

Bringing Artificial Intelligence to Wireless Networking

THE JOURNEY TO A VIRTUAL
WIRELESS ASSISTANT



Bringing Artificial Intelligence to Wireless Networking

THE JOURNEY TO A VIRTUAL WIRELESS ASSISTANT

For centuries, new technologies have ushered in entirely new eras of progressive change in all facets of life, and have revolutionized countless industries. The invention of the steam engine brought about the industrial revolution and expanded trade and transportation. Quantum physics was the foundation of the electronics revolution that brought us transistors, TV, radio, and computers. And the Internet has brought about a stunning information and communication revolution, which is still sending shock waves across virtually every industry, and to the very core of our cultures and lifestyles.

Many pundits predict that Artificial Intelligence (A.I.) is the next big “game changing” technology, poised to impact virtually every facet of our lives in the coming years. According to Gartner Inc., by 2020, A.I. technologies will be virtually pervasive in almost every new software product and service, and A.I. will be a top five investment priority for more than 30 percent of CIOs.

In the world of wireless networking, A.I. is already showing enormous value. The Mist Learning WLAN uses machine learning and neural networks to simplify operations, expedite troubleshooting, and provide unprecedented visibility into the user experience. But we are just on the cusp of its true potential, with the promise of a true virtual wireless assistant right around the corner that can proactively identify and fix problems and predict future events quickly and reliably.

How do you take advantage of A.I. in wireless networking today, and what steps should you be taking to position yourselves for this emerging world? Let us show you how. Below is an overview of how we are leveraging A.I., what it takes to build an AI-driven WLAN, and what this technology can do for your business.

WHY IS A.I. TAKING OFF NOW?

A.I. technology has been studied in research labs and universities for many years, but only recently has A.I. found its place in practical applications due to advancements in computing power, big data, and open source technologies.

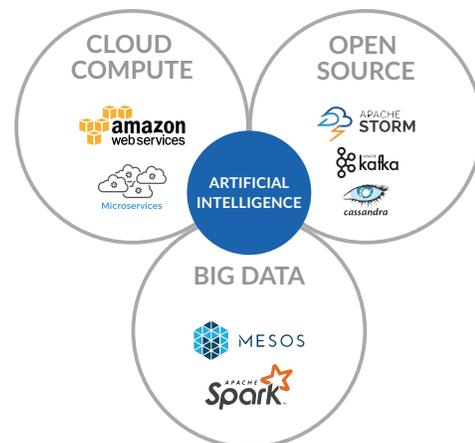
Modern Cloud Compute

Even though neural networks and machine learning concepts have been around since the 1950s, the modern cloud did not emerge until the mid-2000’s when the compute power needed to solve large computational problems became available. Cloud infrastructures like Amazon AWS, Google Cloud, and Microsoft Azure have turned A.I. into a mass market technology by pricing compute cost effectively (with elastic growth), enabling companies of all sizes to quickly and cost-effectively build A.I. platforms on massively scalable and secure global cloud infrastructures.

Additionally, these cloud platforms leverage distributed micro services API architectures, which allow services to be updated more quickly than traditional embedded software architectures and without disruption to existing services. This gives businesses a competitive advantage and lets IT focus precious resources on strategic projects.

Big Data

Highly scalable and cost effective storage is a second factor in the mass adoption of A.I. A Gigabyte (GB) of storage in the cloud costs as little as \$0.005 / month, allowing huge amounts of unstructured



data to be stored cost effectively. In addition, big data platforms like Spark (developed at Berkeley's Algorithms, Machines, and People Lab) are allowing programmers to work with almost infinitely large data sets that expand well beyond the capacities of a single server. By combining these large datasets with machine learning techniques, a new and exciting discipline has emerged called computational science that allows companies to solve complex problems, like predicting genetic diseases, forecasting financial markets, and processing terabytes of wireless data.

Open Source Technologies

LinkedIn, Facebook and other large companies have invested tens of millions of dollars in software that was subsequently opened up to the masses for constructing powerful applications, systems, and services. This open source software, created specifically for massively distributed cloud services, allows companies of all sizes to cost effectively build extremely scalable A.I. platforms.

Cassandra is an example of best-of-breed open source software. It allows anyone to deploy a proven fault-tolerant database in the cloud that is capable of storing enormous amounts of data with full resiliency. Similarly, Spark is open source software that allows data to be distributed over a cluster of fault-tolerant machines while leveraging distributed shared memory. Storm, another open source software solution, is a distributed stream processing computation framework that uses custom created "spouts" and "bolts" to define information sources and manipulations for the batch processing of distributed streaming data.

When choosing an A.I. vendor for wireless, make sure to take a look at what is under the hood.

WHY CIOs SHOULD EMBRACE A.I. IN THEIR WIRELESS STRATEGY

Wireless networking is at an inflection point whereby the traditional way of deploying, operating and managing Wi-Fi networks won't suffice anymore. More specifically, there are three fundamental market transitions occurring in wireless networking today that are making A.I. an indispensable necessity.

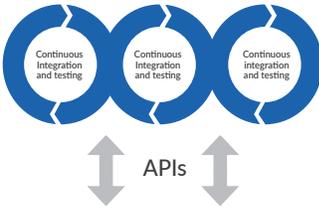
First, Wi-Fi is increasingly becoming the primary Internet access technology. It is more business critical than ever and therefore has to be more predictable, reliable, and measurable than ever. At the same time, it is harder than ever to troubleshoot wireless given the myriad of mobile device types, applications, and operating systems, coupled with the sheer quantity of mobile users and wireless enabled IoT devices. This transition requires better visibility into the mobile user's end-to-end experience, and it creates a need for new automated management tools that replace manual, mundane tasks with automation, proactive insight and full programmability.

Second, mobile users are becoming accustomed to personalized wireless services on their mobile devices that leverage contextual information, like location. And companies see location as a key way to bring value to business operations through better customer/employee/guest engagement and new insight into mobile user behavior (i.e. analytics.) Bluetooth® Low Energy is emerging as the interoperable industry standard for indoor location, having been accepted and embraced by all major smart phone manufacturers (e.g. Apple supports iBeacon and Google supports Eddystone). However, large scale Bluetooth®LE deployments are being held back by the need for an overlay network of battery beacons. This is changing, however, with the virtualization of beacons, usage of machine learning for calibration and accuracy, and convergence of BLE and Wi-Fi, which eliminates the need for an overlay network. As a result, BLE and indoor location is moving from a nice-to-have to a must-have capability.

Third, enterprises are moving IT support for sales, HR, and finance to managed cloud services to get better efficiency and to allow internal IT skills to be better aligned with the core business. Even security, storage, and other key infrastructure elements are rapidly being transitioned to the cloud. Wireless networks, however, have been slower to adopt this transition, with more than 90% of the WLAN market still delivered via on premise controllers. Moving wireless to the cloud gives CIOs a more scalable and resilient infrastructure with better operational simplicity. In addition, it gives CMOs and business owners actionable insight from the petabytes of data flowing through wireless networks today. This is why cloud wireless is the fastest growing segment of network IT, with 1/3 of the total market expected to transition to the cloud by 2020 (IDC).

Wireless Networking Needs A.I.

THE EVOLUTION OF IT TO DEVOPS



- API- first
- Real-time cloud
- Distributed software architecture

CONVERGENCE OF WI-FI AND BLUETOOTH LE



Indoor location is now a “must have”

- Way finding
- Push notification
- Resource allocation
- Asset tracking

SHIFT TO MANAGED SERVICES VIA CLOUD



Wireless is last man standing

Startup companies have always been the driving force of disruptive innovation in market transitions. In wireless, for example, we saw it with the transition from autonomous APs to controller architectures, which was championed by new companies like Airespace (now Cisco) and Aruba (now HPE). This phenomenon will see itself repeated with the move to AI-driven networking. Large legacy networking companies cannot start with a blank sheet of paper and bring about an A.I. led paradigm shift into the market, because they are encumbered by existing investments in legacy solutions. Furthermore, they lack domain expertise and have resources split amongst many different silos of products. This has created a vacuum for a new wireless vendor – i.e. Mist - to lead the wireless industry into the next phase of technology adoption, driven by A.I.

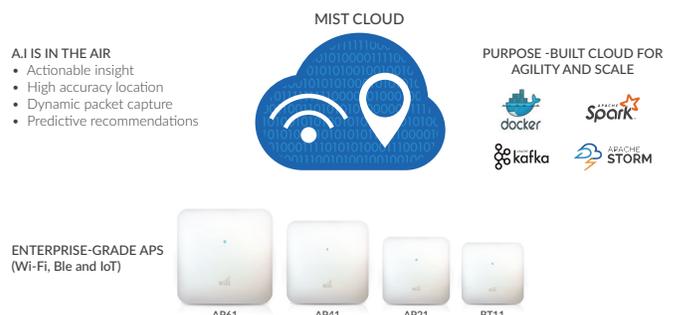
MIST – THE NEW WIRELESS NETWORK

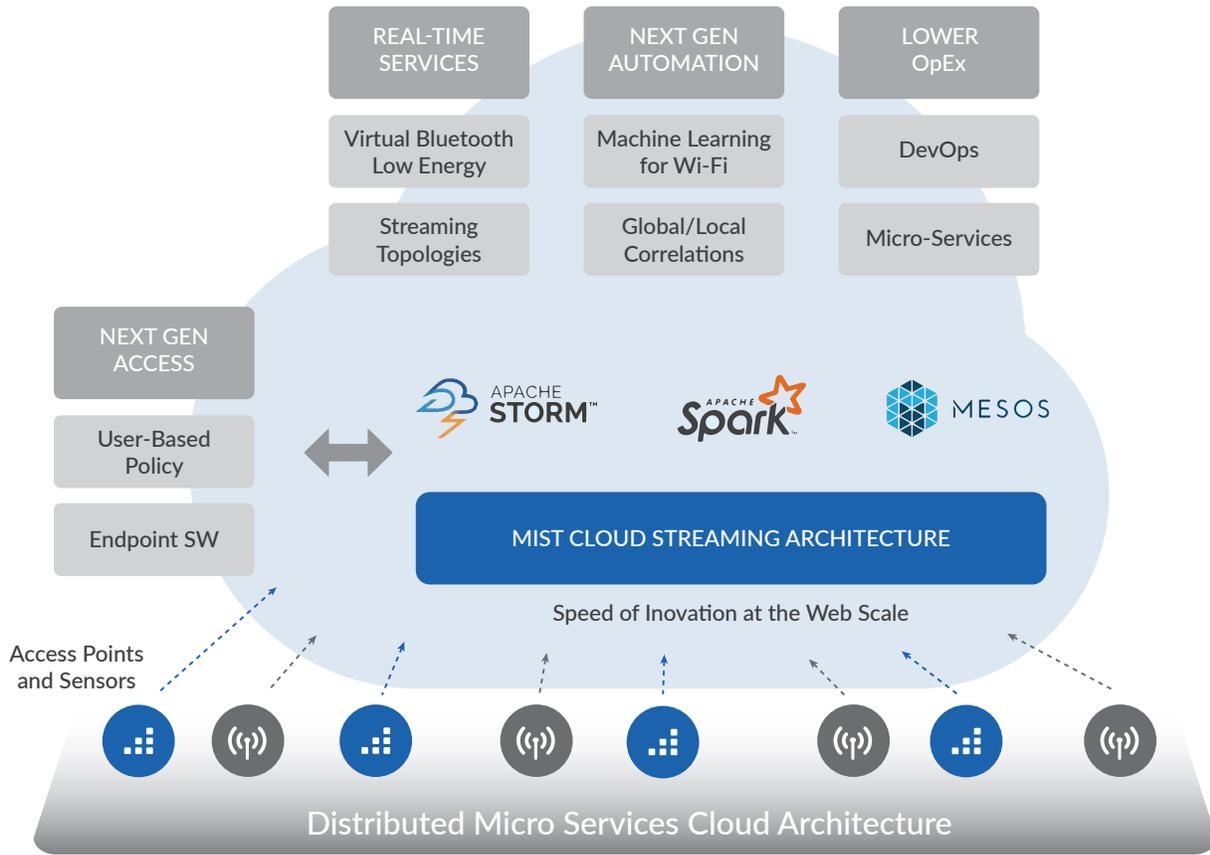
Mist built the first AI-driven wireless platform, designed specifically for the smart device era. The Mist Learning Wireless LAN makes Wi-Fi predictable, reliable and measurable by providing unprecedented visibility into the user experience and by replacing time-consuming manual IT tasks with proactive automation. In addition, Mist is the first vendor to bring Enterprise grade Wi-Fi, BLE and IoT together to deliver personalized, location-based wireless services without requiring battery-powered beacons. All operations are managed via Mist’s modern cloud architecture for maximum scalability, agility, and performance.

The Mist team is ideally suited for bringing A.I. to wireless networking. We have combined data scientists and cloud architects with decades of wireless domain expertise to build the first truly innovative WLAN platform in over a decade.

At the core of our solution is the Mist cloud, purpose-built on a micro services architecture for rapid deployment of new services without impacting existing services. The Mist cloud uses the latest proven cloud technologies for message handling, data storage, and real time data processing. In addition, everything is open and 100%

The Mist Learning WLAN





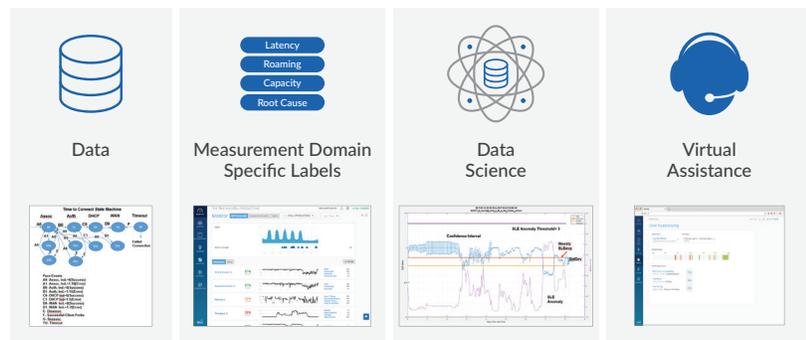
programmable via APIs for maximum flexibility. This gives CIOs the speed of innovation they need to compete in a globally mobile world that is moving at an ever increasing pace.

The Mist cloud architecture provides a solid foundation for real-time A.I.-driven wireless operations. An enormous amount of data can be ingested and processed in real time, which allows unprecedented visibility into user behavior and simplifies operations through event correlation, baselining and anomaly detection. In addition, it lets the Mist network predict user problems before they happen.

It is worth noting that not all clouds are created equal. The first generation wireless clouds are merely virtual WLAN controllers stored in distributed data centers. While they simplify deployment and management, they do not fundamentally change the software architecture, and thus do not provide elastic scale and the performance, agility, and resiliency of the Mist cloud. In addition, and perhaps most importantly, they are not capable of supporting all of the features critical to an A.I.-driven WLAN, which include:

- Data collection
- Data measurement using domain specific metrics

The Foundation of an A.I. Driven WLAN



Over 100 Pre and Post Connection States Tracked in real-Time



- Data pipeline to support an evolving toolbox of data science algorithms
- Virtual wireless assistant

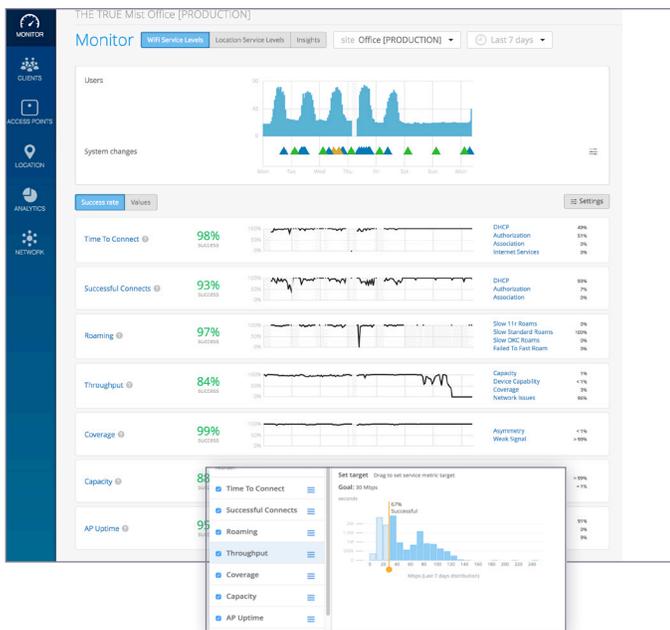
Data collection

Just as all great wines start with great grapes, any meaningful A.I. solution begins with massive amounts of quality data. A.I. continually builds its intelligence over time through data collection and analysis, so the more diverse data that is collected, the smarter it gets.

The Mist platform has a unique Proactive Analytics and Correlation Engine (PACE), which provides the foundation for A.I. data collection and analysis in the Wi-Fi / BLE domain. PACE collects over 100 pre- and post-connection user and location states in near real-time from every wireless device. This state information is sent to the Mist cloud, where A.I. algorithms are used for real-time analysis.

Enterprise business who are embracing BLE and mobile apps into their wireless strategy are also bringing data from the mobile device to deliver on high-accuracy location services to enable contextual services.

Mist's architecture allows for the capacity and performance to aggregate global metadata across customers. Not only is Mist capable of collecting data for insight into a specific client behavior and location information, it can provide insights and analytics across device types, operating systems, applications, and more. This is key for baselining and monitoring trends, and identifying macro issues early so they can be addressed proactively.



Domain Specific Design Intent Metrics

Whether trying to build a system that can play Jeopardy, help a doctor diagnose cancer, or help an IT administrator diagnose wireless problems, all A.I. solutions need labeled data based on domain specific knowledge to break the problem down into small segments that can be used to train the A.I. models.

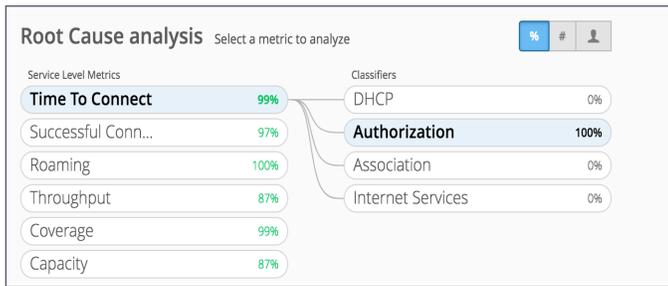
In the Mist environment, this is achieved using design intent metrics, which are structured data categories created by Mist's domain experts to classify and monitor the wireless user experience.

For example, Mist lets you set, monitor, and enforce your own Service Level Expectations (SLE) for various key Wi-Fi metrics such as "Time to Connect", "Successful Connections", "Throughput", "Coverage", "Capacity", "Roaming" and "AP uptime". These are then used to quantify the Wi-Fi performance of clients, Access Points, and entire locations.

For example, you can define a throughput SLE of 30 Mbps for all users

in your main campus. PACE will tell you exactly what percentage of the time this SLE is being hit, which users are not getting this level of service, and which device types/operating systems/applications are consistently causing problems. In addition, it can predict if this SLE will be achieved in the future based on current conditions.

Mist has similar metrics that are also applicable to the location experience, such as "Location Latency", "Jitter", "Dropped Requests", and "AP uptime". With Mist, you can use Wi-Fi and BLE metrics together to deliver the best wireless services with confidence – i.e. the



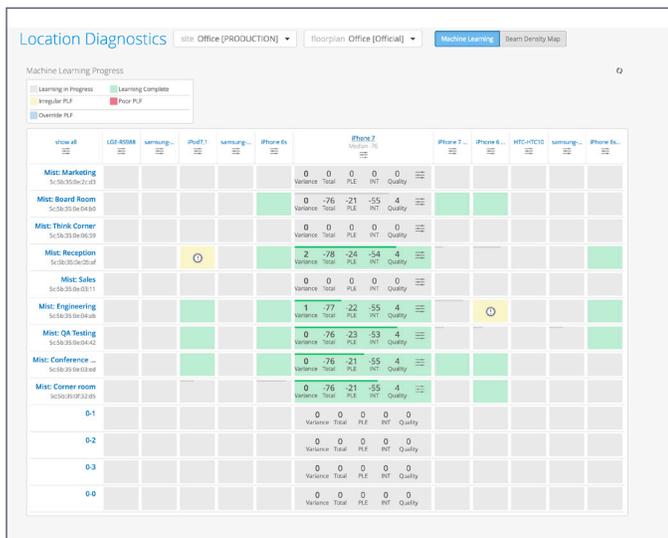
user experience is completely measurable. In this respect, Mist is fundamentally changing the paradigm in wireless networking from managing wireless Access Points to managing the end-to-end user experience.

Data Science Toolbox

Now that the problem is divided into domain-specific chunks of metadata, this metadata is ready to be fed into the powerful world of machine learning and big data. Mist uses various techniques, such as supervised / unsupervised machine learning and neural networks, to analyze data and provide actionable insight.

For example, the Mist platform performs time series anomaly detection with event correlation to identify the root cause of Wi-Fi and BLE problems so remediation can happen quickly. The 100+ state metrics listed above are analyzed for anomalies and correlated to identify problems in the wireless, wired and device domains (e.g. device type, operating systems, access point, DHCP server, Authentication server, DNS latency etc.) For example, an abrupt failure when onboarding a mobile device can be traced back to an association, authentication, DHCP, or other pre- and post- connection factors.

In addition, Mist identifies if temporal events, such as improper change control or Radio Resource Management (RRM) adjustments, contributed to a poor wireless experience. For example, if a network administrator changed a configuration at 3:00am that caused connection times to increase, the Mist platform will trigger an anomaly and correlate it back to the configuration change for rapid troubleshooting and remediation.



For location, Mist also has unsupervised machine learning algorithms in the tool box to calculate changing path loss models for all mobile devices in real-time. This eliminates the need for manual calibration of BLE, which is one of the largest operational costs that have hindered the deployment of indoor location services to date. In addition, it provides a more consistent and reliable user experience across various mobile device types.

In addition, Mist uses A.I. for security behavior analytics. Unlike traditional vendors, the Mist platform maintains a state machine and a baseline on key metrics for every physical device (access point, clients) and logical entity (location, site, site-groups) that complements flow information and a rich elastic cloud data store. By detecting unusual network activity at every level of the network, the Mist platform can accurately detect existing and day-zero threats. In addition, Mist's accurate location technology can be used to accurately locate accidental or malicious rogue devices and provide location-based access to resources.

In a traditional WLAN environment, raw data is placed into an unstructured database, where the data must be analyzed by a domain expert. Mist, on the other hand, uses a data science toolbox that automates the process and delivers a higher degree of accuracy in a shorter period of time.

Virtual Wireless Assistant

Most people experience collaborative filtering when they pick a movie on Netflix or buy something from Amazon and receive recommendations for other similar movies or items. Beyond recommendations, collaborative filtering is also used to sort through large sets of data and put a face on an A.I. solution.

Mist uses this methodology to turn all the data collection and analysis into meaningful insight or action. It is akin to a virtual wireless expert that helps solve complex problems.

The Mist virtual wireless assistant combines quality data, domain expertise, and syntax (metrics, classifiers, root causes, correlations, and ranking) to provide predictive recommendations on how to avoid problems and actionable insights on how to remediate existing issues. Mist allows human creativity and intelligence to intervene and provide feedback on the correctness of the recommendations to train the Mist expert system.

With the proper “education”, the Mist virtual A.I. assistant will learn wireless network nuances, and be able to respond to questions like “what went wrong?” and “why did that happen?”. The framework also allows Mist to extend its Virtual Assistant to more predictive “What-If?” scenario analysis. For example, if an enterprise plans to roll out a new application or new client devices, the Mist platform can provide an impact assessment on the current network. Or if a Retailer plans to expand beyond its current footprint, Mist can provide capacity planning guidance based on current network performance.

Remember, we said the more data collected, the more intelligent A.I. becomes. When a network problem occurs, the Mist virtual wireless assistant provides several reasons with various confidence levels. With continuous feedback from IT administrators (i.e supervised machine learning), the assistant gets more accurate and more confident over time.

In addition, with Mist’s APIs, this data can be exported or automated via workflows, enabling the assistant to proactively notify the right people of exactly what is occurring.

Join the A.I.-Driven Wireless Journey

“The business world has been battered by successive waves of new technologies over the past few years, and A.I. could ultimately prove to be the tsunami of them all... Failing to embrace it could mean missing out on an opportunity for early transformation.” *Nick Ismail, Information Age*

Wireless networks are becoming more business-critical than ever, yet, trouble-shooting them becomes more difficult every day, due to the many different devices, operating systems, and applications. Without a wireless A.I. strategy, IT simply cannot keep up with stringent wireless user requirements.

Companies of all sizes can take advantage of Mist’s AI-driven wireless solution today. By combining a strong team of wireless experts with dedicated data scientists, Mist built the first wireless platform that delivers the following:

- Wi-Fi that is predictable, reliable and measurable
- Wireless operations that are simple and cost effective
- Location services that deliver amazing new wireless experiences.

When A.I. is in the Air, anything is possible. To learn more, visit our resources page or sign up for a live Mist demo.