18,137 Data Points Later: What Oxit's Amazon Sidewalk Field Test Reveals About Real-World Coverage

Introduction

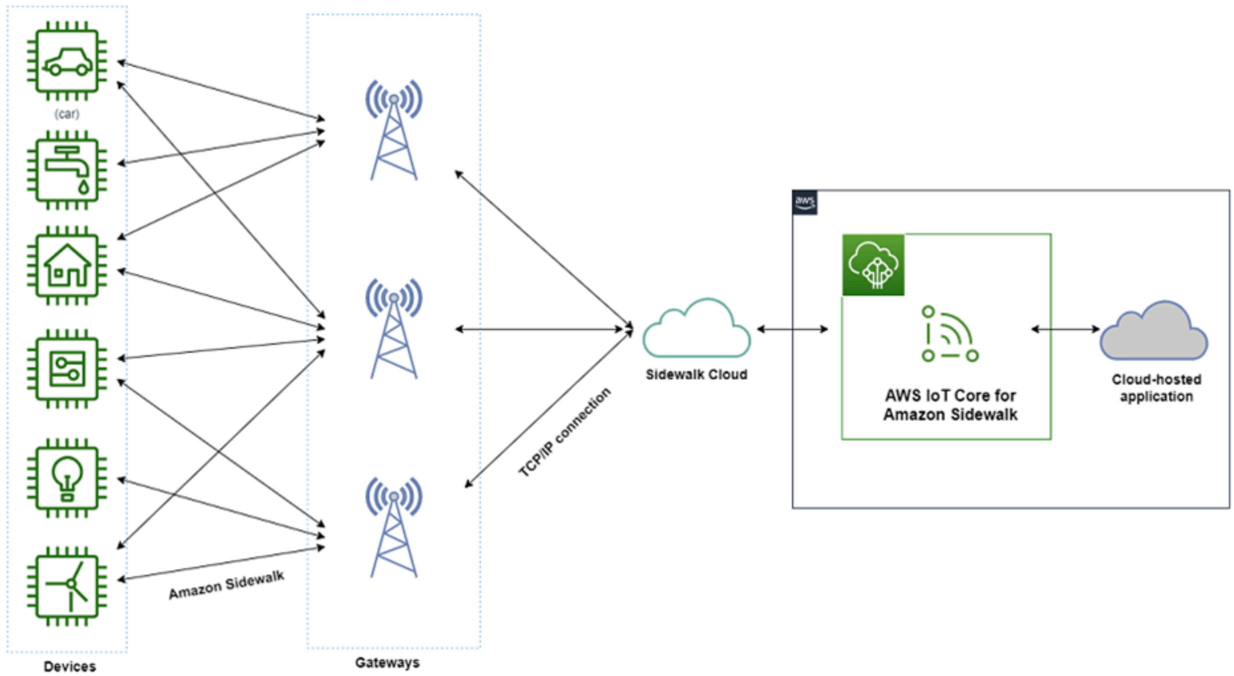
Armed with nothing more than an Amazon Sidewalk test kit, Oxit embarked on a 370-mile journey to put Amazon's ambitious IoT network to the test. This article takes you on a deep dive into the real-world coverage of Amazon Sidewalk, as revealed by Oxit's field testing across diverse environments, from urban centers to rural highways. What makes this experiment intriguing is its use of only the standard Amazon Sidewalk Test Kit, showcasing the network's capabilities under authentic conditions without any specialized equipment.

Amazon Sidewalk supports IoT connectivity by extending the reach of devices far beyond the limits of traditional Bluetooth and Wi-Fi. We will explore the intricacies of Amazon Sidewalk's coverage and compare it with conventional IoT networks to highlight its range and connectivity across a wide array of environments. Get ready to discover how Amazon Sidewalk is pushing the boundaries of IoT and paving the way for a more connected future.

Sidewalk Intro

First, if you haven't read our Amazon Sidewalk: A Comprehensive Guide - check it out for a great introduction.

Amazon Sidewalk is a secure, free-to-connect community network powered by Amazon Sidewalk Bridges such as Amazon Echo and Ring devices, which facilitate cloud connectivity for IoT devices. Available exclusively in the USA as of May 2024, Amazon Sidewalk is tailored for energy-efficient, low-data applications. The network's coverage and capabilities are defined by RF modulation technologies, specifically operating in the 2.4GHz band with Bluetooth Low Energy (BLE) and the 915MHz band using Frequency-Shift Keying (FSK) and LoRa - Chirp Spread Spectrum (CSS).



Amazon Sidewalk Network Architecture

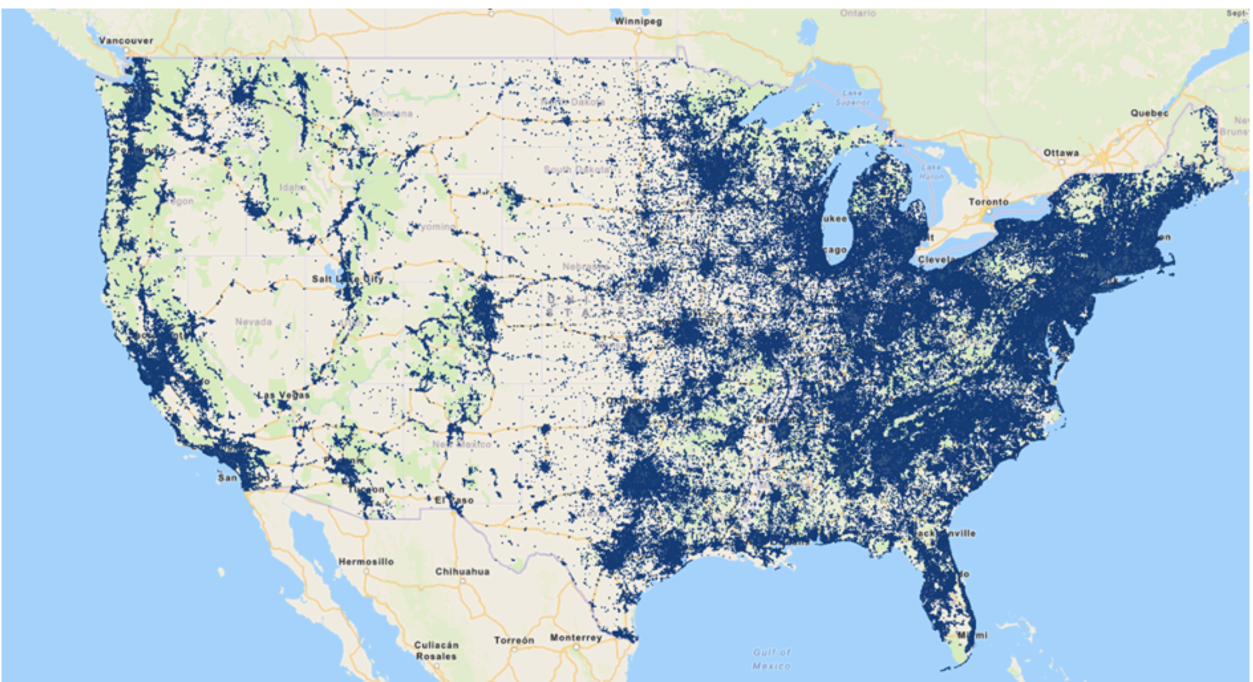
Understanding Coverage with Amazon Sidewalk

Understanding how far Amazon Sidewalk can extend its connectivity web is crucial for seeing the incredible value it brings to the IoT landscape. According to Amazon, 90%+ of people in the U.S. live in areas covered by Amazon Sidewalk, making the answer likely "yes" to the question, "Is my neighborhood covered?" Amazon provides a public coverage map (shown below) highlighting Amazon Sidewalk availability across the U.S., offering users a clear understanding of its extensive reach.

Amazon Sidewalk relies on existing devices like Echo and Ring products, which act as Amazon Sidewalk Bridges (Gateways), to establish network connectivity. These bridges use a small portion of internet bandwidth (500MB Max per month) to support the Amazon Sidewalk network. Amazon Sidewalk-enabled devices—including smart locks, motion sensors, cameras, and wildfire detectors—can securely transmit encrypted data to an Amazon Sidewalk Bridge up to half a mile away. This bridge then uses its internet connection to securely relay the data to the cloud. As a result, users receive real-time alerts and notifications on their mobile devices, including water leak alerts, air quality readings, and camera motion alerts, providing valuable insights that help monitor and manage their environments.

By enabling Amazon Sidewalk on Amazon devices within a household, users help expand this seamless network, making Amazon Sidewalk an innovative and practical solution for broad IoT connectivity.

Search any area in the US for coverage with the [Live Amazon Sidewalk Coverage Map].

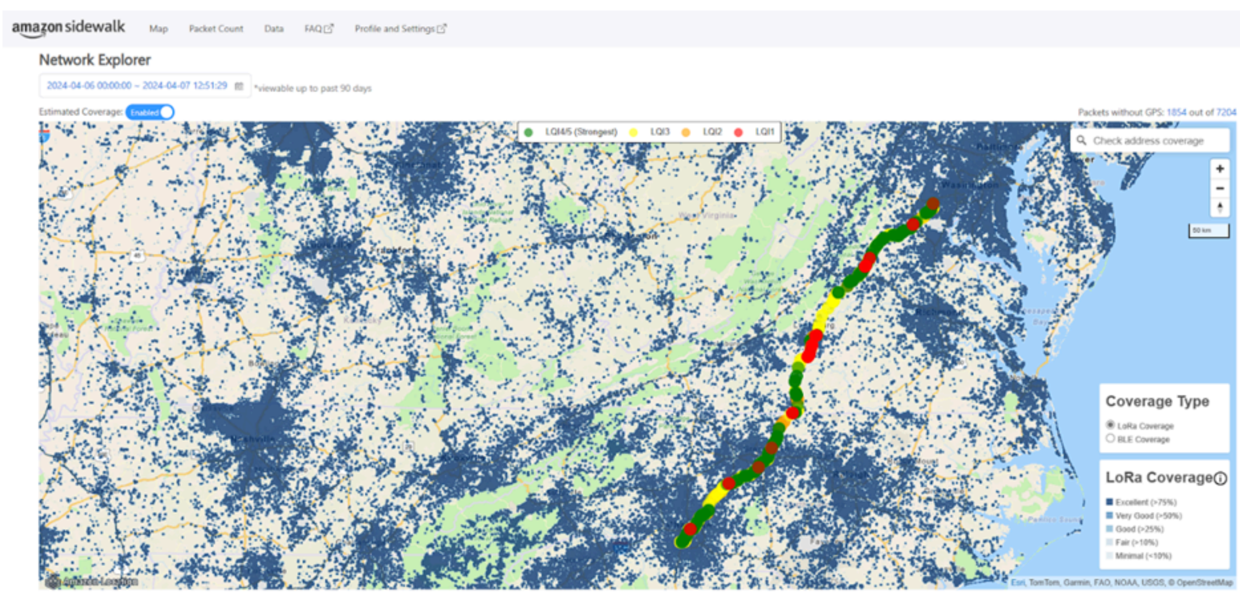


Amazon Sidewalk Coverage Map

Exploring Amazon Sidewalk Coverage: Field Testing Insights from Oxit

In an effort to validate the extent of Amazon Sidewalk's network coverage, Oxit conducted an extensive field experiment to assess its reach and reliability. Our findings shed light on the network's efficacy in extending connectivity to IoT devices.

Oxit conducted this experiment using Amazon's Sidewalk Test Kit to analyze network coverage across various regions and states. Our journey spanned a total of 370 miles from Charlotte, North Carolina, to Manassas, Virginia, and back (round trip). The GNSS tracker was placed on the dashboard of the vehicle, positioned near the edge of the windshield to maximize signal reception and minimize obstructions. We covered both urban and rural regions in North Carolina and Virginia, passing through towns like Charlotte, Concord, Lynchburg, and Charlottesville.



Each dot shows a successful ping from the Sidewalk network at 10-second intervals in this data from a Sidewalk Test Kit. The colors indicate strength. The blue overlay indicates blanket coverage

In our field experiment covering a 370-mile route from Charlotte, NC, to Manassas, VA, and back, Oxit collected a dataset of 18,137 expected uplink packets. Here's a breakdown of our findings:

Key Observations

Urban vs. Rural vs. Highways

- Urban Areas: The network performed well, with few instances of packet loss or prolonged blackouts, confirming that urban settings are well-served by Amazon Sidewalk Bridges.
- Rural Areas: Roughly 30-40 instances were noted where the Amazon Sidewalk network was absent for around 10 miles. These gaps were mainly in less populated areas, which makes sense due to fewer community-based Amazon Sidewalk Bridges.
- Open Highways: Observed 5-10 instances of blackouts lasting up to 30 miles and 3 instances where the network was absent for up to 60 miles, typically on open highways where the infrastructure is less dense.

Signal Strength and Frequency Bands

- Bluetooth Low Energy (BLE): The BLE signal generally performed well in short-range urban environments but lost effectiveness in rural and highway scenarios due to limited signal propagation.
- Frequency-Shift Keying (FSK): Provided consistent mid-range coverage, effectively connecting smart devices across detached structures and outdoor spaces, with better results in suburban and semi-urban areas.

- Chirp Spread Spectrum (CSS): Displayed superior long-range connectivity, successfully connecting devices over miles in both urban and rural settings. However, signal strength diminished in highly congested areas due to potential interference.

Strategic Placement of Amazon Sidewalk Bridges

- The data reinforces the importance of strategic Bridge placement. Adding more Bridges in areas with limited or no coverage can significantly enhance network availability.

Amazon Sidewalk Packet Loss

Understanding packet loss is crucial to assessing the effectiveness of the Amazon Sidewalk network. In this analysis, we provide an in-depth examination of the packet loss data, taking into account significant interruptions and external factors like battery depletion, to offer a more accurate representation of the network's performance.

The total expected uplink packets for the Amazon Sidewalk Test Kit was 18,137, based on the assumption that the device should transmit data every 10 seconds over a roughly 50-hour period. However, during the testing, there were instances where the device's battery was depleted, resulting in periods where no data could be transmitted. To account for this, we adjusted the total expected uplink packets to 12,074, excluding the times when the device battery was too low to function. This adjustment allows for a more realistic assessment of the Amazon Sidewalk network's performance.

Packet Loss Rate Breakdown

- Total expected uplink packets: 18,137
- Significant interruptions due to test kit battery depletion: 6,063
- Total expected uplink packets (excluding battery depletion instances): 12,074
- Successfully packet transmissions: 9,824
- Adjusted unsuccessful packet transmissions: 2,250
- Adjusted packet loss rate: 18.67%

The adjusted packet loss rate of 18.67% represents a more realistic assessment of the Amazon Sidewalk network's performance, as it accounts for instances where packet loss was due to test kit battery depletion.

Potential Causes for Packet Loss

- Environmental Factors: Losses occurred due to physical obstructions, such as buildings and natural terrain, especially in rural or mountainous areas.
- Technical Limitations: Some packet losses were likely due to limitations in the Amazon Sidewalk technology, including range limitations of BLE and signal interference in areas with dense electronic activity.
- Insufficient Amazon Sidewalk Bridge Density: The observed packet losses were more frequent in areas lacking sufficient network infrastructure, indicating the need for a denser network of Amazon Sidewalk Bridges to ensure consistent coverage.

The adjusted packet loss rate of 18.67% highlights the challenges in network stability, influenced by environmental and technical factors. This data underscores the need for strategic enhancements in both technology deployment and infrastructure development to reduce packet loss and improve the reliability of the Amazon Sidewalk network.

These improvements could potentially enhance connectivity for IoT devices, particularly in under-served areas, and ensure more robust data transmission across varying landscapes.

Network Blackouts: Lost Network Details

During our extensive field testing of the Amazon Sidewalk network, we systematically recorded instances of network blackouts. Here's a statistical breakdown of where and how frequently these losses occurred:

Total Blackouts Recorded: We noted a total of 48 distinct blackouts during the entire journey.

Duration and Frequency of Blackouts

- Short-term Blackouts (1-2 miles): Occurred in 38 instances, primarily in rural and open highway areas.
- Medium-range Blackouts (10-30 miles): Noted in 7 instances, these were more prevalent along less populated highway stretches.
- Long-range Blackouts (50-60 miles): Encountered in 3 instances, exclusively on open highways where Amazon Sidewalk infrastructure was notably sparse.

Impact by Area Type

- Urban Areas: Only minor interruptions were noted, with quick recovery, indicating robust network infrastructure in densely populated regions.

- Rural Areas: More frequent and prolonged blackouts, highlighting the challenge of sparse Amazon Sidewalk Bridge distribution.
- Highways: Significant blackouts in connectivity, reflecting the need for enhanced network coverage in these areas.

This underscores the areas of potential improvement for Amazon Sidewalk, particularly in expanding and strengthening network coverage in rural and highway regions to ensure consistent connectivity.

Mapping Reality: Theoretical vs. Actual Sidewalk Coverage

Our field test provided valuable insights into the discrepancies between the theoretical coverage shown on Amazon Sidewalk's official maps and the actual coverage experienced during our experiment:

Coverage Consistency

- Theoretical Coverage: According to Amazon's coverage maps, Amazon Sidewalk should provide broad connectivity across tested areas.
- Actual Experience: While the coverage was generally consistent with projections, notable exceptions were identified.

Coverage Discrepancies

- Coverage Overestimation: Approximately 10% of the areas shown as covered on the map experienced no actual Amazon Sidewalk connectivity.

- Unexpected Coverage: Around 5% of the time, Amazon Sidewalk was available in areas not indicated on the official maps.

These findings highlight the need for continuous updates to Amazon Sidewalk's coverage maps to more accurately reflect real-world connectivity, ensuring that users have a reliable guide to network availability.

Factors Affecting Amazon Sidewalk Reach & Reliability

Understanding the elements that influence the range and effectiveness of Amazon Sidewalk is crucial for maximizing its potential in various environments.

Here are the key factors

- Absence of Amazon Sidewalk Bridges/Gateways: The lack of enough Amazon Sidewalk Bridges can significantly reduce network coverage and effectiveness.
- Network Density: Higher densities of Amazon Sidewalk-enabled devices create a more robust mesh network, enhancing range and reliability.
- Physical Obstacles: Structures like buildings and trees can obstruct Amazon Sidewalk signals, particularly at the 900 MHz frequency, which, despite good penetration capabilities, is still susceptible to barriers.
- Environmental Interference: Interference from other electronic devices and networks in the same frequency bands can impact signal strength and reliability.
- Device Transmission Power: Limited transmission power, regulated to conserve battery life, can reduce the range and coverage of devices.
- Antenna Design: Efficient antenna designs improve signal transmission and reception, enhancing overall network coverage.

- Weather Conditions: Adverse weather conditions like rain, fog, and humidity can affect radio frequency propagation, potentially degrading signal quality.
- User Participation: The extent of user participation, with more users opting in, can expand the network's reach and stability.

Specific Environment Behavior

- Metallic Environments: Signal may be severely disrupted in metallic settings.
- Underground Areas: Coverage is typically weak or non-existent underground due to signal obstruction.
- Inside Buildings: Signal strength can vary significantly based on building materials and internal obstructions.
- Extreme Temperatures: Both high and low temperatures can affect device performance and signal integrity.
- Rural Areas: Less effective in rural settings due to fewer Amazon Sidewalk Bridges and lower device density.

The performance of Amazon Sidewalk is dependent on a combination of technological, environmental, and human factors. Optimizing these elements can significantly enhance coverage and reliability, making Amazon Sidewalk a more versatile and robust solution for smart device connectivity across diverse settings.

Amazon Sidewalk vs Traditional IoT networks

In the dynamic world of IoT connectivity, Amazon Sidewalk emerges as a standout option with its unique capabilities. This comparison aims to delineate Amazon Sidewalk's advantages and limitations relative to traditional and emerging IoT technologies, offering a clearer picture of its role in the expansive IoT ecosystem. The key comparison points are listed below.

Extended Reach and Cost Efficiency

- Traditional Wi-Fi and Cellular: Often limited by range, larger power consumption, and higher costs.
- Amazon Sidewalk: Provides extended reach with lower operational costs, ideal for devices like environmental sensors, tracking devices, and smart locks that do not demand high bandwidth.

Balancing Bandwidth and Cost

- High-Bandwidth Cellular Data: Typically used for data-intensive devices but can be costly.
- Amazon Sidewalk: Offers a more economical solution for devices requiring moderate bandwidth.

Range and Power Efficiency

- Bluetooth: High bandwidth but limited range.
- Wi-Fi: Wide coverage but higher power consumption.
- Amazon Sidewalk: Bridges the gap with extended-range connectivity at lower costs.

Technology Complexity and Reliability

- 5G: Offers reliable long-distance data delivery but at higher complexity and cost.

- Amazon Sidewalk: A simpler, cost-effective alternative for less demanding applications.

Amazon Sidewalk harnesses a community-driven network that grows stronger and more reliable as more devices join, providing extensive coverage and redundancy without additional costs.

IoT Protocol \ Feature	BLE	Wi-Fi	Cellular
Range	Low to Medium (10m to 100m)	Medium (50m to 100m)	High (km)
Power Consumption	Low power	High	Power Hungry
Data Rate	Low (1 Mbps)	High (Mbps-Gbps)	High (Mbps-Gbps)
Frequency	2.4 GHz	2.4 GHz, 5 GHz	Various bands (e.g., 700 MHz to 2.5 GHz)
Typical Use Cases	Wearables, healthcare, smart home devices	Home/office internet, local area networking	Mobile communication, broadband internet
Connectivity	Personal area	Local area	Wide area
Security	High (encryption)	High (WPA3, encryption)	High (encryption, SIM card)
Deployment Cost	Low (devices with BLE capability)	Low to Medium (routers, access points)	High (Infrastructure)

IoT Protocol \ Feature	LoRaWAN	Amazon Sidewalk
Range	High (2-5 km Urban, 15km Rural)	Medium to High
Power Consumption	Low Power	Low Power
Data Rate	Low (0.3-50 Kbps)	Low (Tens of Kbps)
Frequency	Various (e.g., 868 MHz in Europe, 915 MHz in the US)	900 MHz (US)
Typical Use Cases	IoT networks, smart cities, agriculture, industrial applications	Extended range IoT devices, smart home, community networks
Connectivity	Wide area	Neighbourhood area
Security	High (encryption, network session keys)	High (encryption, network keys)
Deployment Cost	Low to Medium (gateways)	Medium (requires Sidewalk Bridge devices)

Amazon Sidewalk presents a compelling choice for IoT connectivity with its community-powered, low-cost network offering expansive coverage. This makes it particularly suitable for environments where traditional networks fail to reach or are too costly to deploy, thus bridging critical connectivity gaps in the IoT landscape.

Navigating Amazon Sidewalk's Coverage Challenges and Limitations

Amazon Sidewalk aims to revolutionize IoT connectivity with its community-driven network, but it encounters specific challenges and limitations that affect its coverage, reach, and reliability. Understanding these hurdles is crucial for optimizing Amazon Sidewalk's potential.

Challenges

- Coverage Gaps in Sparse Areas: The network's reliance on community devices like Amazon Echo or Ring limits its reach in areas with low population density or where fewer people use these devices. Check out Oxit's MCM Solution that combines Amazon Sidewalk and LoRaWAN (Helium, Senet, Everynet, TTN) to get more range out of a single hardware module.
- Rural and Remote Areas: Lack of consistent coverage due to fewer residential networks.
- Industrial and Commercial Zones: Inadequate coverage where consumer-grade devices are unsuitable.
- Potential Solution: Deployment of dedicated Amazon Sidewalk Bridges in under-covered areas and integration of mobile Amazon Sidewalk Gateways in Amazon delivery vehicles to enhance connectivity dynamically.
- User Participation Dependency: Amazon Sidewalk's performance is heavily influenced by the number of users who opt into the service, using their home internet bandwidth. In regions with low adoption rates, network coverage is notably diminished.

Limitations

- Geographical Restriction: Currently limited to the United States and Puerto Rico, restricting its global applicability and testing.
- Limited Protocol Support: Not all Amazon Sidewalk Bridges support the full range of Amazon Sidewalk communication protocols, leading to variable device connectivity and network robustness.

- Data Transfer Constraints: The CSS / LoRa link type used by Amazon Sidewalk limits packet size to 19 bytes, which may hinder the network's ability to handle larger data requirements efficiently.
- Higher Latency: Compared to direct connections like Wi-Fi or cellular, Amazon Sidewalk can experience higher latency, impacting time-sensitive applications.
- Infrastructure Dependency: The effectiveness of the network is contingent upon the presence of a sufficient number of community network bridges, which may lead to instability in newly developed or less populated areas.

The success of Amazon Sidewalk in broadening IoT connectivity faces challenges rooted in its community-based infrastructure and technological constraints. Enhancing device compatibility, expanding geographic availability, and increasing user participation are critical steps toward mitigating coverage limitations and improving the network's overall reliability.

Conclusion

Oxit's 370-mile field test has provided a real-world examination of Amazon Sidewalk's capabilities and limitations. The results are clear: Amazon Sidewalk is bridging gaps and extending the reach of IoT devices like never before.

Key insights from Oxit's experiment highlight Amazon Sidewalk's ability to deliver reliable connectivity across urban landscapes, while also identifying areas for improvement in rural and highway settings. The network's impressive performance in urban environments, coupled with its potential for optimization in rural and highway contexts, showcases its immense promise.

The true power of Amazon Sidewalk lies in its community-driven framework, which harnesses the strength of readily available Amazon devices to create a robust, adaptable network. As more devices join the network, Amazon Sidewalk's coverage and reliability will continue to grow, making it a sustainable and future-proof solution for IoT connectivity.

While challenges remain, such as network density, environmental interference, and user engagement, Amazon Sidewalk's potential is undeniable. By addressing these issues head-on and continuously innovating, Amazon Sidewalk is set to bridge the gap between smart homes and smart cities, bringing in a new wave of seamless, far-reaching IoT communication.

Oxit's real-world testing has provided a tantalizing glimpse into the future of IoT connectivity. As Amazon Sidewalk continues to evolve and expand, it holds the key to unlocking a more interconnected, intelligent world, redefining what's possible in the realm of smart device connectivity.