

IT@Intel: Optimizing and Troubleshooting Wi-Fi Networks Using Client Analytics

Intel IT collaborated with Intel’s Connectivity Solution Group and Cisco to refine and expand the features and use cases of Intel® Connectivity Analytics software, enabling us to manage our network better

Authors

Liran Klein
WLAN Tech Lead, Intel IT

Ifat Pecznik
Network Specialist, Intel IT

Omri Barkay
Principal Engineer, Intel IT

Dan Codorean
Client Engineer, Intel IT

Nir Metzger
Marketing Senior Director,
Client Computing product group

Shai Monzon
Product Marketing Director,
Client Computing product group

Executive Overview

Thousands of Intel’s employees connect to the corporate Wi-Fi network every day. When connectivity issues occur, both productivity and user experience (UX) suffer. Intel IT makes every effort to optimize the network performance. Still, until recently, we had little visibility into client behavior through traditional network monitoring solutions because they report issues only from the network infrastructure perspective. At the same time, endpoint IT tools are limited to operating system data.

Based on its existing market presence with PC Wi-Fi products, Intel’s Connectivity Solution Group developed Intel® Connectivity Analytics technology. The group collaborated with Cisco—a well-known enterprise Wi-Fi network infrastructure supplier—and Intel IT to develop compelling use cases and solutions that utilize Intel Connectivity Analytics. Intel IT provided product feedback and practical applications of the technology in our enterprise environment and helped optimize the use cases over Intel’s network infrastructure. Our input helped to better define the data and analytics needed to achieve the desired business outcomes, such as faster troubleshooting, mean time to repair (MTTR), reduced network total cost of ownership, and a better UX.

Intel IT now uses Intel Connectivity Analytics—delivered through the Cisco Catalyst Center (previously Cisco DNA Center) and cloud dashboard—to improve the management of Intel’s Wi-Fi network. We are also working with the overall ecosystem to expand the use cases for Intel Connectivity Analytics and further enhance AI for IT Operations (AIOps). We have reduced some client-side troubleshooting from upwards of 15 minutes to 10–15 seconds. Similarly, finding the root cause for ubiquitous network issues—which could take days—now often takes seconds as well.

We encourage other IT departments to consider deploying IT tools powered by Intel Connectivity Analytics for Wi-Fi, which is built into Intel® Wi-Fi adapters and requires no software installation or maintenance. It can be utilized by Cisco and other Intel Connectivity Analytics Program members.

In addition, we are now working with Intel’s Connectivity Solution Group to develop an additional Intel Connectivity Analytics offering that shares data through a PC agent to the cloud and expands the available connectivity analytics beyond Wi-Fi to include Thunderbolt™ technology, Bluetooth, Ethernet, and more.

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Intel IT Contributors

Jennifer Delgado, Industry Engagement Manager

Donald Pearson, Industry Engagement Manager

Jeff Sedayao, Industry Engagement Manager

Wendy West, External Communications Manager

Acronyms

AP	access point
MTTR	mean time to repair
RF	radio frequency
RSSI	received signal strength indicator
UX	user experience
WLAN	wireless local area network

Business Challenge

In today's digital world, underperforming corporate Wi-Fi network performance can be a bottleneck to employee productivity and can degrade user experience (UX). However, Intel IT historically has found that optimizing wireless local area network (WLAN) performance can be difficult because traditional network infrastructure management and diagnostics tools have limited visibility into, and cannot control, client-side behavior. For example, at the network infrastructure level, it is typically challenging to determine why a device made an unusual roaming decision or if a connectivity issue is due to out-of-date wireless driver or access point (AP) firmware interoperability issues. In addition, there is generally little visibility into end-user application usage and UX problems caused by Wi-Fi connectivity issues. In other words, understanding the client device logic using traditional network equipment monitoring is like trying to decipher what is happening on the ground while hovering above in a helicopter.

In a complex Wi-Fi environment like Intel's that includes dynamic radio frequency (RF) conditions, multiple device types, and multi-platform vendors, it is imperative to understand the underlying root cause of network performance degradation issues. That way, we can determine if the issue can be improved on the infrastructure side (such as adding more APs or changing AP power and channel settings) or if it is a client-specific problem due to a bug that affects certain clients in particular conditions that cause sub-optimal device behaviors, such as frequent roaming or not using the AP that is the best candidate to serve the client connectivity needs.

Because traditional network management systems that we use to manage Intel's WLAN—like older versions of Cisco Catalyst Center—include only partial data about roaming (for example, a record of the event without information about why roaming occurred and which AP candidates were found), network managers must use additional systems when troubleshooting anomalies related to client roaming behavior. In the past, Intel IT had to create custom tools to collect Microsoft Windows events from the PC OS and generate reports based on them. However, additional tools increase operational costs and technical debt.

In an ideal world, we could reduce mean time to repair (MTTR) by extending the observability of network components to the client device itself and expanding network visibility insights to include the client roaming decision logic. The ability to extract the complete data from a single tool that sees both infrastructure-side and client-side data is a game changer.

Cisco and Intel Collaborate to Deliver Next-Gen Wireless Client Visibility

Intel's Connectivity Solution Group has long been aware of the need for client-side data to help optimize Wi-Fi network performance and has been working with the ecosystem to bolster client-side visibility for network managers. Over the last three years, Intel's Connectivity Solution Group, Cisco, and Intel IT have collaborated to take advantage of the unique telemetric data already captured by Intel® Wi-Fi drivers. The collaboration makes that data available to network managers and then create a roadmap to add new telemetric and analytics capabilities to address additional network management challenges and use cases.

Intel connectivity engineers modified the Wi-Fi driver to expose the additional telemetry and created a secure provisioning mechanism that ensures that only certified APs receive the extra data. Intel IT engineers also provided feedback on what additional data types were needed and what use cases would be most advantageous.

Intel engineers and Cisco collaborated to enable authorized APs to access the Wi-Fi driver data, and Intel's Connectivity Solution Group developed Intel® Connectivity Analytics software. The solution helps network managers to:

- Reduce incident MTTR
- Predict and prevent network incidents before they impact users
- Identify issues caused by the RF layer from the client point of view
- Understand the benefits of adopting protocol advancements and the effect of throughput, range, and client density changes with transitions to WLAN 6/6E/7
- Obtain insights about IT infrastructure deployment



“Cisco and Intel have a rich history of successful collaboration, and we are excited to continue our joint efforts to enhance Wi-Fi experiences for both users and IT organizations. We share a vision in which devices and the network work together and make each other smarter to achieve the best security and reliability possible.”

— Matt MacPherson, Wireless CTO, Cisco

Overview of Intel® Connectivity Analytics for Wi-Fi Networks

Intel Connectivity Analytics started as a collaboration between Intel’s Connectivity Solution Group and Cisco, enabling device analytics to be shared with Cisco’s network management systems, which today exist on most of the Intel Wi-Fi-based PC install base. The solution provides granular driver-level wireless client insights for any client using Intel Wi-Fi products while connected to a supported Cisco wireless network.¹

The solution uses a Catalyst or Meraki AP topology from the Cisco Enterprise Network portfolio. The APs automatically collect the Wi-Fi telemetry sent from the clients and forward it securely to a Cisco Catalyst controller, Cisco Catalyst Center management platform, or a Cisco Meraki Cloud management platform. The solution then processes the data and presents network managers with intelligent reports and insights (see Figure 1).

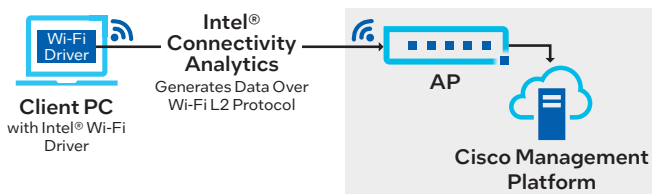


Figure 1. Intel® Connectivity Analytics sends client PC telemetry data through the AP to a Cisco management platform for analysis and report generation. There is no software installation or management needed—the analytics software is part of the Wi-Fi driver.

Using the solution requires very little IT effort to gain valuable network behavior insights. There is no software installation or management needed—the analytics software is part of the Wi-Fi driver. And, because we already use Cisco’s network management solutions like Cisco Catalyst Center or Cisco Meraki dashboard, there are no additional capital expenditures to gain network performance insights. The telemetry is forwarded over the Layer 2 (L2) Wi-Fi protocol from wireless clients to the AP and then to the Cisco Catalyst Center or Meraki Cloud management platform. We have found that the transfer of telemetry and AP certification uses a negligible amount of Wi-Fi network bandwidth.

Available Reports

Network managers have access to several real-time reports based on telemetry:

- Station information (such as hardware model), software and OS version, power information (AC or DC), platform model, and manufacturer
- Environment information (such as roaming reason), current received signal strength indicator (RSSI), and candidate APs
- Missed beacon information, which provides the previous AP’s Basic Service Set Identifier (BSSID)
- Low signal information
- Failed AP identification
- Unknown APs

¹ Visit the [Intel Analytics Connectivity FAQ](#) for the software/hardware compatibility matrix.

Use Cases

For Wi-Fi devices, some examples of use cases that Intel Connectivity Analytics can address include the following:²

- Identifying driver and hardware issues. The station information report provides network administrators with driver-level client information that is unavailable in typical telemetry. This additional information allows network administrators to pinpoint the software driver or hardware model used by clients experiencing a poor Wi-Fi connection. Problems could include an out-of-date driver, an unrecognized Wi-Fi card, or a potential issue with the Wi-Fi antenna on the WLAN client adapter.
- Troubleshooting roaming issues, such as indicating the reason for roaming, which may include (but is not limited to) missed beacons, low RSSI, exclusion of the current AP from the OS, or an AP with a stronger signal being available.
- Detecting poor connectivity and bad coverage pockets, suggesting the presence of interference or the necessity of adding APs.
- Pinpointing APs that are not functioning as expected and that may need to be updated or replaced.

Real-life Example: Detecting a Coverage Hole

Using Intel Connectivity Analytics client telemetry, we identified a client device with multiple low RSSI events (a signal strength of -84 to -85 dBm, which indicates a poor and unreliable connection) over time, as shown in Figure 2.³ Drilling down into the details, we found that all the low RSSI events were associated with a specific AP (all events had the same BSSID, which is the Media Access Control [MAC] address of an AP). Then, we went even deeper into the details to see what the Tx (transmit) power for that AP was. It was transmitting at the highest possible power level, suggesting insufficient coverage in the specific area.

Finally, we accessed an AP floor map for the relevant area, which revealed a lack of neighboring APs close to the problematic AP, resulting in poor signal strength for client devices. Adding an AP in this area could solve this coverage gap. This example demonstrates how advanced reporting or aggregation options in the Cisco Catalyst Center can easily show us global insights and trends.

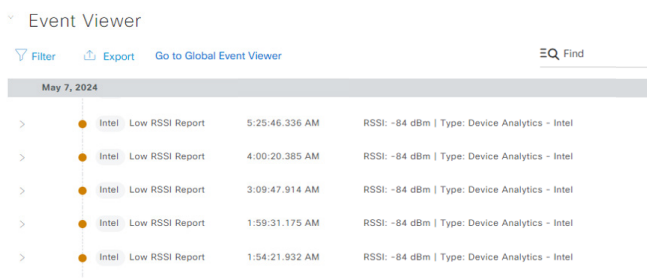


Figure 2. The Intel® Connectivity Analytics Event Viewer in Cisco management platforms alerts network admins to repeated low signal connections for a device.

² For more information, read the Cisco blog, [Cisco and Intel: Next-Gen Wireless Client Visibility with Intel Connectivity Analytics!](#)

³ RSSI is measured in decibel milliwatts (dBm), where a larger negative number represents a lower signal strength. For example, an RSSI of -70 dBm is stronger than an RSSI of -85 dBm. An RSSI of -50 dBm is a strong signal, while -85 is very weak.

Real-life Example: Troubleshooting a Roaming Issue

Figure 3 shows a Roam Events report that displays a client device with many roaming events that happened due to missed beacons. These events caused the device to connect to a less preferable AP that had a signal of -68 dBm (instead of an AP with a signal of -56 dBm). This information led us to discover sub-optimal client behavior, for which we developed an improved driver design to prevent undesirable roaming events. In this scenario, we would not be able to identify the issue without viewing the client-side data.

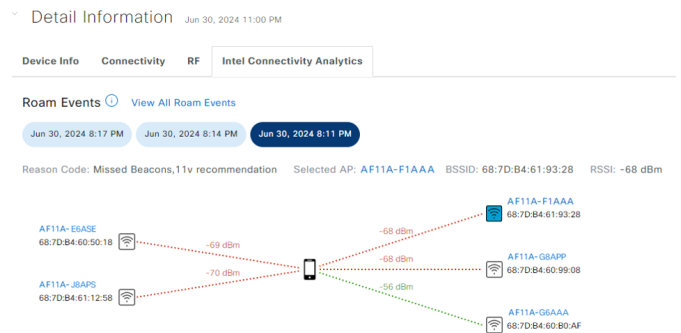


Figure 3. The Intel® Connectivity Analytics Roam Events report in Cisco management platforms alerts network admins to problems with missed beacons, which can point to a client-side bug that needs fixing.

Intel IT as Customer Zero

The WLAN is the default network at Intel and is critical for day-to-day operations. The WLAN supports Intel’s diverse users who represent typical office use cases and serves factory, labs, guest, and employee hotspot use cases. Due to our extensive and diverse Wi-Fi usage, our testing of new Intel Connectivity Analytics features typically uncovers issues quickly, and we can offer realistic environment mimicking and test beds before releasing features to external customers.

Intel IT often plays a customer-zero role, helping Intel’s product teams to design and refine products through deep expertise and in-the-trenches consumption of the product. We did exactly this when Intel’s Connectivity Solution Group was developing Intel Connectivity Analytics. We provided the field experience and requirements while the Connectivity Solution Group translated that information to the Wi-Fi product team. We supported the Connectivity Solution Group’s initiative to provide Cisco with additional client-side telemetry to enhance Cisco’s overall monitoring and observability offering. For example, we provided input on what data would be most useful, helped define specific use cases and reports, and shared data about specific analysis and troubleshooting.

Intel IT’s collaboration with Cisco on the Intel Connectivity Analytics initiative—as well as further refinement of the product—was enabled by the propagation of newer Wi-Fi network interface cards and Wi-Fi driver versions to the Intel IT-supported laptop fleet along with an upgrade to Catalyst APs and controllers, as well as Cisco Catalyst Center.

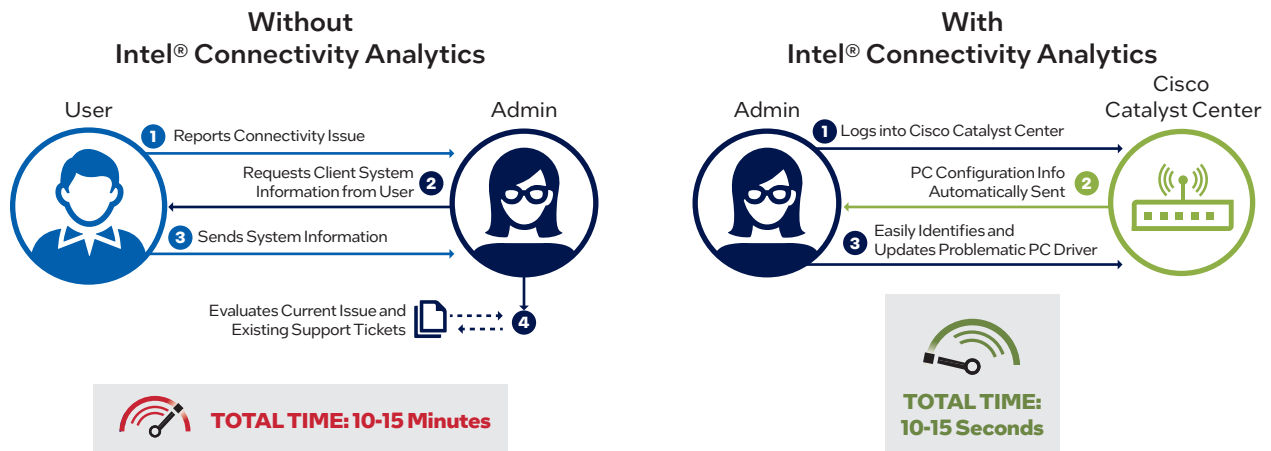
Results

With the Intel Connectivity Analytics data now available in Intel IT's Cisco Catalyst Center and Cisco Meraki dashboard, troubleshooting time and effort have been reduced. Infrastructure and client data are aligned and displayed in a single user interface, making combining network infrastructure and client PC perspectives easier. Because Intel Connectivity Analytics is embedded in the Wi-Fi driver and the network performs the analytics and presentation of the data, we can optimize Wi-Fi network performance with little extra effort or cost. Previously, internal custom scripts and automation jobs were necessary for collecting and managing client data, but these efforts are no longer required.

To illustrate how transformational the solution is, consider the troubleshooting scenarios depicted in Figure 4.

On the client side, troubleshooting a connectivity issue without Intel Connectivity Analytics could take 10–15 minutes, and the IT administrator could fix only one client at a time. Intel Connectivity Analytics has helped MTTR drop significantly to 10–15 seconds, and the solution can simultaneously identify numerous problematic connections. For network issues, it might take days to diagnose what is causing a rash of connectivity problems. With Intel Connectivity Analytics, we can now discover the root cause of a problem in a matter of seconds.

Client Connectivity Issues (Single User)



Network Connectivity Issues (Multiple Users)

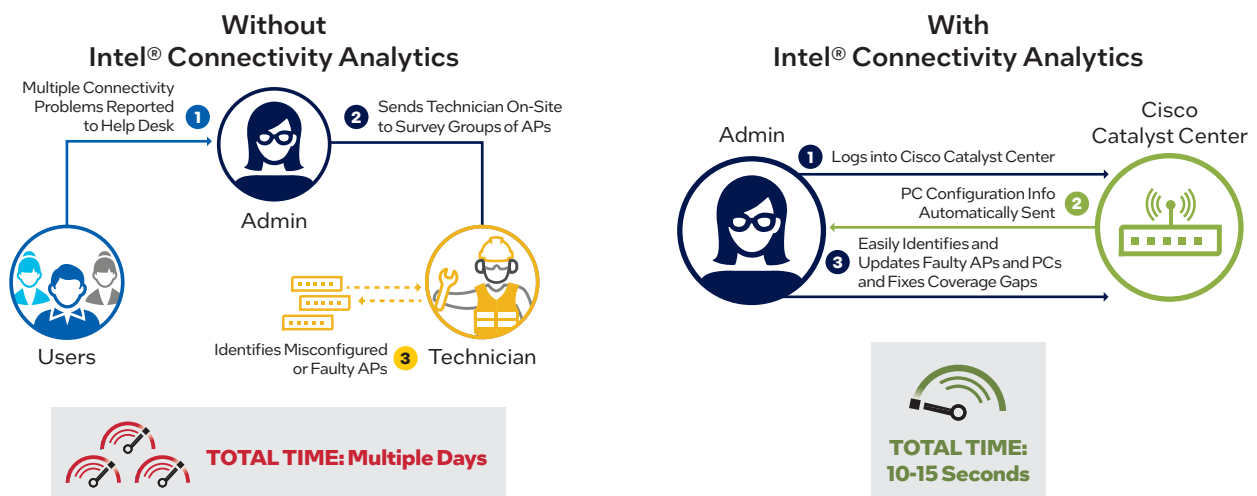


Figure 4. Intel Connectivity Analytics reduces Wi-Fi troubleshooting from days or minutes to mere seconds.

Next Steps

The current Intel Connectivity Analytics implementation substantially improves client troubleshooting. Going forward, the raw data that is already available can be used to generate fleet-level trends or conduct advanced analytics. Existing tools and anomaly detection frameworks can be seamlessly integrated with this raw data as needed. Building on the existing collaborative work with Intel Connectivity Analytics, Intel and Cisco are evolving additional analytics that can be enabled with Intel Wi-Fi product-based devices. For example, Cisco APs will be able to obtain additional insights from the client devices that use Intel Wi-Fi adapters. Cisco APs will also be able to get roaming insights from the adapters and perform an in-depth analysis of the OS and power source information. This will deliver more information to a network management platform like the Cisco Catalyst Center or Cisco Meraki dashboard.

In addition to collaborating with Cisco on Intel Connectivity Analytics based on Wi-Fi L2 analytics-sharing technology, Intel's Connectivity Solution Group has expanded Intel Connectivity Analytics beyond Wi-Fi analytics by installing a software agent on the PC that enables the collection and sharing of data Over The Top. This additional technology enables solutions providers that do not have access to the network APs firmware to develop IT tools based on an installed software agent, while adding analytics and use cases beyond Wi-Fi connectivity. This offering extends Intel Connectivity Analytics to include additional connectivity technologies such as Ethernet, Thunderbolt™ technology, Bluetooth, and more. Intel IT is excited to help the industry improve network infrastructure proficiency, integrate Intel Connectivity Analytics with existing systems and data, and provide an enhanced UX. We will continue to work with Intel's Connectivity Solution Group to refine and evolve Intel Connectivity Analytics capabilities and features.

Conclusion

Intel IT played a pivotal role in the collaboration between Intel's Connectivity Solution Group and Cisco. We use Intel Connectivity Analytics to improve the Wi-Fi network UX and network management efficiency. The solution's insights enhance network manageability, expedite troubleshooting, reduce MTTR, and deliver better overall network management total cost of ownership. The broader set of real-time data supports more sophisticated AIOps models that predict and self-heal client issues, ultimately resulting in a better UX.

The partner-led Intel® Connectivity Analytics Program helps create market innovation by making Intel Connectivity Analytics telemetry data available to innovative solution providers.⁴ Through the program, Intel can provide companies with PC-level insights and additional engineering and marketing resources to help them improve their services as Wi-Fi standards and other connectivity technologies continue to evolve. Ongoing ecosystem collaboration through the Intel Connectivity Analytics Program can help optimize the UX and network management benefits of Intel Connectivity Analytics.

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⁴ Visit the [Intel® Connectivity Analytics Program](#) website as well as the [program announcement](#).



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