation schemes than Bluetooth, which allows it to achieve higher data rates and longer range.

Wi-Fi signals in the 2.4 GHz frequency band can travel farther than those in the 5 GHz frequency band, but they are more susceptible to interference and can become congested in crowded areas. The range of a 2.4 GHz Wi-Fi signal can vary from a few meters to several hundred meters, depending on the above factors. However, for most home and office use cases, the effective range of a Wi-Fi signal is typically between 30 meters indoors and up to 100 meters outdoors with clear line of sight. Remember, 5 GHz Wi-Fi range is a lot less. The counterintuitive part is that when Bluetooth and Wi-Fi ranges increase, the devices ‘see’ more other devices in the area and the need to accommodate each other thus increasing congestion issues. That is when the benefit of a dedicated DECT frequency band pays off again.

DECT has a specified range of 50 meters indoor and 300 meters outdoor. Because interference is much less a factor, the real-life performance is much better with IRIS, especially in urban environments, and even more so in crowded settings.

Security:

Authentication and authorization mechanisms protect against unauthorized access and tampering of communications (like uncommanded start or stop of audio), such as to ensure that only authorized devices can access the system.

The Streamit IRIS system encrypts control data. The audio is transmitted unencrypted. So, in theory eavesdropping is possible, which is hardly an issue as this audio is coming from a loudspeaker near the receiver anyway. But it does protect against unauthorised broadcasts and unauthorized access to the system.

Quality

IRIS uses the OPUS codec for audio transmission. This codec is designed to compress digital audio signals to reduce the amount of data required for transmission while maintaining a high level of audio quality. Opus, developed by the Xiph.Org Foundation and standardized by the Internet Engineering Task Force, is a lossy audio coding format that efficiently encodes speech and general audio in a single format. Its low-latency feature allows for real-time interactive communication, while its low-complexity is suitable for embedded processors. Blind listening tests have ranked it as the highest-quality standard audio format at any given bitrate until transparency is achieved, surpassing MP3, AAC, and HE-AAC.

Opus is relatively unknown, which is surprising as it is the audio format used by Soundcloud, known as the place for new artists to showcase their music directly.

The widespread use of DECT in handsets eclipsed the fact that DECT is capable of 20 Hz to 20 kHz transmission. The current IRIS devices are single channel 48 kHz sample rate at 16 bit, which is basically CD quality and are thus very suited for high fidelity audio transport. (CD is 16 bit @44,1 kHz and is lossless)

Low latency

Low latency: DECT devices have very little latency, making them ideal for applications where like multichannel audio or syncing with an image is needed. As explained above. Wi-Fi streaming, well any IP protocol, achieves higher reliability by using a buffer. This buffers directly leads to latency.

Opus has a low algorithmic delay of 26.5 ms by default, making it ideal for use in real-time communication, networked music performances, and live lip sync. Despite its exceptionally low delay compared to competing codecs, Opus performs competitively with these formats in terms of quality per bitrate. IRIS was designed for real time audio, moreover the synchronicity between channels is better than 150 microseconds.

Future proof.

The Streamit implementation is suitable for stereo and even multichannel use, up to 10 channels of audio can be used. For example, DECT offers the option of transmitting stereo audio over two parallel audio channels.

Drawback(s)

Are there no downsides? Well yes: Configuration. Wi-Fi vs DECT vs Bluetooth: The configuration of wireless audio devices depends on the protocol used and the specific devices. Wi-Fi and Bluetooth usually have a simpler configuration than DECT, which requires a base station. Most DECT implementations rely on fixed, pre-set connections like a telephone base station and handsets. Streamit has made an app to greatly simply setting up connections which is important.

The day-to-day users are not confronted with this setup. It is a setup you only do once at commissioning and when changing hardware or adding receivers. The Streamit implementation offers 1 to 100 transmitters to receiver ratios and can handle up to 10 channels in the same space.

Real world example of Mission Critical use:

Since the late 1990s, DECT has been widely used in many hospitals and healthcare institutions. DECT systems were previously used in almost all homes with wireless devices, and they are still in use at many locations. DECT is still widely used as a Nurse Call System (NCS) for patient calls, Medical Call System (MCS), and as a Medical Alarm System (MAS). DECT systems can be fully monitored and supervised, making them suitable for mission-critical use.

Meanwhile, Wi-Fi is increasingly being used for audio communication. Notably, only the 5 GHz band is used for voice communication and healthcare alarms in Wi-Fi. The 2.4 GHz band is simply not reliable enough. All smartphones of patients, visitors, and employees also generate a lot of traffic in this radio band. This is one of the reasons why Wi-Fi is not suitable for mission-critical use: you do not have sufficient control over the radio connection.

Conclusion

While Bluetooth and DECT are both wireless technologies that enable short-range communications, there are several key differences between them. DECT is more geared to reliable, low latency audio distribution stemming from the way it was designed.