

How to measure and monitor Wi-Fi performance through your customers' eyes

Introducing a unique scoring system to help MSPs objectively define 'good' or 'poor' Wi-Fi service With Wi-FI more essential than ever, it is time for the industry to move beyond 'best-efforts' and adopt objective, measurable performance criteria, like the cellular industry.



# Key learnings in 60 seconds

- There is no universally agreed measure for evaluating Wi-Fi service performance standards. In isolation, speed is an inadequate benchmark. From an end-user perspective, availability, accessibility, reliability and performance are also defining metrics.
- Wi-Fi performance should be measured end-to-end, incorporating all relevant connection protocols. Moreover, it should focus on the services used by customers – and how they are used – to accurately reflect their real world experiences.
- The key metrics can be evaluated by periodically sampling them (two or three times every hour) using a small number of strategically-located 'virtual customer' devices. This methodology mirrors a proven approach employed in the telecoms and wireless services market.
- Aggregated grade point average (GPA) scores, used to benchmark performance, can be derived from KPIs
  (e.g. availability, reliability, access times, speed and latency) that are weighted to meet the personal requirements and expectations of the end-user.
- By cost-effectively generating this comparable and actionable data, Wi-Fi and internet service trends can be monitored and managed to ensure they are being delivered as promised.



# Why is Wi-Fi performance measurement still DIY?

### Wi-Fi has historically been treated as a 'best effort' service, and it is still often a 'do-it-yourself' deployment.

Remote connectivity to support homebased employees, distance learning and global corporate functions, however, has become mission critical, as demonstrated in the wake of the coronavirus pandemic. Despite this, the performance criteria for Wi-Fi remains woefully underdeveloped, especially when compared to cellular service.

Wi-Fi performance evaluation needs to mature rapidly, beyond the basic criterion of speed, to include such factors as availability, accessibility, reliability and application performance. This paper defines a methodology and process to support the delivery of 'carrier-grade' Wi-Fi service for any location.

### The Wi-Fi service challenge

There is no generally agreed measurement, methodology or scoring approach to objectively define 'good' or 'poor' Wi-Fi service.

In the absence of an accepted method, and probably because the first generation of internet services were slow, customers and marketeers focused on speed. Low speeds can indeed be a significant problem and speed is relatively easy to measure and quantify.

As the industry evolved through the various generations of wireless and Wi-Fi services however, it focused on speed (or more specifically maximum throughput) as being the primary definition of 'good' – and this is still true today.

Most marketing of fifth and sixth generation technologies (think 5G, WiFi 6) focuses on speed only. This approach reveals its limitations with the simple question - "what speed defines a 'good' Wi-Fi network?"

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# "What speed defines a **'good'** Wi-Fi network?"





# Fast is not the only criterion that defines a good product or service – **fast food anyone?**

### What makes for a 'good' Wi-Fi service?

If we approach this question from the perspective of the customer, the answers do not have a strong technical focus and they can be applied across any network or network infrastructure.<sup>1</sup> They are technology independent.

#### What really matters to customers?

- Availability: Is the service available when and where I need it?
- Accessibility: How easily (quickly) can I use it? If it has a captive portal or paywall and I'm required to watch promotional videos, or complete surveys, the time to access the network degrades the service experience.
- **Reliability:** Can I successfully connect 100% of the time or just 40%?
- Performance: How well does it deliver the services I am trying to use? Does the video buffer? Are the webpages slow to render? Is the response from the gaming server too slow?

The above metrics can be used to define a 'good' Wi-Fi service. They can all be measured and objectively quantified to produce service standards and set benchmarks for comparing properties, events, services and technology upgrades.

1 A case can be made that the security of a Wi-Fi network is also a factor in service quality. Security however encompasses everything from the voluntary sharing of personal information through to hacking and data theft. The focus of this paper is service performance, which would not typically include security and data policies.

#### **Measuring Wi-Fi service**

At first glance, trying to measure a service that needs to work 'everywhere' (at least everywhere in your building) and 'all the time' can seem daunting.

"Won't I need to collect and measure every connection on my network to reliably characterize the service?" "Won't that require many resources and prove very expensive?" The answer to these questions is a resounding "no".

The service can be periodically sampled and accurately measured with a surprisingly small number of regular measurements. The same statistical principles that are applied to quality control in factories and surveys across populations can allow you to know what the measured performance is and how confidently you can express that performance – the confidence interval, or margin of error.

For your measurement to accurately reflect what a customer will experience when using the service, the measurement methodology needs to closely match how a customer uses the service. "Won't I need to collect and measure every connection on my network to reliably characterize the service?" "Won't that require many resources and prove very expensive?" The answer to these questions is a resounding "no".

ASSURING WI-FI SERVICES WHEN REMOTE CONNECTIVITY IS CRITICAL

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# Seeing Wi-Fi from the customers' perspective



#### Measurement should be end-to-end

The Wi-Fi service is delivered to the customer over the client device, the radio network, the internet and the end-point server (for example, YouTube) using the same OS and apps as the customer.

Measurements of the performance over just a section of the internet highway, from the Wi-Fi access point to the property's gateway switch for example, cannot accurately represent the experience of the customer. This approach is a little like trying to predict the final score of a sports game by watching some of the first half.

#### Measurements should be of the services used by customers

Internet and Wi-Fi services are delivered using many connection protocols. One measurement type (for example, TCP max. throughput speed) is not necessarily a good, or even appropriate, indicator for all services.

Some services, such as gaming or Voice over Internet Protocol (VoIP), are 'good' when the service response time (latency) and packet loss are low. Others, such as email, are not so dependent on these parameters.

#### The device or client sampling the service should be representative of a typical customer device

Making service measurements with instruments or radios that have significantly different performance (better RF sensitivity and gain, for example) produce measurements that do not reflect the user's experience and the quality of the service delivered.





# Measuring Wi-Fi performance like telecoms providers

A proven methodology for measuring telecom and wireless services (think cellular service benchmarking and regulatory audits) is to take a device, typical of those used by a customer, and sample the network by making calls and executing data sessions just like a user does.

If an appropriate number of samples are measured and established statistical principles applied, it is then possible to make accurate claims about the performance of the overall service. For Wi-Fi, a few devices periodically accessing and measuring the services can do the same thing.

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The number of devices/samples needed and the economics (cost) of collection can be surprisingly low for a high-value office, public venue or high-use location.

Epitiro's Virtual Customer (ViC) Agents, for example, can be placed at a few key locations and left to continuously measure and report the Wi-Fi service performance. Half a dozen Agents, with each one located every 5,000 sq ft or so, provides comprehensive coverage for a 30,000 sq ft property. The Agents can be located in the places where the service really matters – the hotel lobby, the conference room and key locations on each floor, for example. This level of sampling gives a very representative view of the service throughout the property.

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# Deciding what is a **'good**' Wi-Fi service for you

Our expectation of 'good' Wi-Fi varies based on such things as cost and location. A free Wi-Fi service in a public location in the countryside is not generally expected to deliver the same service or performance as a premium paid-for service in a high-tech corporation.

As Wi-Fi technology and our connected networks improve, the definition of 'good' is going to change. It is therefore important that our measurement and scoring system can adapt. It's appropriate to define your score (or service grade) per SSID/ interface, setting different levels for Premium Wi-Fi (Wi-Fi 6), versus free (2.4GHz), for example.

One solution is to take a set of key performance indicators, set thresholds against a scoring range (e.g. from one to five), apply a weighting based on what is important to you, (speed, latency, availability etc) and let the computer calculate the score automatically.

This method allows you to set a score and apply it across a service - a grade point average (GPA) for your Wi-Fi based on the subjects that are important to you.

# Setting up your Wi-fi scoring system

Performance Indicator	Scores					
	5	4	3	2	1	Weight: 100%
Upload Speed (Mbps)	50	30	20	10		25
Download Speed (Mbps)	50	30	20	10		25
Latency (ms)	15	40	70	100		30
Web Page Load Time (ms)	200	400	800	1000		20
Video Start Delay (ms)	300	450	700	1000		0
File Transfer Downlink Speed (Mbps)	10	8	6	3		0
File Transfer Uplink Speed (Mbps)	8	6	4	2		0

Example of thresholds and weights for a performance score based on four key KPIs (N.B. three KPIs are weighted to zero in this example).





# Focusing on the KPIs that matter to your customers

Let's take a closer look at the Key Performance Indicators that determine Wi-Fi service:

**Availability:** Is the service **where** I want it and available **when** I need it?



The measurement devices periodically connect and test multiple services or SSIDs. The connection rates are measured and reported for each attempt against each service interface. With appropriate placement of a few devices, it is easy to objectively measure **service availability.** 

#### Accessibility: How long does it take to authenticate and receive internet service?



The time taken to access the Wi-Fi services can also be readily measured. The total connection time is measured from when the client/customer tries to associate to the network (connects the Wi-Fi radio) until they are granted internet service.

This process can also involve automatically navigating a captive portal (splash page) which may take 2-3 minutes. Using this approach, the **service accessibility** can be objectively measured and benchmarked.



**Reliability:** Is the Wi-Fi service consistent and dependable? Does it only work well at certain times of the day?



The quality of a Wi-Fi service can vary dramatically, depending on how busy or congested the system is. It is important to measure continuously throughout the day. This is illustrated above by observing the throughput speed and latency (for example) across 24 hours in a busy airport.

The capacity of this network relative to the demand is a key factor in determining the quality of the service as seen by the user. It is critically important to measure the performance during the busiest times of the day. This is when most of your users are experiencing the service.

When KPIs are continuously measured throughout the day and their values aggregated over time, it is simple to create reliability metrics for any given period. Hours can be aggregated to days and weeks, while Agents can be aggregated to floors, buildings and campuses, enabling **service reliability** to be measured and reported across a span of time or space.



A grid illustrating a week of service reliability over 24 hours at key locations on a campus



**Performance:** Do the applications and services I use perform well?

The performance a user gets depends on both the network and the applications they are using. For example, sending data (live streaming) requires good upload performance and receiving data (web browsing) requires good download performance. Many systems have far poorer upload performance than download, so they may be suitable for browsing the web but not for streaming your live activities.

For overall good performance, it is important to measure the performance of the network and the performance of key network services. In the dashboard, the first five measurements are KPIs of the network and the remaining four are KPIs of specific applications – moving files to and from, starting a video and browsing the web.







## Do I need to know for every minute/hour/day?

Most businesses and service providers do not have good metrics on service availability and performance day-to-day or week-to-week. They may have information on the **network availability** (as reported by the network elements) but this is not the same as the **service availability**. The service requires all the network elements to be working and interworking together, including elements outside of the network typically being observed by the managed service provider (MSP).

Measuring the services two or three times each hour, every hour, gives a very meaningful and manageable set of data for benchmarking service performance.



### Do I measure per building, per floor, per key location?

Yes. Decide where your service availability is important and measure there. For example, in an airport, Wi-Fi service may not be critical in every basement and closet, but in the customer lounge, ticket counter, boarding areas and restaurants, it is essential. A few well-positioned samples can give a very complete picture of your overall Wi-Fi service.

In the hospitality industry, you know where your customers spend their time, so prioritizing measurements and service performance to those locations is essential. Simply knowing numbers with little regard to location can lead to you missing the impact on your customers until it's too late and you are having to respond to complaints.







# How to compare Wi-Fi performance across different properties

Having established a reliable and consistent method of measuring end-toend Wi-Fi service performance, it then becomes easy to compare Wi-Fi and internet service across multiple properties using the same methodology.

The relative performance of infrastructure, and even technology such as Wi-Fi 5 vs Wi-Fi 6, can be compared by measuring and focusing on what matters to the customer – the service performance.

With measurements relayed continuously, the KPIs can be aggregated and scored each hour by SSID/service.

Every important location and SSID has a set of KPIs and an hourly score. The KPIs and scores are easily aggregated by, for example, floor, property or campus and also by hour, day or week to produce comparable and actionable data for managing your Wi-Fi service to your customers.



Reports containing key information about the level of service performance, and whether it's improving or degrading over time, can be auto generated and delivered to anyone who needs to know.





## A periodic performance score based on service KPIs







Example of auto-generated performance reports for a campus location







# Conclusion

We have developed a methodology for measuring any Wi-Fi or wireless service, based on the end-to-end service performance.

This approach accounts for the performance of the network, the client and the specific internet services. It is both vendor and technology agnostic, allowing it to be applied regardless of the brand of Wi-Fi equipment or the technology implementation. Economically, this is a cost-effective and flexible way to characterize a network and a service. It requires a few low-cost clients and a connection to a cloud-hosted measurement and scoring solution.



### About the author

Des Owens is Co-Founder and Chief Operating Officer of Epitiro. Epitiro was established to support the goal of providing everyone with high-quality connected internet services. Des has previously held senior and founding roles at Spirent Communications, Metrico Wireless, Actix and T-Mobile. He has decades of experience helping the mobile industry measure and optimize network performance and the user experience.





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