AMBEENT | Edge-corE NETWORKS

Elevate your Wi-Fi experience through Cloud intelligence

White Paper
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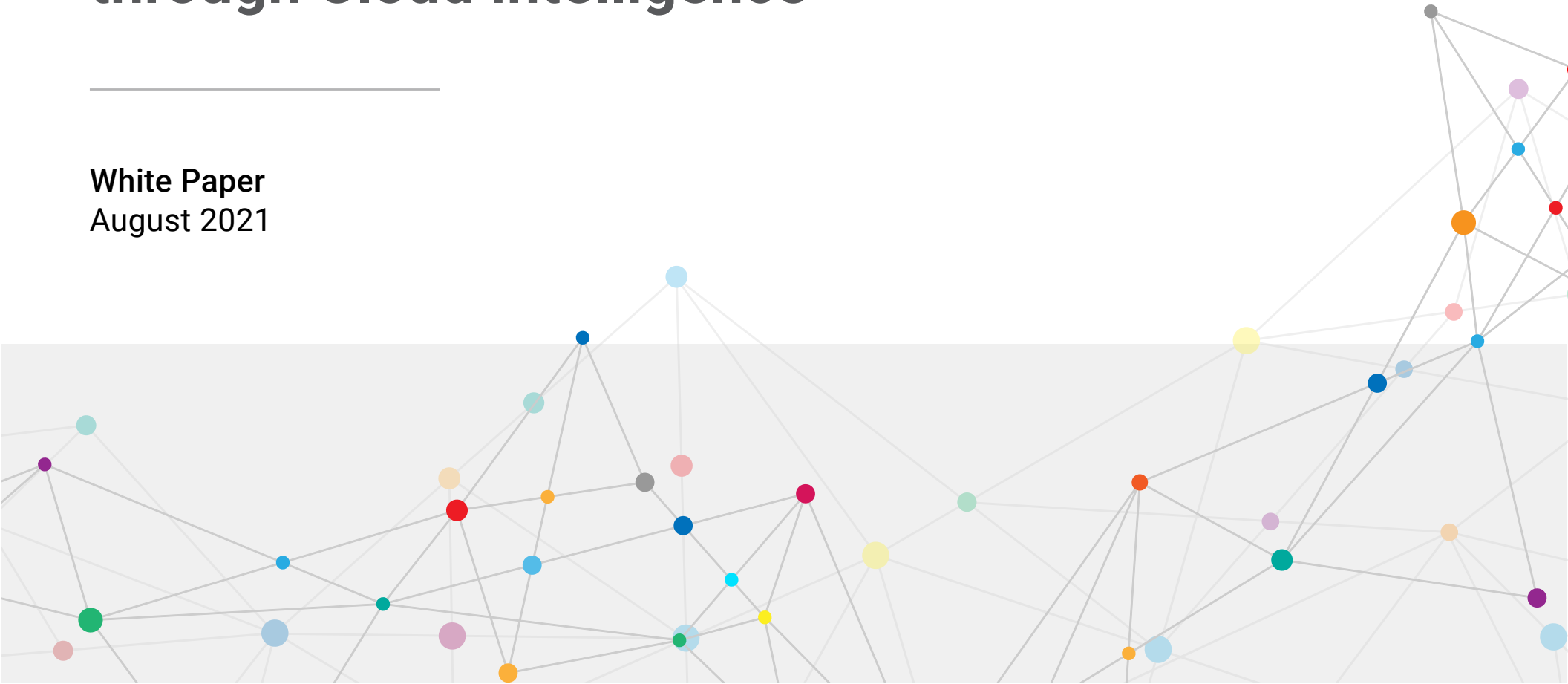

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Executive Summary

The success of Wi-Fi – its ubiquity and low price point due to immense economies of scale – is owed in good part to operating in unlicensed spectrum that is shared by users.

This inevitably leads to degraded performance in what economists describe as “tragedy of the commons.” But is Wi-Fi destined to be a victim of its own success? Or, is it possible to raise the performance of Wi-Fi networks to be on par with that of mobile networks that operate on expensive licensed spectrum?

In this paper, we introduce a solution that provides direct and measurable improvement to Wi-Fi network performance and reliability. The solution combines Ambeent Wi-Fi spectrum optimization algorithms with Edgecore’s access points and ecCLOUD cloud controller products. The combined solution improves baseline Wi-Fi performance by 80%-100%, reduces call center support calls by up to 25% and increases the speed of resolving technical support tickets by up to 50%.

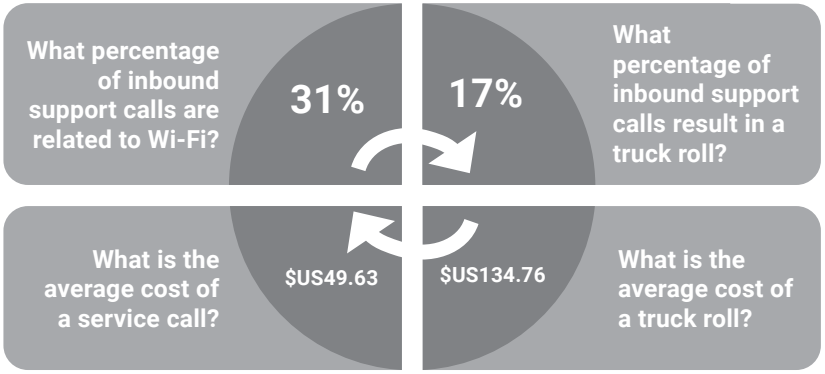
The Ambeent-Edgecore solution benefits enterprise and service provider Wi-Fi deployments. Enterprises would be able to achieve reliable Wi-Fi service that rivals those of cellular technologies. ISPs looking to provide differentiated service to work-from-home (WFH) users would have the capability to optimize their subscribers Wi-Fi performance and isolate the reasons for performance bottlenecks and shortcomings instantaneously and proactively. Service providers seeking to offload subscribers from their congested cellular networks shall be confident that the performance of Wi-Fi will be near that of optimized mobile networks.

Situational Overview

Spiraling Operational Costs. High quality and reliable broadband user experience is hampered by Wi-Fi network quality. Service providers face endless subscriber complaint calls and high customer churn.

Maravedis research[1] shows that 31% of inbound support calls are related to Wi-Fi with the average service call cost standing at about $50; and 17% of inbound calls result in truck rolls costing as high as $135 on average[2].

Exhibit: Key Figures of Wi-Fi-Related Support



MARAVEDIS
Wireless Infrastructure Analysts

[1]In its annual industry report, Maravedis conducted an extensive survey on home Wi-Fi issues. The online survey took place during the September and October 2019 timeframe and gathered 218 responses, 42% of which were from service providers worldwide.

[2]Source: Managed Home Wi-Fi Networks for the Smart Home 2020-2025

[3]https://www.oecd.org/coronavirus/policy-responses/keeping-the-internet-up-and-running-in-times-of-crisis-4017c4c9/

Service calls are expensive and add up to the operating expenditure. The massive increase in use of home Wi-Fi during the COVID-19 pandemic, decreased the quality of experience (QoE).

Some service providers experienced as much as 60% more Internet traffic compared to that before the pandemic[3] testing the resilience and capabilities of broadband networks. In parallel, some service providers experienced a 40% increase in the number of call center complaints because of low internet speed and unstable connections. As online economy is becoming routine in the post-pandemic world, service providers will have to ensure new levels of reliability, security, and trust with their customers.

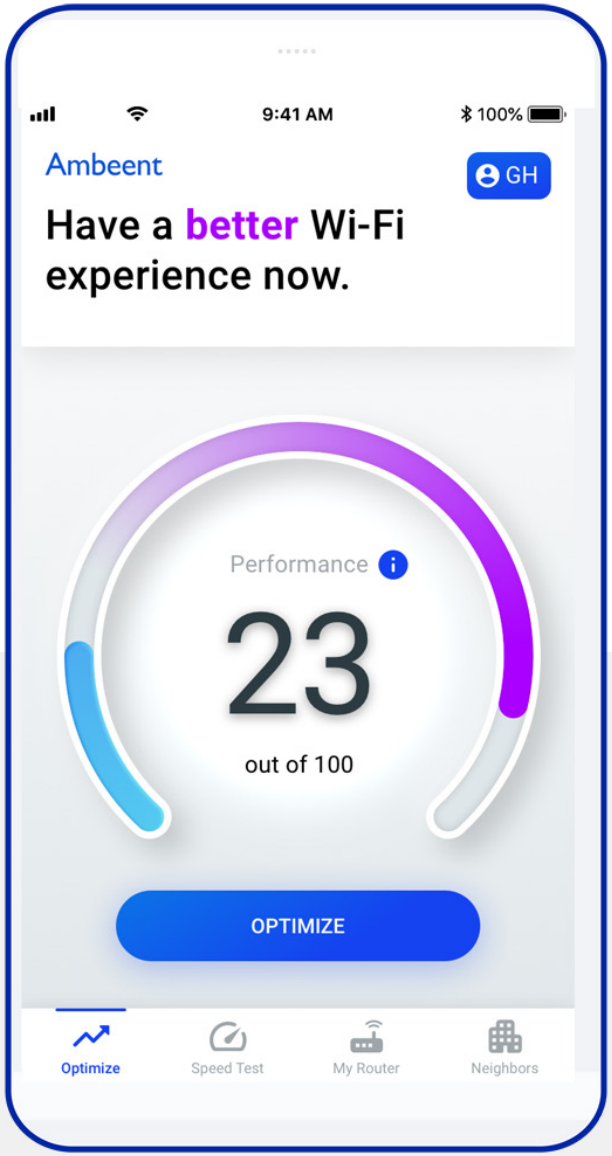
Changing workplace. What was once entirely within the control of enterprise network teams now lies outside physical corporate boundaries. Geographically distributed remote work setups depend on external technologies and third-party providers, which is a constellation that results in blind spots for IT teams responsible for delivering seamless digital experiences to remote workers.

The combined Ambeent-Edgecore solution presented next aims to improve the Wi-Fi user experience and reduce operating costs for both enterprise and internet service providers.

Solution Overview

Edgecore integrated Ambeent's spectrum orchestration engine to help service providers and enterprises optimize the performance of their Wi-Fi networks and maximize their reliability. The solution consists of the following elements:

1. Edgecore Wireless Network Solutions
2. Edgecore ecCLOUD Cloud Controller
3. Ambeent Cloud-Native Wi-Fi monitoring, Diagnostics and Optimization engine.
4. Ambeent Digital Experience Monitoring
5. Ambeent Synthetic Performance Diagnostics and Forecasting for Network Monitoring and Optimization
6. Benefits of the Combined Solutions



Edgecore Wireless Network Solutions

Edgecore Networks delivers wired and wireless networking products and solutions through channel partners and system integrators worldwide for data center, service provider, enterprise, and small and medium-sized business (SMB) customers.

As wireless standards have developed over the years, Edgecore has kept pace and continued to deliver controller-based or cloud-based management solutions, enterprise-grade access points, enterprise switches, and 60 GHz products to meet the market's need with robust Wi-Fi performance, user-friendly and advanced security.

Edgecore Cloud Controller

The Edgecore ecCLOUD is a cloud-based controller that provides unified visibility and control for Edgecore wired and wireless devices.

ecCLOUD simplifies the task of device deployment, management and monitoring at a single site or multiple sites across different geographical locations. The ecCLOUD enables IT staff to manage their network with centralized intelligence and scalable solution. Furthermore, ecCLOUD enables service providers to create multiple administrator accounts with differentiated privileges, increasing management security.

With ecCLOUD, the IT staff can easily navigate the following tasks with a single portal:

- **Multi-site and Multi-level Management:** Provide scalable network management, enabling service providers to scale the deployment after initial deployment.
- **Centralized Device Management:** Manage all of your wired and wireless networks from anywhere using the intuitive user interface and enabling intelligent network management.
- **Service Plan by Time and Volume:** Provide Authorization, Authentication, and Accounting (AAA), security, and guest access management. The built-in account database allows you to create multiple service plans for tiered Wi-Fi service with different usage quotas, time, and number of device per account.
- **SSID-based Custom Captive Portal:** Support captive portal, or splash page, network administrators can fully customize the unique branding or advertising Wi-Fi login pages per Service Set Identifier (SSID) with the built-in captive portal editor.
- **Logs, Report and Monitoring:** Offer logs & reports from its monitoring interface, including service devices status, real-time client list with traffic usage, uptime, and association SSID, etc.

Ambeent Cloud Native Wi-Fi Monitoring, Diagnostics and Optimization Engine

Wi-Fi is designed to operate in a decentralized network topography, which provides a high degree of flexibility. Yet, this flexibility reduces performance as Wi-Fi networks scale in numbers. The limits on Wi-Fi's unlicensed spectrum leads to radio frequency interference which lowers throughput. Interference is especially a problem in areas with many Wi-Fi modems, such as apartment blocks. The solution of this challenge is an element of centralized management capability to enhances the scalability of Wi-Fi networks. Centralized management has to be unobtrusive and easy to implement as not to detract of the benefits of Wi-Fi networks.

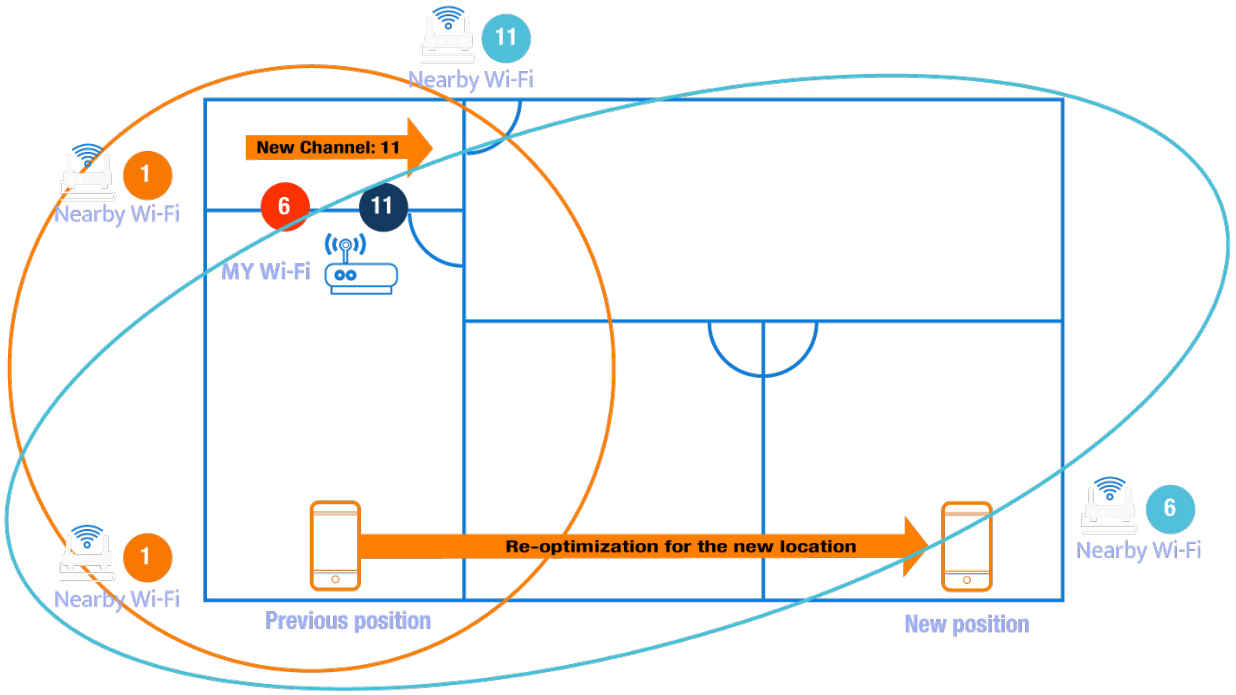
To achieve this, Ambeent developed an efficient user-centric technique to optimize the performance of Wi-Fi networks. Data is collected from end-user devices and sent to a cloud-based central repository to feed into machine learning algorithms. Channel optimization is carried out in a collaborative way, after considering various parameters, including the real-time requirements of all Wi- Fi access points in a given cluster, thereby, optimizing the channel allocation in that cluster. The result is smart and dynamic channel allocation to respond instantly to interference from nearby wireless networks and devices, thereby substantially improving Wi-Fi performance and QoE. The solution is available for Android devices for now.

The technology is covered under various pending patents related to self-organizing network (SON) technologies for smart and adaptive management of evolving Wi-Fi access node parameters; and cloud-based software defined network (SDN) technologies for remote management and control of Wi-Fi access points, which include filtering, data mining, clustering, machine learning and dynamic optimization.

The selection of device-centric approach for Wi-Fi access network optimization provides the following benefits:

User centric and location aware optimization.
The Ambeent App/Software Development Kit (SDK) on an end-user device scans channel conditions in a given environment, as opposed to relying on a centralized gateway (i.e., access point) to make channel assignment decisions. Various parameters – such as an end-user's location, application-based consumption rates, access point (AP) model and capabilities, condition of neighboring APs, transmission power, load balancing, and varying backhaul capacities – are cross-correlated to achieve optimal channel allocation.

Channel assignments are significantly more precise and dynamic. For example, a user utilizing channel 6 who walks to the kitchen, where their neighbor also utilizes channel 6, will have their device moved to another channel by the algorithm. Wi-Fi performance outcomes are optimized regionally, and for each individual user device in the home, by rationalizing the quality of local Wi-Fi traffic that considers end-user usage patterns.

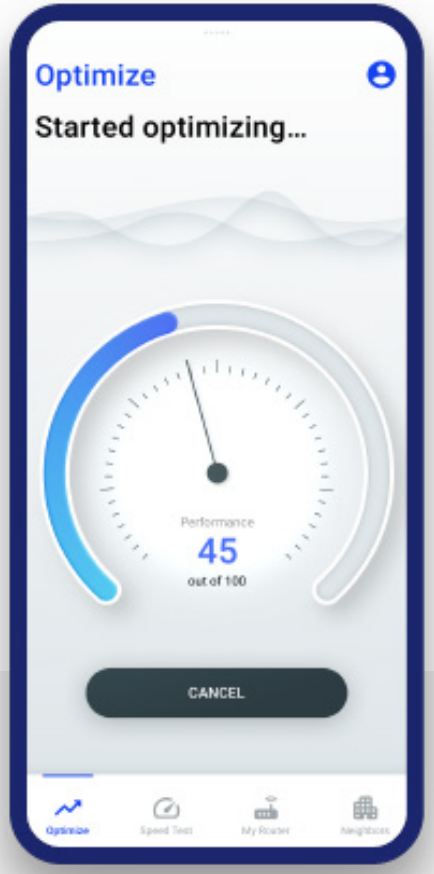


Application-aware optimization. The need to allocate channels according to session types becomes inevitable when too many neighbors densely use the available non-overlapping channels. For instance, a 4K TV streaming video or collaboration application commands different throughput and latency needs than web browsing or email activity. Ambeent's algorithms give priority access to clean channels to applications requiring high throughput, thereby resulting in better QoE.

Remote configuration of access points

Ambeent delivers the industry's first patented technology that enables end-user devices to communicate with access points and change channels without manual intervention. The system continuously monitors the radio frequency environment and channel conditions, fixing interference issues automatically before end-users or network teams become aware of their existence.

Moreover, end-users themselves can manually optimize their Wi-Fi performance with a single click. The solution acts as the first line of resolution of Wi-Fi problems, thereby relieving network teams by decreasing the number and duration of service calls.



Ambeent AI Engines for Wi-Fi performance optimization
Ambeent's Artificial Intelligence (AI) algorithms identify Wi-Fi network performance problems from the pool of traffic data, and fixes known problems directly. It also analyzes trends in performance and predicts future requirements to avoid future problems altogether.

The Wi-Fi network management system constantly adds to its knowledge base, extends its repertoire of known problems and solutions, and raises user experience standards even higher.

Ambeent Digital Experience Monitoring (DEM)

Ambeent DEM delivers monitoring proactively and in real-time at each level of the digital value chain (network, infrastructure, device and application). It differentiates itself from other DEM platforms by focusing on fault or incident management and resolution, resource management, and network parameter tuning and modification to optimize the QoE of service delivery.

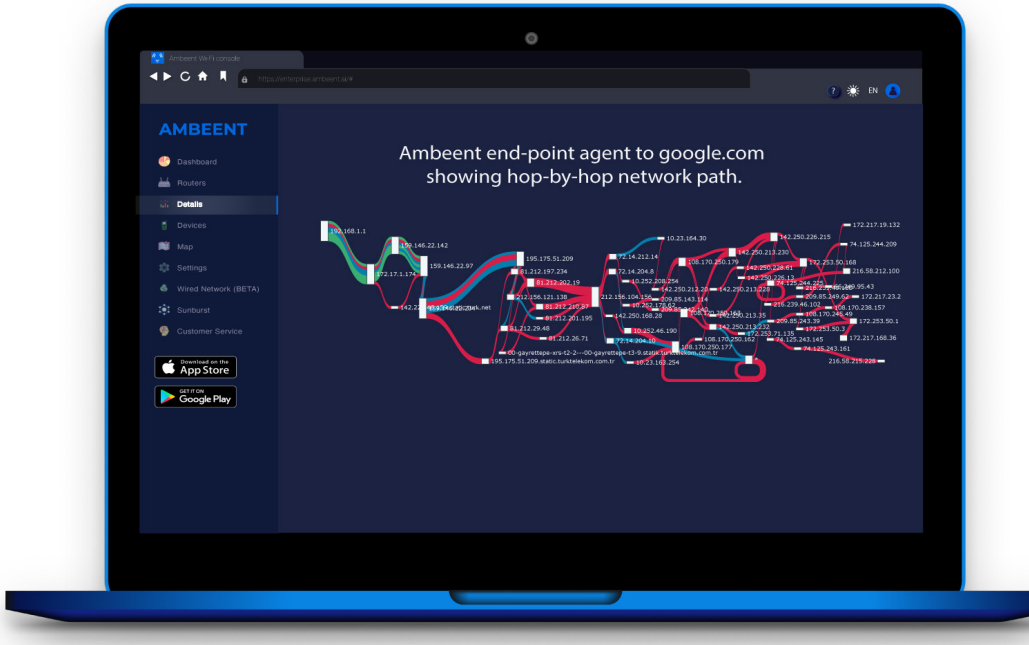
Key capabilities of Ambeent DEM include:

- Real-time digital experience monitoring that handles different types of applications/services/infrastructure with easy-to-view dashboards for different types of clients
- Context-adjusted, application or traffic type-based experience monitoring
- Proactive problem identification with synthetic tests and QoE scoring
- Monitoring of usage patterns for QoE optimization (e.g., for home, multi-storey buildings, large venues)
- Adjustment/tuning of network parameters (e.g., throughput, speed, bitrate, etc.) to optimize QoE for the application
- Resource optimization with network planning, e.g., AP placement
- Service-level targeting with customized QoE/performance thresholds (i.e., app-level thresholds)
- Real-time packet tracing and analytics
- Ad-hoc communication infrastructure to increase coverage
- Access point rating system for smart off-loading and handover decisions

Synthetic Performance Diagnostics and Forecasting for Network Monitoring and Optimization

Ambeent synthetic testing delivers end-to-end network monitoring and diagnostics to help baseline performance during different times or work hours across different locations, and to resolve issues before end-users are affected. Odd behavior and security and performance issues are thoroughly monitored in continuous synthetic tests. On-demand testing allows network teams to manage or tune network infrastructure for better WLAN/WAN performance so as to avoid congestion and support connectivity prior to specific events. Among the benefits of synthetic tests include:

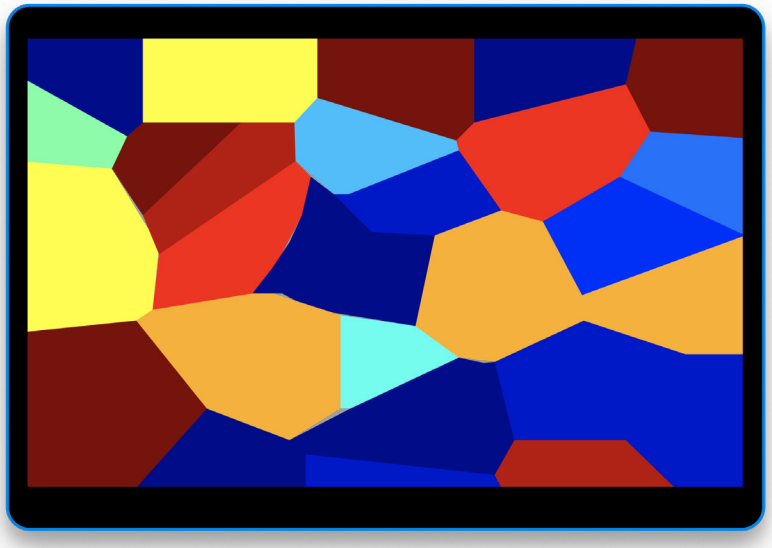
- End-to-end visibility across device, infrastructure, network and app domains and identification of domains in which issues occur
- Automated testing to baseline performance at different times or work hours and locations
- Odd-behavior analysis across device, infrastructure and network domains (e.g. cyber-attacks, the existence of rogue APs, unusual bandwidth consumption, coverage or interference issues, etc.)
- Prediction of network and infrastructure issues to resolve before they impact QoE



Benefits of the Combined Solutions

Edgcore clients could access the Ambeent platform through ecCLOUD cloud controller. The Ambeent Platform delivers a comprehensive toolkit to allow networks administrators monitor and enhance the digital experiences of Wi-Fi users by focusing on issue management and resolution for QoE-optimized service delivery. Clients can expect 80%-100% improvement in baseline Wi-Fi performance and 25% reduction in service calls. Additional performance improvements clients experienced include:

- Link speed improvement up to 280%.
- Wi-Fi speed improvement up to 400%.



Enhance customer experience and satisfaction

80% -100%
improvement in baseline Wi-Fi performance

Reduce operational costs

25%
drop in service calls with spectrum management and automatic access point configuration

Smarter Wi-Fi

50%
reduction in ticket resolution time

Conclusion

Combining Edgecore's wireless network solutions and ecCLOUD cloud controller with Ambeent's AI/ML capabilities for spectrum access control helps service providers and enterprises improve the performance of Wi-Fi networks. Service providers and enterprises can pin-point problems in network performance to accelerate resolution time. More importantly, predictive AI/ML analytics enable network managers to take proactive measures to avoid service degradation or outage. The crown jewel of the solutions – Wi-Fi spectrum access optimization – raises the performance of Wi-Fi networks to near those of cellular networks.

AMBEENT

About Ambeent

Ambeent is an innovator in network intelligence and the management of Wi-Fi and 5G technologies, with a mission to enhance digital experiences and help organizations of all sizes meet their connectivity objectives. Ambeent substantially improves end-to-end service performance with its patented radio frequency interference management technology powered by AI/ML as well as by delivering deep visibility and highly contextualized management of networks and digital experiences in hybrid environments. Ambeent's SaaS/PaaS business and deployment models are available to customers across a variety of industries to enhance Wi-Fi as well as CBRS and 5G networks. For more information, visit **www.ambeent.ai.**

Edge-corE NETWORKS

About Edgecore Networks

Edgecore Networks Corporation is a wholly owned subsidiary of Accton Technology Corporation, the leading network ODM. Edgecore Networks delivers wired and wireless networking products and solutions through channel partners and system integrators worldwide for Data Center, Service Provider, Enterprise and SMB customers. Edgecore Networks is the leader in open networking, providing a full line of open 1G-400G Ethernet OCP Accepted™ switches, core routers, cell site gateways, virtual PON OLTs, packet transponders, and Wi-Fi access points that offer choice of commercial and open source NOS and SDN software. For more information, visit **www.edge-core.com.**