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The WiFi Quality Institute: Why Speed Tests Do Not Measure Real Wi-Fi Quality

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1. Introduction — The Illusion of Performance

In hospitality environments, offices, and high-density residential buildings, the most common way people attempt to evaluate WiFi performance is by running a speed test.

When guests complain about slow connectivity, the immediate response is often simple: open a browser, run a speed test, and observe the result. If the test shows high download and upload speeds, the network is frequently considered “healthy”, and the issue is assumed to lie elsewhere — with the device, the user, or the internet service provider.

However, this approach is fundamentally misleading.

A speed test measures internet throughput at a specific moment from a specific device to a specific server. It does not measure the real quality of the WiFi network itself.

In real-world wireless environments, high throughput measurements do not necessarily indicate high-quality connectivity. Users may still experience unstable connections, latency spikes, or dropped sessions even when speed tests report substantial bandwidth. Understanding this discrepancy requires distinguishing clearly between Internet Capacity and WiFi Network Performance.

The limitations of speed testing can be understood by comparing static test conditions with real-world Wi-Fi usage scenarios.

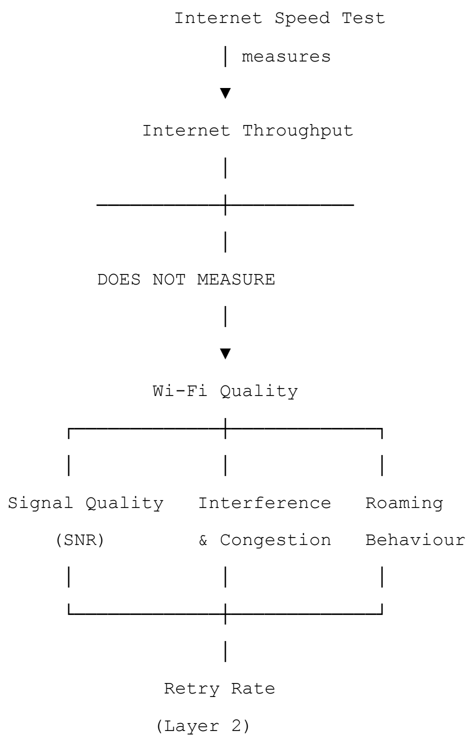

Figure 1 — Conceptual difference between Internet throughput measurements and real Wi-Fi network quality.

As illustrated in Figure 1, traditional speed tests measure peak throughput under static conditions, while real-world Wi-Fi performance is affected by mobility, roaming events, interference and network load.

Common Issues Observed in Real-World Deployments

Experience across many real-world WiFi deployments shows recurring design and configuration problems that remain invisible when networks are evaluated only through speed tests.

2. Methodological Scope

This report presents a conceptual and technical analysis of the limitations of Internet speed tests as indicators of wireless network quality.

The observations presented are based on the operational characteristics of IEEE 802.11 wireless networks and on practical experience derived from real-world deployments in hospitality, office and residential environments.

The purpose of the report is not to present experimental measurements but to identify structural factors that influence Wi-Fi performance and that remain largely invisible when network quality is assessed exclusively through Internet throughput tests.

3. Physical Layer Inefficiencies

Suboptimal Access Point Placement

Access points are often installed where it is convenient or visually discreet — inside cabinets, behind walls, or in technical rooms — rather than where radio propagation is optimal. A speed test performed near the device may show good performance, while areas just a few meters away suffer from poor signal quality or packet loss.

Under-provisioned Access Point Deployments

Another common issue observed in real-world deployments is the installation of an insufficient number of access points relative to the size and usage of the environment.

In hospitality venues, for example, a multi-floor building with dozens of guest rooms is sometimes served by only a small number of access points in an attempt to reduce installation costs or simplify infrastructure.

While a speed test performed near an access point may still report high throughput, the network may struggle to provide consistent performance across the entire property. Devices located farther from the access points may experience low signal quality, reduced data rates, and increased retransmissions.

In addition to coverage limitations, insufficient access point density can also create capacity problems. When many users connect to the same access point, all devices must share the same wireless medium, which can lead to increased contention for airtime and degraded user experience.

As a result, networks that appear adequate when evaluated through isolated speed tests may perform poorly during normal multi-user operation.

Signal Attenuation from Building Materials

Building materials can significantly affect wireless signal propagation. Thick stone walls, reinforced concrete, metal structures, and elevator shafts can substantially weaken or even block WiFi signals as they travel through a building.

Speed tests cannot reveal these physical constraints, because they measure only instantaneous throughput rather than the radio environment in which the connection operates. In practice, the Signal-to-Noise Ratio (SNR) and the attenuation introduced by walls and structural elements are among the main determinants of connection stability and usable throughput.

Industry guidance for professional WiFi design consistently highlights the importance of accounting for wall attenuation and building materials when planning wireless coverage. Measurements published by Ekahau show that common materials can introduce significant signal loss — for example drywall may attenuate signals by around 3 dB, brick walls around 10 dB, and reinforced concrete even more. [1][2]

As a result, two rooms separated by structural elements may experience drastically different wireless performance, even when they are physically close to the same access point.

4. Frequency and Infrastructure Bottlenecks

Over-reliance on the 2.4 GHz band

Many legacy networks still rely heavily on the 2.4 GHz spectrum. Even when a speed test reports moderate throughput, this band is often highly congested and offers only a limited number of non-overlapping channels, which can lead to increased retransmissions and inconsistent performance.

One reason for this congestion is that the 2.4 GHz band is shared by a wide range of devices beyond WiFi networks themselves. These include neighbouring wireless networks, Bluetooth devices, wireless peripherals, and various consumer electronics operating in the same frequency range.

Household appliances may also contribute to interference. For example, microwave ovens operate at frequencies around 2.45 GHz, which lies within the same unlicensed spectrum used by WiFi. While modern appliances are typically well shielded, malfunctioning or poorly shielded devices can generate interference that degrades wireless performance nearby. [3]

As a result, the 2.4 GHz band often experiences higher levels of noise and channel contention than newer WiFi bands, making it more difficult to maintain stable connections in dense environments.

Outdated Wired Infrastructure

In some environments, modern WiFi access points are connected to legacy switches limited to 100 Mbps Fast Ethernet.

When a speed test is performed from a single device, the result may reach around 90–95 Mbps, which can create the impression that the network is performing normally.

However, this measurement hides a structural limitation.

If the internet connection available to the venue exceeds 100 Mbps, the Fast Ethernet link between the access point and the switch becomes a hard bottleneck. All wireless traffic generated by the users connected to that access point must pass through that single 100 Mbps link.

As a result, when multiple clients are active simultaneously, the total available throughput is capped by the switch port. Even if the internet service provides several hundred megabits per second, the access point cannot deliver more than the capacity of its wired uplink.

In practice, this means that multiple users sharing the same access point will compete for the same limited bandwidth, effectively negating the benefits of a higher-speed internet connection.

This type of bottleneck is rarely visible in a simple speed test performed by a single user, but it becomes evident during normal multi-user operation.

Improvised wireless backhaul links

In historic buildings or rural venues, wireless bridges or mesh links are sometimes deployed without proper spectrum analysis or planning. This can introduce hidden latency and instability that short speed tests may not clearly expose.

5. Configuration and Protocol Issues

Legacy data rates

Allowing extremely low minimum data rates can significantly reduce overall WiFi efficiency. A single distant device operating at a very low rate can consume disproportionate airtime, slowing down all other clients connected to the same access point.

Improper roaming configuration

Speed tests are usually performed while the device is stationary. They do not reveal roaming problems, where devices remain connected to distant access points instead of transitioning smoothly to closer ones, leading to unstable connectivity when users move through a building.

6. Internet Bandwidth vs WiFi Network Performance

One of the most common misunderstandings is the assumption that WiFi quality is primarily determined by internet bandwidth. In reality, internet bandwidth and WiFi network performance represent distinct technical concepts.

The difference between these two aspects can be illustrated by comparing the metrics typically measured by speed tests with those that influence real wireless performance.

Speed tests primarily measure short-term end-to-end internet throughput between a device and a remote server. However, many of the factors that determine the stability and usability of a WiFi network are related to radio conditions and medium access behaviour rather than raw bandwidth.

The following table summarises several key metrics relevant to wireless network performance and indicates whether they are typically captured by conventional speed tests.

Metric	Measured by Speed Test	Impact on Real WiFi Quality
Download / Upload Speed	Yes	Relevant for large data transfers
Latency and Jitter	Partially	Critical for video calls and interactive applications
Packet Loss	Rarely	Causes freezing and re-buffering
Signal-to-Noise Ratio (SNR)	No	Determines connection reliability
Channel Utilisation	No	Indicates how congested the wireless medium is
Roaming Handoff Time	No	Affects connectivity while moving

As the table illustrates, several parameters that significantly affect the user experience—such as signal quality, channel congestion, and roaming behaviour—are not directly evaluated by conventional speed tests.

A venue may have a 1 Gbps fibre connection, yet still deliver poor WiFi quality if the wireless network is affected by interference, poor access-point placement, or inefficient configuration.

Conversely, a well-engineered WiFi deployment with modest internet bandwidth can often provide a much more stable and responsive user experience.

7. The Role of Layer 2 Retransmissions

A critical factor often overlooked by synthetic throughput tests is the Layer 2 Retry Rate. In a Wi-Fi environment, when a packet is corrupted due to interference or low SNR, the 802.11 protocol must retransmit it. If a device has to retransmit a packet multiple times, a speed test may still report a high average bandwidth because it measures average throughput rather than the efficiency of the wireless medium. However, each retry introduces additional delay, causing latency (ping) to spike or fluctuate. This can create a "jittery" experience in which real-time applications such as VoIP or video conferencing become unstable, even when the reported connection speed appears adequate.

8. Beyond the Speed Test

Evaluating WiFi quality requires a broader and more structured methodology that considers multiple technical dimensions of a wireless network. Throughput alone provides only a partial picture. A meaningful evaluation must take into account how the network behaves across space, under load, and during normal user activity.

Key aspects include the following:

Coverage and Signal Quality

Users should experience reliable connectivity throughout the entire environment, not only in areas immediately surrounding access points.

Proper coverage evaluation involves measuring not only signal strength but also signal quality relative to background noise, typically expressed through metrics such as Signal-to-Noise Ratio (SNR). Even when signal strength appears sufficient, poor SNR can result in unstable connections, reduced data rates, and frequent retransmissions.

Coverage assessments therefore aim to identify weak coverage areas, dead zones, and locations where the radio environment may compromise performance.

Network Stability

A WiFi network should remain stable under realistic usage conditions.

Testing a network with a single device provides very limited insight into its behaviour during normal operation, where multiple users are connected simultaneously and generating different types of traffic.

Stability testing typically examines how the network performs under concurrent usage, including web browsing, streaming, video calls, and background data synchronization. These scenarios can reveal congestion, airtime contention, or configuration issues that remain invisible when Wi-Fi performance is assessed only through basic single-device speed tests.

Interference Analysis

WiFi operates in shared radio spectrum and is therefore inherently susceptible to interference.

Sources of interference may include neighbouring wireless networks, Bluetooth devices, wireless cameras, and other equipment operating in the same frequency bands.

As discussed earlier in Section 4, the problem is particularly evident in the 2.4 GHz band, where a limited number of non-overlapping channels must be shared among many devices and networks. Household appliances such as microwave ovens may also generate radio noise within this frequency range.

High levels of interference can reduce throughput, increase latency, and cause unstable connections.

The behaviour of Wi-Fi networks is defined by the IEEE 802.11 family of standards, which specify a shared-medium communication model. Unlike modern wired Ethernet, which operates in full-duplex mode, Wi-Fi communication on a given channel is effectively half-duplex: a radio must alternate between transmitting and receiving and cannot perform both simultaneously on the same channel.

This fundamental characteristic means that multiple devices must compete for access to the medium, which can significantly affect performance in dense environments.

Consequently, all devices on a network share the same transmission medium and must coordinate access to the channel to avoid collisions. This is managed through the CSMA/CA (Carrier Sense Multiple Access with Collision Avoidance) protocol, which forces devices to "listen" and wait for a clear channel before transmitting. This coordination introduces a protocol overhead that consumes airtime—a factor that raw speed tests cannot isolate or measure accurately. [4]

However, WiFi networks often face interference not only from external devices but also from neighbouring WiFi networks operating on the same channel.

This phenomenon is known as Co-Channel Interference (CCI). It occurs when multiple access points transmit on the same channel and must therefore compete for the same airtime. In dense environments such as apartment buildings, hotels, or offices, several networks may share the same channel, forcing devices to wait before transmitting and reducing overall network efficiency. [5]

Because WiFi is a shared medium, increased channel utilisation can degrade performance even when signal strength appears strong and speed tests report acceptable bandwidth.

Effective evaluation therefore requires analysing the radio environment, including channel utilisation, interference sources, and the distribution of neighbouring networks across available channels.

Roaming Behaviour

In environments with multiple access points, such as hotels, offices, or large homes, devices must transition smoothly between access points as users move through the building.

Poor roaming behaviour can lead to temporary connection loss, stalled applications, or dropped voice and video calls. In many cases, devices remain connected to a distant access point even when a closer one is available — a phenomenon commonly referred to as the “sticky client” problem.

Evaluating roaming performance involves measuring how quickly and reliably devices transition between access points during normal movement within the environment.

A stationary speed test fails to evaluate one of the most critical aspects of professional Wi-Fi: roaming. In multi-AP environments, seamless connectivity depends on the correct implementation of IEEE 802.11k (Neighbor Reports), 802.11v (Network Assisted Steering), and 802.11r (Fast BSS Transition). Without these protocols properly configured, devices often exhibit "sticky client" behavior —remaining attached to a distant, degraded Access Point even when a closer, stronger one is available. A speed test performed while standing still will never reveal if these handoff mechanisms are functional. Consequently, a user walking through a lobby might experience a total connection drop or severe jitter during an 802.11 re-authentication phase, despite previous speed tests showing excellent bandwidth. [6]

Real User Experience

Ultimately, the quality of a WiFi network should be judged by the experience it delivers to users performing real tasks.

Activities such as video conferencing, cloud access, streaming media, or remote work applications are often more sensitive to latency, jitter, and packet loss than to raw download speed.

For this reason, meaningful WiFi evaluation should include application-level testing that reflects the types of services users actually rely on, rather than relying exclusively on synthetic throughput measurements.

Addressing these issues typically requires careful radio planning, appropriate infrastructure design, and proper configuration of wireless networks.

Conclusion

Speed tests measure internet throughput, but they do not measure WiFi quality.

A reliable wireless network depends on many factors — radio propagation, interference management, infrastructure design, roaming behaviour, and overall network engineering.

Understanding and evaluating these factors requires methodologies that go beyond simple bandwidth measurements.

Developing structured methodologies for evaluating real-world Wi-Fi performance is a central objective of the research programme of the WiFi Quality Institute.

These considerations highlight the importance of structured methodologies for evaluating wireless network quality in real-world environments.

Glossary

Access Point (AP)
A network device that allows wireless client devices to connect to a wired network using Wi-Fi.

Channel Utilisation
The proportion of time a Wi-Fi channel is actively used by devices transmitting data. High channel utilisation indicates a congested wireless environment.

Co-Channel Interference (CCI)
A situation where multiple Wi-Fi networks operate on the same channel and must share transmission time, reducing overall efficiency.

CSMA/CA (Carrier Sense Multiple Access with Collision Avoidance)
The protocol used by Wi-Fi networks to coordinate access to the shared wireless medium by ensuring devices listen for a free channel before transmitting.

Latency
The time it takes for a packet of data to travel from source to destination, typically measured in milliseconds (ms).

Jitter
Variation in packet latency over time. High jitter can disrupt real-time applications such as video calls or VoIP.

Packet Loss
The percentage of data packets that fail to reach their destination during transmission.

Retry Rate (Layer 2 Retransmissions)
The percentage of Wi-Fi frames that must be retransmitted due to interference, low signal quality, or collisions on the wireless medium.

Roaming
The process by which a wireless device transitions from one access point to another while maintaining network connectivity.

Signal-to-Noise Ratio (SNR)
A measure of signal quality that compares the strength of the Wi-Fi signal to the level of background noise.

Throughput
The actual rate at which useful data is successfully transmitted across a network connection.

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