

5 GHz in the Internet of Things: The Game-Changer You Might Be Overlooking

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Introduction

In the rapidly evolving Internet of Things (IoT) landscape, the selection of a Wi-Fi frequency band is a critical design decision that significantly impacts network performance, reliability, latency, range, and power efficiency. Wi-Fi technology traditionally operates in the 2.4 GHz and 5 GHz bands, with the 6 GHz band introduced more recently through Wi-Fi 6E. While support for the 2.4 GHz band is widely regarded as the default operating band for many Wi-Fi devices, incorporating 5 GHz capability remains at the discretion of device manufacturers.

Early IoT devices predominantly adopted Wi-Fi 4, which operates almost exclusively in the 2.4 GHz band due to its broader range and lower cost. However, the increasing demand for higher data throughput, reduced latency, and improved reliability has driven a shift toward dual-band Wi-Fi 6 solutions. These newer devices can dynamically operate on either the 2.4 GHz or 5 GHz band, depending on environmental conditions and application requirements.

The 5 GHz band offers several advantages: higher data rates, reduced interference, lower latency, and improved power efficiency—making it particularly well-suited for applications such as IP cameras and industrial automation. Additionally, its broader spectrum and greater number of non-overlapping channels

help mitigate congestion from common household devices like microwaves and Bluetooth® peripherals that operate in the 2.4 GHz range. For battery-powered or energy-sensitive IoT solutions, the lower average current draw of 5 GHz connectivity in real-life conditions presents a compelling case for adoption as it results in a more predictable battery life-time planning.

Wi-Fi Generations and Adoption Trends in IoT

Over the past 25 years, Wi-Fi has evolved into one of the most pervasive wireless communication technologies, underpinning connectivity across homes, enterprises, public spaces, and industrial environments. As of 2025, cumulative global Wi-Fi device shipments are projected to reach 48.8 billion, with over 23.3 billion devices currently in active use. Annual shipments have surged to 4.1 billion units, underscoring Wi-Fi's central role in the digital ecosystem.

The evolution of Wi-Fi is driven by a structured innovation cycle, typically introducing a new generation every four to five years, as standardized by the IEEE 802.11 working groups. Each new generation brings enhancements in throughput, efficiency, latency, and spectrum utilization. Adoption typically begins with access points and high-performance clients - such as smartphones, laptops, and tablets - before expanding into broader applications, including consumer electronics, industrial systems, and IoT devices.

A significant milestone in this trajectory is the Wi-Fi 6 20 MHz Low Power certification program, launched by the Wi-Fi Alliance in 2024. This initiative is specifically designed to address the unique requirements of IoT applications, such as constrained power budgets, limited bandwidth needs, and dense deployment environments. By enabling Wi-Fi 6 features in narrowband (20 MHz) channels, this certification paves the way for more efficient, scalable, and power-conscious IoT deployments.

The widespread adoption of Wi-Fi 6, with its natively dual-band (2.4 GHz and 5 GHz) support, coupled with the IoT-specific 20 MHz Station certification profile, is paving the way for interoperable and commercially viable dual-band IoT devices.

As Wi-Fi continues to evolve, its role in the IoT landscape is expected to deepen, offering a robust foundation for next generation connected devices that demand both performance and efficiency.

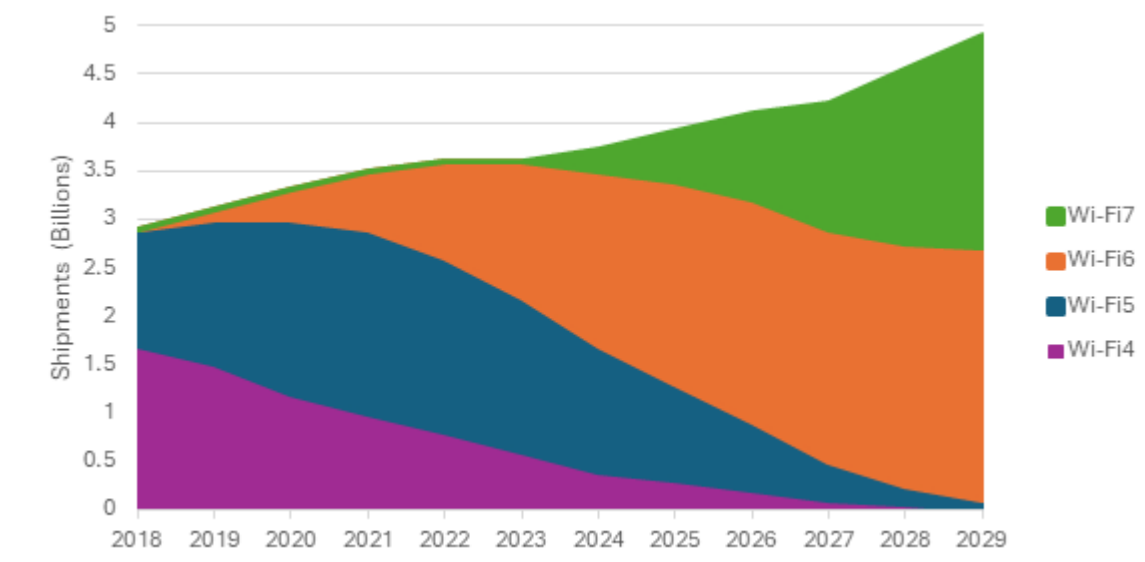


Figure 1: Wi-Fi devices shipped by generation 2018-2029

Source: IDC Research, 2025,

[Powering a connected world: Wi-Fi® momentum in 2025 | Wi-Fi Alliance](#)

Technical Drivers Behind 5 GHz Utilization in IoT

1.Channelization and Interference Management in the 5 GHz Wi-Fi Spectrum

Within the Wi-Fi spectrum landscape, the 5 GHz band offers a significant leap in performance and efficiency compared to the legacy 2.4 GHz band. One of the most notable distinctions lies in the available spectrum: the 5 GHz band provides approximately 500 MHz of usable bandwidth, whereas the 2.4 GHz band offers only about 60 MHz. This expanded spectrum allows for up to 28 non-overlapping channels in the 5 GHz range, compared to just three in the 2.4 GHz band.

This abundance of non-overlapping channels plays a critical role in minimizing network congestion and interference, which are common challenges in densely populated environments. With more available channels, devices can operate with fewer collisions and reduced contention, leading to fewer retransmissions, lower latency, and improved throughput. When combining these factors with shorter active-time duration collectively contributes to lower average power consumption, as devices spend less time and energy managing failed transmissions or waiting for access to the medium.

The 5 GHz band, with its shorter wavelength, offers higher data rates and more stable connections but at the cost of potentially reduced range and weaker wall penetration. In contrast, the 2.4 GHz band provides better coverage and obstacle penetration, making it suitable for long-range applications like environmental monitoring. Another important aspect is band-edge implication on the actual transmit power that devices

may use which in-turn affects coverage – the 2.4GHz with its only 3 non-overlapping channels results with two channels that are at the spectrum band-edge, world radio regulations may result with actual lower transmit power at these channels due to strict out-of-band mask requirements, the 5GHz holds much more channels far from the band-edge with a more predictable transmit power and coverage. Furthermore, the 2.4GHz suffers from greater interference due to limited non-overlapping channels. Understanding these trade-offs is essential for selecting the appropriate band based on the specific performance, range, and power requirements of an IoT deployment.

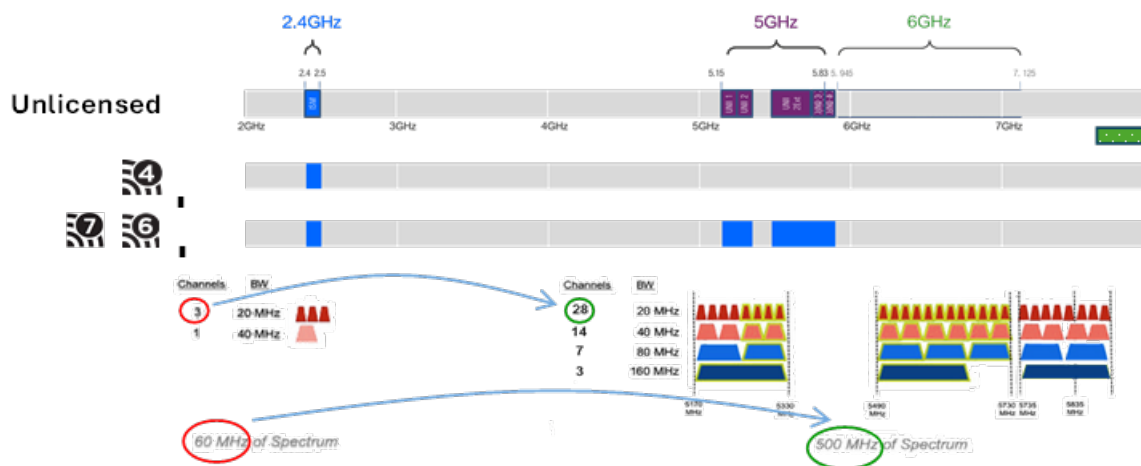


Figure 2: Wi-Fi 2.4/5GHz spectrum overview

2. Operational Efficiency of Wi-Fi in the 5 GHz Band

Beyond differences in frequency range and signal propagation, a critical operational distinction between the 2.4 GHz and 5 GHz Wi-Fi bands lies in the transmission rates of management and control frames, as defined by their respective basic rate sets. These frames—such as beacons, probe requests, and acknowledgments—are essential for maintaining network connectivity and coordination.

In the 2.4 GHz band, these frames are typically transmitted at legacy data rates (1, 2, 5.5, or 11 Mbps) to maintain backward compatibility with older 802.11b/g devices. While this approach enhances range and reliability, it comes at a cost: lower transmission speeds result in longer airtime usage for each frame, increasing channel occupancy, the likelihood of contention, and longer average backoff durations. This, in turn, leads to longer active mode periods, thus higher average power consumption and reduced spectral efficiency, particularly problematic in dense IoT environments where numerous devices compete for limited bandwidth.

In contrast, the 5 GHz band benefits from a higher basic rate set, with mandatory minimum transmission rates of 6, 12, and 24 Mbps as defined by the 802.11a standard. These higher rates enable faster

exchange of management frames, significantly reducing airtime utilization of those messages, combined with the lesser congestion probability, results with faster (thus shorter) sleepy devices packet exchange.

Sleepy devices (such as IoT) maintain a “sleepy-connected” status by periodically waking up (e.g. based on the DTIM or TWT periods that can be as short as few milli-sec) to sync on the AP beacons, look for data transmission targeted to them or take part in link maintenance actions (e.g. Wi-Fi keep-alive, TCP keep-alive, etc.) – these periodic active state affect significantly the average power-consumption of the IoT device, and thus the expected battery-life planning of IoT devices. Surprisingly even to many Wi-Fi and IoT experts – 5GHz is likely to result in much shorter average active periods during sleep states, thus with lower average power consumption for sleepy connected Wi-Fi devices. Not only average power consumption is crucial for IoT devices - the more efficient use of the wireless medium in the 5GHz spectrum, results in lower average latency which in some IoT applications is crucial for proper user experience or targeted functionality (e.g. a security control panel, air-condition control, emergency button, door-lock, etc.), even in high-density IoT deployments.

However, this efficiency comes with a trade-off. The higher transmission rates in the 5 GHz band reduce the effective range of management frames, potentially impacting device association, and connectivity at the edges of coverage areas or in environments with significant physical obstructions.

For IoT applications, where device density, power constraints, latency tolerance, and reliable connectivity are paramount, understanding these operational differences is essential. The choice of frequency band and its associated transmission characteristics can directly influence network scalability, device battery life, and the overall quality of service.

Comparative Analysis of IoT Device Operation in 2.4 GHz vs. 5 GHz Wi-Fi Bands

There are few critical factors influencing Wi-Fi performance (especially when considering those that impact average power consumption for sleepy connected devices) in IoT deployments:

- **Basic Rate (PHY)** - is the rate set used for transmitting management and control frames. These frames—such as beacons, probe requests/responses, and association or disassociation of messages—are essential for maintaining network coordination and connectivity.
- **Timeslots**, including symbol timeslot, SIFS, PIFS, and DIFS
- **Backoff duration** (when the medium is found busy)

1. PHY Basic Rate

Packets sent in basic rate:

- Beacon
- Probe request (STA tx)
- Probe response (AP reply)
- Authentication / Deauth

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- Association / Reassociation
- Control frames – e.g. RTS / CTS / ACK / Block-ACK

As the 2.4GHz and 5GHz are based on different standards, they hold different PHY basic rates:

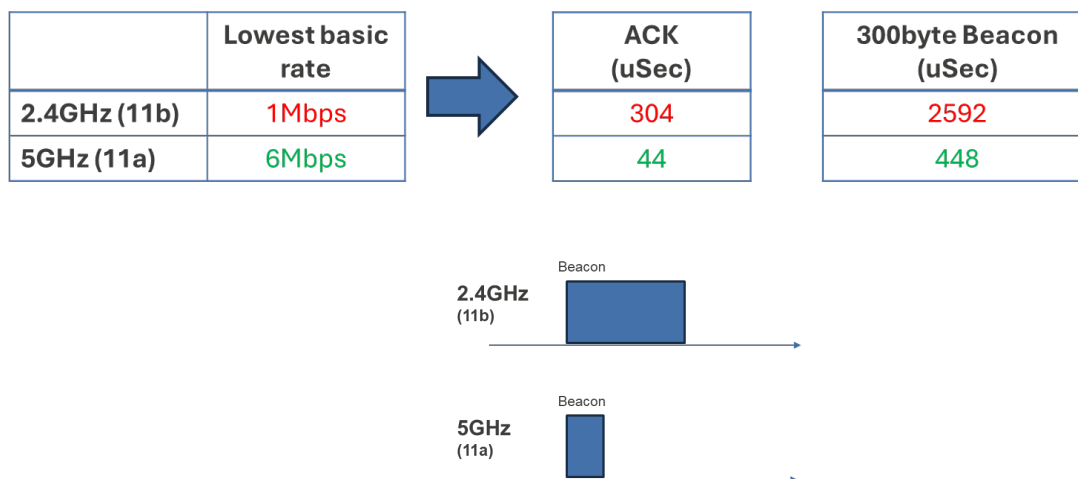


Figure 3: Wi-Fi 2.4/5GHz beacon and management frame timing

Thus, the average duration of beacons or management frames in 2.4GHz is longer than that of equivalent transactions in the 5GHz band.

2. PHY Time-slots

As the 2.4GHz and 5GHz are based on different standards, they hold different PHY durations for these basic interactions:

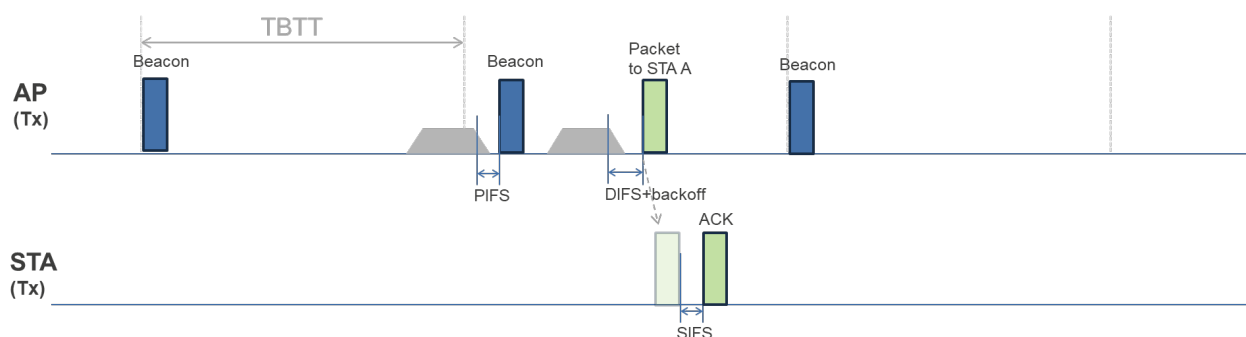


Figure 4: Wi-Fi PHY time slot overview

- Time slot – is the basic PHY time-slot allocation unit
- PIFS – the beacon minimal wait time before beacon transmission

- DIFS – the minimal wait time before packet transmission
- SIFS – the minimal wait time before receiving a packet and sending corresponding reply (e.g. ACK) to it.

	PHY Type	Time-slot	SIFS	PIFS SIFS+1xslot	DIFS SIFS+2xslot
2.4G (11b)	DSSS	20uS	10uS	30uS	50uS
2.4G (11g/n/ax, OFDM)	OFDM	9uS	16uS	25uS	34uS
5GHz (11a/n/ac/ax/be, OFDM)	OFDM	9uS	16uS	25uS	34uS

Table 1: Wi-Fi 2.4/5GHz PHY time slots

3. Back-off Periods (Wi-Fi MAC)

The Wi-Fi MAC parameters are also different in the 2.4 and 5 GHz bands, resulting with different back-off periods if the medium is found busy.

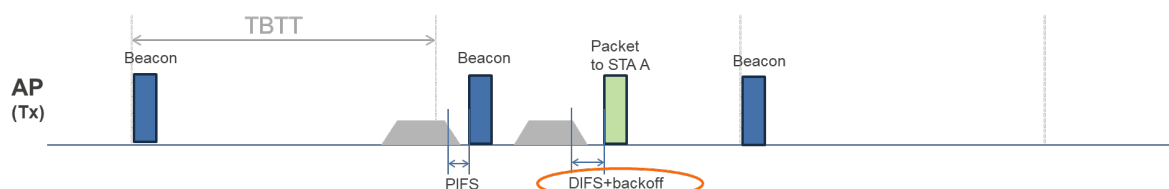


Figure 5: Wi-Fi 2.5 and 5GHz DIFS and backoff period

If channel is found busy when trying to transmit:

1. device waits until the channel is **idle for a DIFS** period.
2. Then it picks a **random backoff** within the contention window (starting 0-CWmin, up to 0-Cwmax time slots).
3. It counts down the backoff slots while the channel remains idle.
4. When the counter reaches zero, the transmission may take place.

	CWmin	CWmax		DIFS	+ Ave. First backoff	= Ave. First wait
2.4GHz (11b)	31	1023	➔	50uS	20uS*16.5 = 310uS	360uS
5GHz (11a) 11n,11ax	15	1023		34uS	9uS*7.5 = 67.5uS	101.5uS

Figure 6: Wi-Fi 2.5 and 5GHz DIFS and backoff period


4. Coverage and Interference Considerations

The 2.4 GHz band with its lower frequency offers wider coverage (lesser attenuation over range) and better wall penetration due to its longer wavelength and lower frequencies.

A note of caution affecting coverage relates to operation at band-edge channels. The 2.4GHz with only three non-overlapping channels is likely to operate in one of the band-edge channels (channel 1 or channel 11). Due to world-radio regulations, specifically considering out-of-band mask compliance, many wireless devices operating in the band-edge are forced to transmit in lower Tx power to meet the regulatory mask constraints – if lower Tx power is mandated, the resulting coverage would be poorer. World radio regulations in the different bands not only relate to band-edge, but also to the maximal allowed transmission power – in many countries the 5GHz maximal transmission power is higher than that of 2.4GHz.

Being limited to only three non-overlapping channels, the 2.4GHz is more susceptible to co-channel and adjacent-channel interference, particularly in environments with many overlapping networks or devices using the same band (e.g., Bluetooth, microwaves).

	2.4GHz	5GHz
Number of non-overlapping channels (20MHz !)	3	>20
Signal Propagation $\propto \log(1/f)$	Better	Higher attenuation (~6dB)
Penetration through walls	Better	Slightly higher attenuation (~2-10dB difference)
Other interference sources than collocated Wi-Fi	BT, Zigbee, Microwaves, LTE, proprietary (e.g. sound streaming)	Radar



Probability for co-channel and adjacent-channel interference	Very High	Low
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Figure 6: Wi-Fi 2.4 and 5GHz co-channel interference

When evaluating Wi-Fi frequency bands for IoT devices, the 2.4GHz band tends to experience significantly higher interference and network load compared to the 5GHz band. Control frames such as beacons are longer at 2.4GHz due to the basic rate of 1 Mbps, whereas 5GHz uses a faster 6 Mbps rate, resulting in shorter beacon durations. Channel access is more agile at 5GHz, with shorter time slots and reduced wait times. Compatibility with legacy devices and potential interoperability issues are more prevalent on 2.4GHz. Consequently, devices operating on 2.4GHz generally experience higher latency, lower throughput, and reduced likelihood of meeting their datasheet-specified performance. Additionally, power consumption for

connected but idle stations is typically higher on 2.4GHz, which can negatively affect battery life. Therefore, the choice between 2.4GHz and 5GHz has a substantial impact on performance, latency, user experience, and power efficiency in IoT deployments.

5. Application Suitability and Deployment Strategy

The choice between 2.4 GHz and 5 GHz should be guided by the specific requirements of the IoT application:

- 2.4 GHz is better suited for long-range, low-data-rate sensors and simple telemetry systems where coverage is prioritized over speed and reliability / latency are less crucial.
- 5 GHz is ideal for always-connected, high-density, time-sensitive applications such as IoT gateways, real-time analytics, and industrial automation, where throughput, latency, and energy efficiency are critical. The 5GHz is also better suited to deliver on more predictable latency/jitter applications and predictable lower average power-consumption for IoT battery-life planning.

Ultimately, a dual-band strategy that leverages the strengths of both frequency bands enables more robust, scalable, and efficient IoT network designs.

How 5 GHz Wi-Fi is Transforming These 5 Key IoT Applications



1. Smart Home Appliances

The growing demand for cloud-connected home appliances is driving widespread Wi-Fi adoption across a broad range of devices—from refrigerators and ovens to washing machines and coffee makers. Key use cases include remote monitoring and control, predictive maintenance, early fault detection, and enhanced user safety and security. The 5 GHz Wi-Fi band offers distinct advantages for these applications. Its lower interference profile is particularly beneficial in kitchen environments, where numerous connected devices and microwave ovens can congest the 2.4 GHz band. Additionally, lower latency in the 5 GHz band enhances responsiveness for real-time interactions, such as voice assistant commands, contributing to a smoother and more intuitive user experience. Higher attainable over-the-air throughputs of the 5 GHz band further contributes to faster over-the-air firmware / graphics updates for the home appliances.



2. Access Control Systems

Access control devices - such as smart locks and video doorbells - are increasingly leveraging Wi-Fi for their connectivity due to its broad coverage, high throughput, and ease of deployment. These systems demand low-latency communication to enable real-time remote access, such as unlocking doors or streaming video feeds with minimal delay. The 5 GHz band offers significant advantages in this context. Its lower latency ensures rapid response times for authentication and control actions, enhancing user experience and security. Additionally, the reduced interference in the 5 GHz spectrum - compared to the congested 2.4 GHz band - supports more reliable and stable connections, which is critical for maintaining continuous operation in security-sensitive environments. These benefits are particularly valuable for battery-powered or intermittently connected devices, where efficient communication directly impacts power consumption and system responsiveness.



3. Smart Sensors

Smart sensors such as temperature monitors, HVAC controllers, thermostats, environmental detectors, and smoke alarms are foundational to modern smart homes, industrial automation, and building management systems. These devices rely on Wi-Fi connectivity to deliver real-time data for applications like climate control, occupancy detection, air quality monitoring, and equipment diagnostics. The 5 GHz Wi-Fi band enhances sensor performance in two key ways. First, its lower interference environment reduces retransmissions, which is critical for power-constrained devices aiming to maximize battery life. Second, in dense deployment scenarios, particularly in industrial settings, the broader spectrum and higher number of non-overlapping channels in the 5 GHz band ensure network stability and low-latency communication, enabling timely and reliable data delivery for responsive automation systems.



4. Cameras, Doorbells, and Monitors

Wi-Fi-enabled video devices, such as IP cameras, video doorbells, and baby monitors, are increasingly integrated into smart home and security ecosystems. These devices rely on real-time video streaming, remote access, and instant notifications to deliver critical functionality. The 5 GHz Wi-Fi band offers two key advantages for these applications. First, its cleaner spectrum reduces interference, which is essential for maintaining uninterrupted video streams, a critical requirement for surveillance, and monitoring. Second, the higher throughput of 5 GHz supports smooth HD and 4K video transmission, minimizing latency and buffering. These capabilities ensure a reliable and responsive user

experience, particularly in environments with high device density or where video quality and continuity are paramount.



5. Smart Medical Devices

The smart medical sector is rapidly expanding, encompassing applications such as patient monitoring systems, medical equipment tracking, emergency alert devices for elderly care, and consumer health monitoring wearables. These devices often transmit critical real-time health data, where latency and reliability are paramount. In environments like hospitals and connected homes, where numerous wireless devices operate concurrently on the 2.4 GHz band, the risk of interference is high. The 5 GHz Wi-Fi band offers a cleaner, less congested spectrum, significantly reducing the likelihood of data collisions and transmission delays. This ensures stable, low-latency communication, which is essential for life-critical applications where data loss or lag can compromise patient safety and system effectiveness.

Dual-Band Wi-Fi: A Strategic Imperative for Scalable IoT Connectivity

Wi-Fi continues to play a pivotal role in the global IoT landscape, accounting for approximately 32% of all IoT connections, according to IoT Analytics. Its ubiquity, scalability, and evolving capabilities make it a foundational technology for connected systems across consumer, industrial, and enterprise domains.

Among the available frequency bands, the 5 GHz Wi-Fi band stands out for its superior throughput, lower latency, lower average power consumption for always connected sleepy devices, and greater spectral efficiency. These advantages are driven by its broader channel availability, reduced interference, and higher baseline data rates, making it particularly well-suited for high-density and performance-sensitive IoT applications, such as industrial automation, healthcare telemetry, and smart consumer devices.

At the same time, the 2.4 GHz band remains indispensable for use cases that demand extended range and better wall penetration, such as environmental monitoring and long-range telemetry. Its ability to support legacy devices and operate effectively in challenging RF environments ensures its continued relevance.

In today's complex and heterogeneous IoT ecosystems, dual-band Wi-Fi support is no longer optional, it is essential. Devices capable of operating across both 2.4 GHz and 5 GHz bands can dynamically adapt to changing network conditions, optimizing coverage, performance, and energy efficiency. This adaptability enables robust, scalable, and resilient connectivity across diverse deployment scenarios.

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By leveraging the complementary strengths of both frequency bands, IoT networks can achieve the optimal balance of reach, reliability, and responsiveness—key attributes for building future-ready, mission-critical connected systems.

For detailed insights into our Dual-Band Wi-Fi IoT MCU development approach, visit the product page [RA6W1](#). To validate the advantages of the 5 GHz band, review real-world performance measurements in our blog post “[Smarter IoT Starts with Wi-Fi 6 Dual Band Adoption](#)”

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