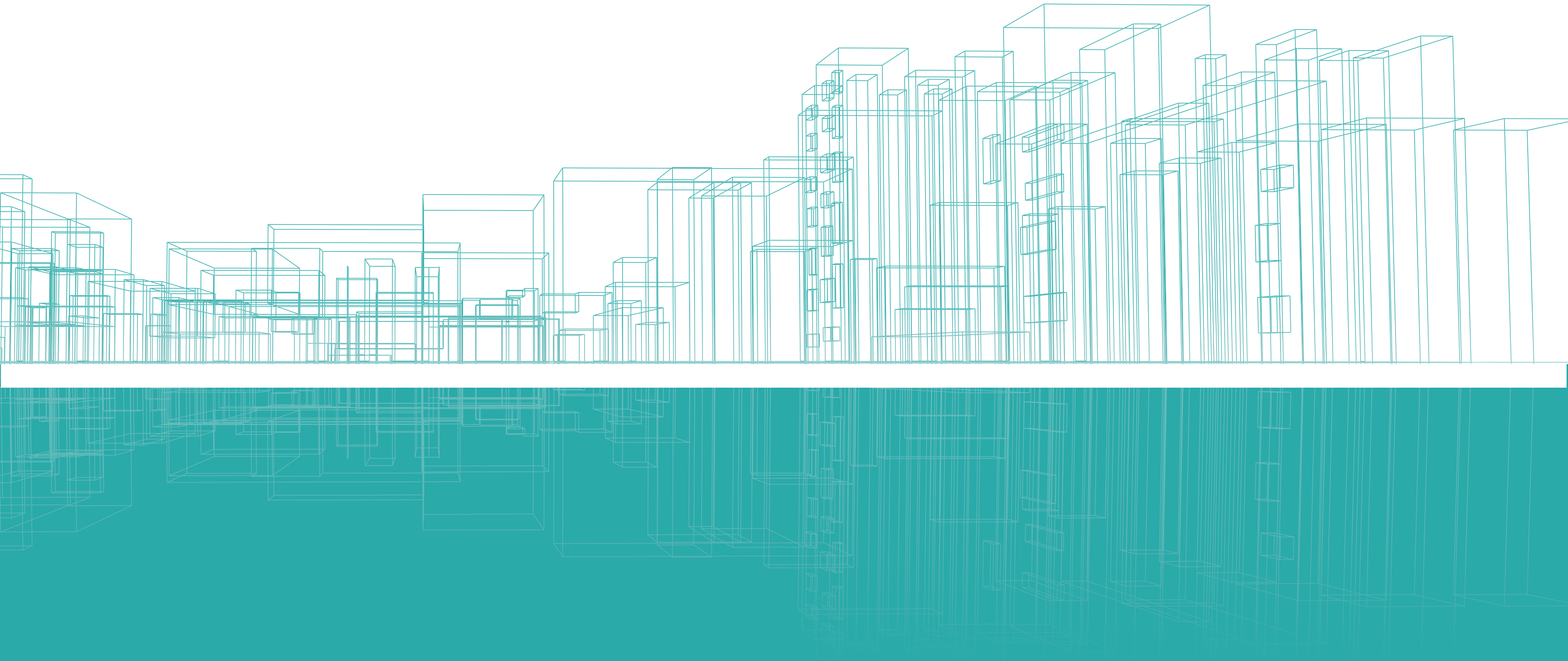
Getting Your IT Infrastructure Ready for the Digital Workplace

A Guide for IT Professionals



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- What does a network that meets the needs of #GenMobile look like?
- Conclusion

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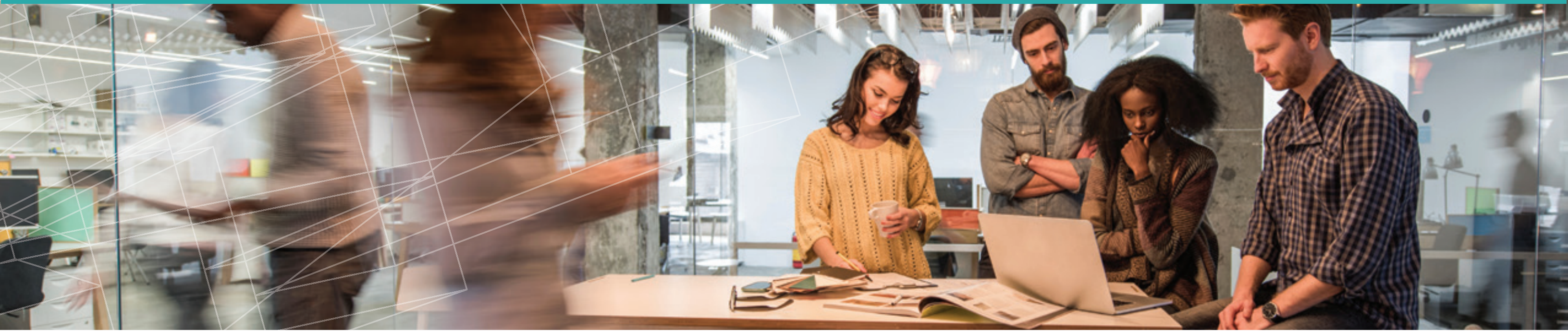


The Rise of #GenMobile

#GenMobile is the next-generation digital workforce that uses mobile devices in ways that are beyond conventional. No longer relegated to work email and personal entertainment, devices in today's mobile-first world are becoming the central component for every aspect of daily productivity.

For personal use, mobile devices and apps provide entertainment, social media, shopping, navigation, and banking. For work, they are used for voice communication, file sharing, video conferencing, CRM, unified collaboration, expense reporting, shared calendaring, help desk support, and project tracking. The lines between our social and work lives are becoming thinner every day, as we can see from the results of the latest industry survey conducted by the Economist Intelligence Unit (EIU):

- 30% of respondents say they would never work for a company that did not allow them to use their own mobile devices for work.
- The ability to work anytime, anywhere is seen as having the single-biggest impact on employee productivity, with 49% believing remote, flexible working was responsible for making them more productive.
- 31% of companies surveyed use mobile communications apps to improve employee effectiveness.

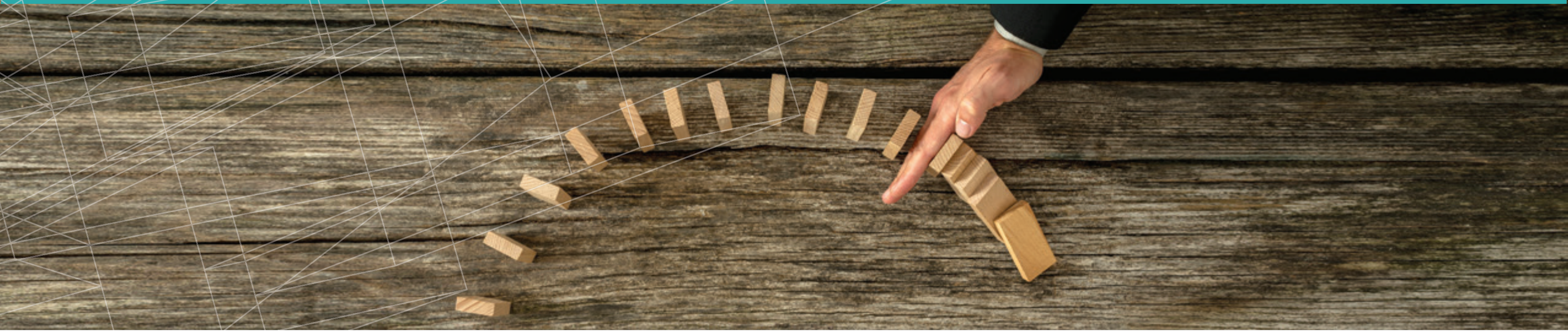
The Internet of Things (IoT) is also creating new opportunities and considerations for the digital workforce as these "headless" devices are coming on-line at a staggering pace. These devices include lighting, temperature control, sound control, appliances, door locks, vehicles, medical equipment, manufacturing machinery, utility meters, parking meters, surveillance cameras, and much more.

#GenMobile is changing the workplace, expecting flexibility in work schedules, work location, and office design. As a result, IT teams and network infrastructure must adapt and support a new set of requirements.

Challenges for IT organizations in supporting the Digital Workplace

1. Migrating away from legacy networks that do not meet the demands of a mobile workforce.
2. Delivering a mobile-first network with the reliability of a wired-only infrastructure.
3. Addressing increased security threats due to the adoption of BYOD and headless IoT devices.
4. Delivering a quality app and collaboration experience at remote locations, anytime.
5. Engaging with customers and employees on mobile devices to improve customer service and operations.

Certainly, these are challenges. But with each challenge comes great opportunity. We believe that organizations that can rise to these challenges and make a move to the digital workplace faster than their competitors will recognize substantial benefits. In the rest of this paper, we will highlight how IT departments can deliver tangible advantages back to their organizations in terms of lowered operational and capital expense, and improved employee and customer experience.



Solutions to these challenges

Solutions to these challenges

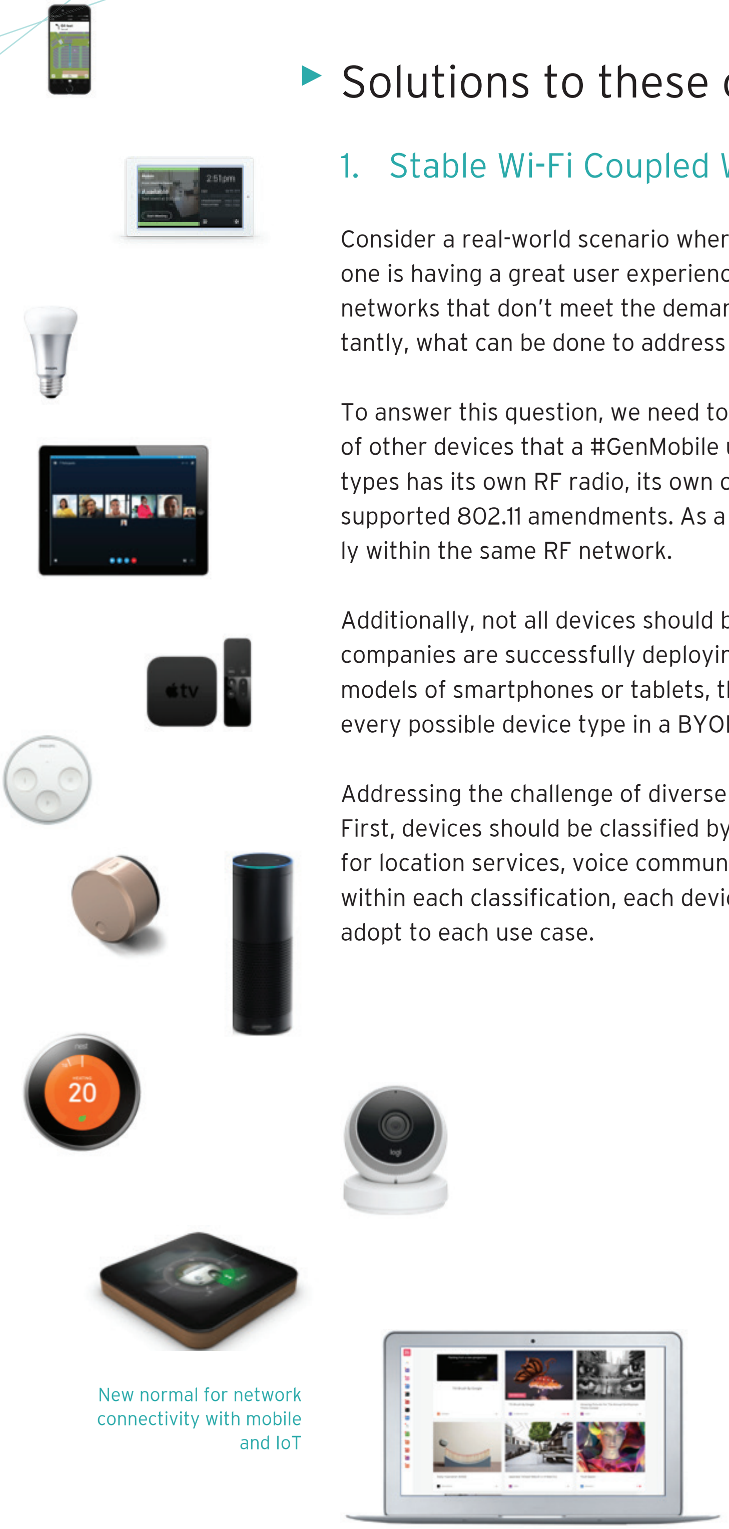
1. Stable Wi-Fi Coupled With a Wired Network That's Equally Smart

Consider a real-world scenario where two users are performing the same tasks on a Wi-Fi network, but one is having a great user experience while the other is not. This scenario is all too common in legacy networks that don't meet the demands of a digital workplace. But why does this occur, and more importantly, what can be done to address it?

To answer this question, we need to look at the device type – the smartphone, the tablet, or the myriad of other devices that a #GenMobile user may have with them at any given moment. Each of these device types has its own RF radio, its own operating system, its own Wi-Fi network driver firmware, and its own supported 802.11 amendments. As a result, each of these device types will often perform much differently within the same RF network.

Additionally, not all devices should be expected to support every company application. While many companies are successfully deploying VoIP and video over Wi-Fi on corporate-issued devices or certain models of smartphones or tablets, the prospect of delivering these applications flawlessly to any and every possible device type in a BYOD environment is a daunting one.

Addressing the challenge of diverse device type behaviors in the mobile-first environment is two-fold. First, devices should be classified by use case. For example, is the device in question meant to be used for location services, voice communication, collaboration, business application access, or IoT? Then, within each classification, each device needs be tested and the RF environment should be designed to adopt to each use case.



New normal for network connectivity with mobile and IoT

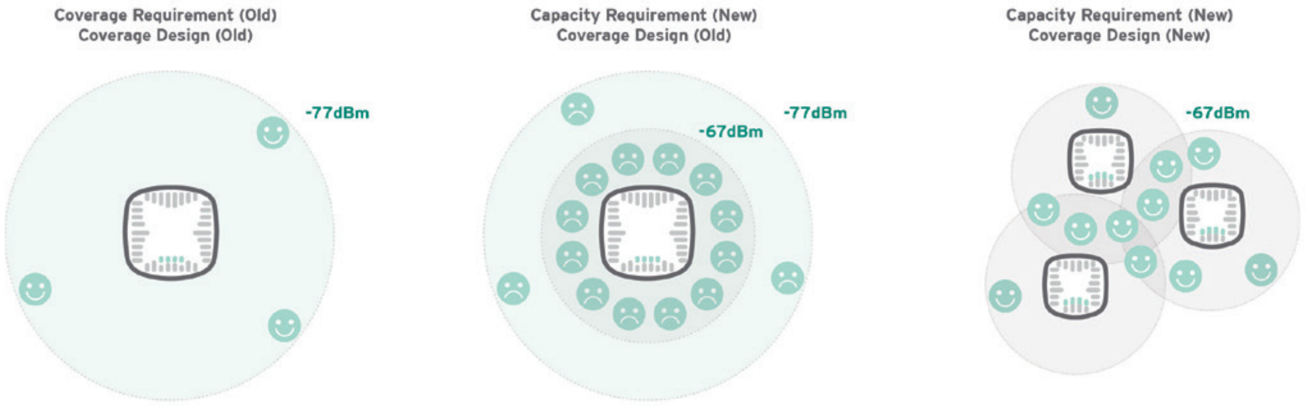
Let's consider another real-world scenario in which a user has great success using gigabit 802.11ac Wi-Fi for all their needs. However, a few times a week, their performance degrades dramatically, even though their device indicates strong signal strength and "4 bars" of connectivity. Upon further investigation, it is determined that the poor performance always occurs at the same time that a large nearby conference room is being used. This is a classic example of a Wi-Fi network that was designed for legacy coverage requirements and not for today's capacity requirements. Upgrading to 802.11ac Wi-Fi is necessary to meet the increasing performance demands at a digital workplace, but is not sufficient.

Historically, Wi-Fi network design was typically centered on signal strength. One would determine the required signal strength for an application, and as long as the entire coverage area maintained that pre-determined signal strength, the network performed as desired.

But things have changed, and the increased density of users and devices, along with the use of real-time, high-bandwidth applications like voice and video, have made focusing only on signal strength inadequate.

When designing a network for #GenMobile users, one must also consider the number of devices, the types of applications, and the throughput requirements needed within a coverage area. Oftentimes where a single access point (AP) might have in the past provided adequate coverage, multiple APs are actually needed today to serve the new capacity requirements of the network. In short, it is crucial to examine the need for both capacity and coverage in a Wi-Fi design for the Digital Workplace.

NEW CAPACITY REQUIREMENTS DEMAND A NEW DESIGN

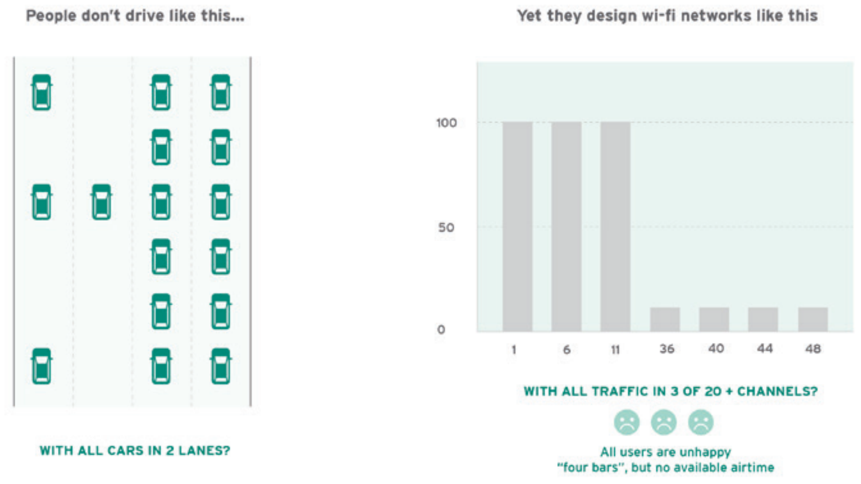


After putting careful thought into designing a network around the devices it will support, the location of the users, and what applications will be used -- all the while keeping in mind capacity vs. coverage -- it is time to take into consideration airtime utilization.

The FCC only permits so much radio frequency (RF) for use in a Wi-Fi network. Subsequently, this RF must be used as efficiently and wisely as possible. There are so many tricks, tips, and factors at play in RF design that an entire white paper could be dedicated to the subject. We will do our best to touch upon the highlights here.

Frequently, device radios use the 2.4 GHz spectrum in spite of the fact that the most bandwidth is found within the 5.0 GHz spectrum. Utilizing mostly the 2.4 GHz spectrum while ignoring the open and unutilized bandwidth available on the 5.0 GHz spectrum can cause needless "traffic jams" for users. While more and more networks are starting to use the 5.0 GHz spectrum, there are a surprising number of legacy Wi-Fi networks designed with a majority of their clients on 2.4 GHz. The end result is a network that resembles a highway where some traffic sits bumper-to-bumper while other lanes remain illogically empty.

AIRTIME (CHANNEL) UTILIZATION IS EVERYTHING



Now let's imagine a different scenario where the IT team has carefully studied the device types they need to support as well as their density and capacity requirements.

They have also configured their network to reduce inefficiencies in their airtime utilization and have carefully selected the appropriate channel width between 20 and 40 MHz (80 and 160 MHz only have a small use case in the SOHO world, and even then, are generally not recommended).

This IT team has reduced excessive overhead (non-payload traffic) by decreasing SSID count, eliminating low data rates, reducing co-channel inference and network retries, and eliminating rogue APs. They have implemented a quality of service (QoS) policy to optimize the performance of real-time applications like VoIP and video. Their network uses airtime fairness to ensure that a few slow users won't degrade the overall performance and throughput.

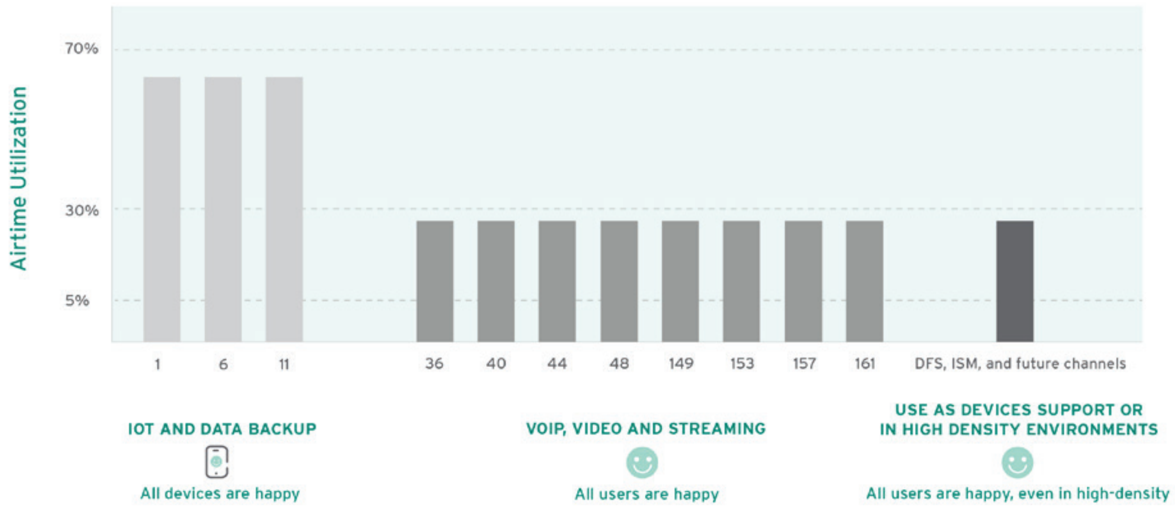
Additionally, the team has carefully studied the use of Dynamic Frequency Selection (DFS) channels, which offer considerable bandwidth, but with two risks. The first risk is that not all devices support these channels. The second is that government regulations may use these sets of frequencies for radar events, thereby crippling Wi-Fi on these channels temporarily.

The IT team has decided to improve capacity in their high-density areas by implementing the use of DFS channels, while also overlaying at least one non-DFS channel in all high-density areas so that both of these risks are mitigated.

Finally, they have carefully monitored their maximum airtime so that overhead does not exceed 5% on any channel, data channels don't exceed 70% utilization, and VoIP / video channels don't exceed 30% utilization. The end result of the combined measures taken in this scenario is a Wi-Fi network that meets all the mobility experience needs of the #GenMobile user.

A WELL-DESIGNED NETWORK MAXIMIZES THE ENTIRE RF SPECTRUM

CLEAN WI-FI NETWORK = MAXIMUM THROUGHPUT



Solutions to these challenges

1. Stable Wi-Fi Coupled With a Wired Network That's Equally Smart

Just as we need to adapt the design of the wireless network to accommodate the needs of #GenMobile and the digital workplace, the wired infrastructure also plays an integral role.

In the past, assigning an identity to an Ethernet port meant a specific VLAN assignment that hardly ever changed. The devices that connected to the Ethernet ports hardly ever moved (e.g. we never took our desktop PCs home or brought our own VoIP phone to work) and the Ethernet ports in meeting rooms or in our cubicles were designated by colors. While coloring cables or ports was a cumbersome way to manage connectivity for digital devices, IT teams were able to overcome the burden since very few of these devices needed to change personality -- they were all "trusted" while within the physical perimeters of the corporate building.

With the arrival of IoT and the "untrusted" nature of these devices on the enterprise network, there has to be a better way to control access to the wired network. One option is dynamically assigning each and every port a configuration as soon as the device type is classified upon connection. In this model, network ops teams would not have to spend hours configuring individual ports or keeping track of which port is assigned for which use. With this approach, any device can now connect to any port. In other words, ports can go "colorless".

Another important consideration regarding the legacy edge port is that it has typically supported only one device at a time, and because of this, a rate of 1 Gbps was more than enough. However, an AP will support many devices at a time, raising concerns that 1 Gbps may become a bottleneck. There may be some debate regarding an AP's ability to exceed the 1 Gbps throughput threshold today, but there is scarcely any disagreement as to whether APs will exceed 1 Gbps in the next three to six years, which is the reasonable life expectancy of an Ethernet switch. Consequently, multi-gig wired ports at the edge should be a component of today's wired infrastructure purchases as a way to future proof.

The continued increase in traffic congestion within the access layer of the wired network requires the implementation of QoS rules on the wired backbone. Business-critical applications (e.g. a wired security camera as an IoT device) need to be classified and prioritized even within the high-capacity wired network, to ensure lower levels of latency and improved speed of operation for business processes.

It is clear that IT networking teams are being asked to do more with the same amount of operational and capital resources they have had over the years. Clearly, IT spending has to be part of the discussion here as we try to find the middle ground between the pervasive, high-capacity Wi-Fi infrastructure and a smarter wired network at the digital workplace.

In addition to automating real-time access control and QoS configuration on wired ports, there is another area where wired access infrastructure can get smarter and enable network ops teams to increase their operational savings: zero-touch deployment. We have gotten so used to the fact that Wi-Fi access points can be deployed with almost no effort -- thanks to Wi-Fi controllers and/or management platforms -- that we can forget how wasteful the time we spend installing and provisioning wired access switches can be. Because the wired network is an essential ingredient for any Wi-Fi project, it is critical that initial deployment of wired access ports be automated, with their configuration centrally managed, just like the Wi-Fi APs. This is true whether the deployment takes place in the campus or at remote branch locations.

The upsurge of BYOD brings with it a key advantage in terms of capital expense savings -- a fast decline in the use of wired desktops and wired VoIP phones. With this change, we no longer need to size our edge closets with the expectation of two or three wired drops per office or cubical. In short, we need less ports, which allows portions of the IT budget to be reallocated towards meeting #GenMobile demands. Additionally, as users move from wired to wireless, and servers – which were traditionally connected to the core -- move to data centers, a cost-saving opportunity arises in the corporate LAN infrastructure. In many cases, it is possible to migrate to a two-tier design of edge and core, as opposed to the more traditional three-tier design of edge, distribution, and core. This again creates cost savings on the wired infrastructure that can be shifted to address the new requirements for connectivity at a digital workplace.

Recommendations Checklist

1. Document the essential set of mission critical application and device mix
2. Dynamically classify each device on the Wi-Fi and wired portions of the network
3. Plan for both coverage and capacity
4. Reduce SSID count and disable lower rates whenever possible on Wi-Fi radios
5. Use DFS channels to overlap non-DFS channels to increase capacity over Wi-Fi
6. Enforce QoS policies on Wi-Fi and wired to improve performance of real-time applications
7. Track channel utilization and enable airtime fairness on Wi-Fi radios
8. Implement 802.3at PoE+ and multi-gigabit wired ports to future proof

▶ Solutions to these challenges

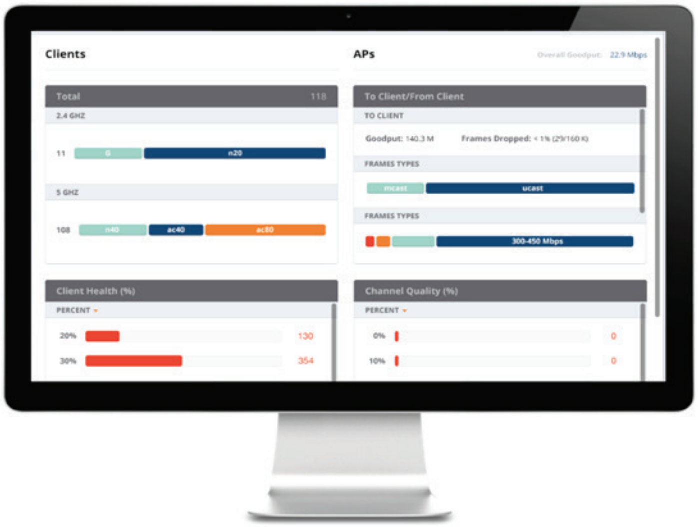
2. Gain Deeper Visibility into the End-to-End User Experience: Proactive vs. Reactive

In the last section, we explained how identifying and understanding device types, coverage vs. capacity planning, and airtime utilization all have a direct effect on the user experience. This brings us to questions such as:

- How do we monitor these critical metrics?
- How do we know the thresholds that indicate a poor user experience?
- Outside of Wi-Fi, what other factors could affect the user experience negatively?
- How do we not only collect the data, but fix the problem before the user even knows a problem existed?

To deliver the best possible user experience, IT departments must be able to predict, rather than react. Collecting key RF metrics such as interference levels, device counts, top talkers, retry rates, and signal strength can go a long way in helping to make those predictions.

These metrics can be collected by production APs or by dedicated monitors and they are normally viewed in a Wi-Fi controller dashboard or monitoring software. Monitors are able to collect more data on more channels in a shorter timeframe than production APs, which is critical to being proactive rather than reactive. While this data is can be used to track the general health status of your Wi-Fi environment, gaining a true snapshot of the user experience will require a deeper dive.



Overall Goodput: 22.9 Mbps

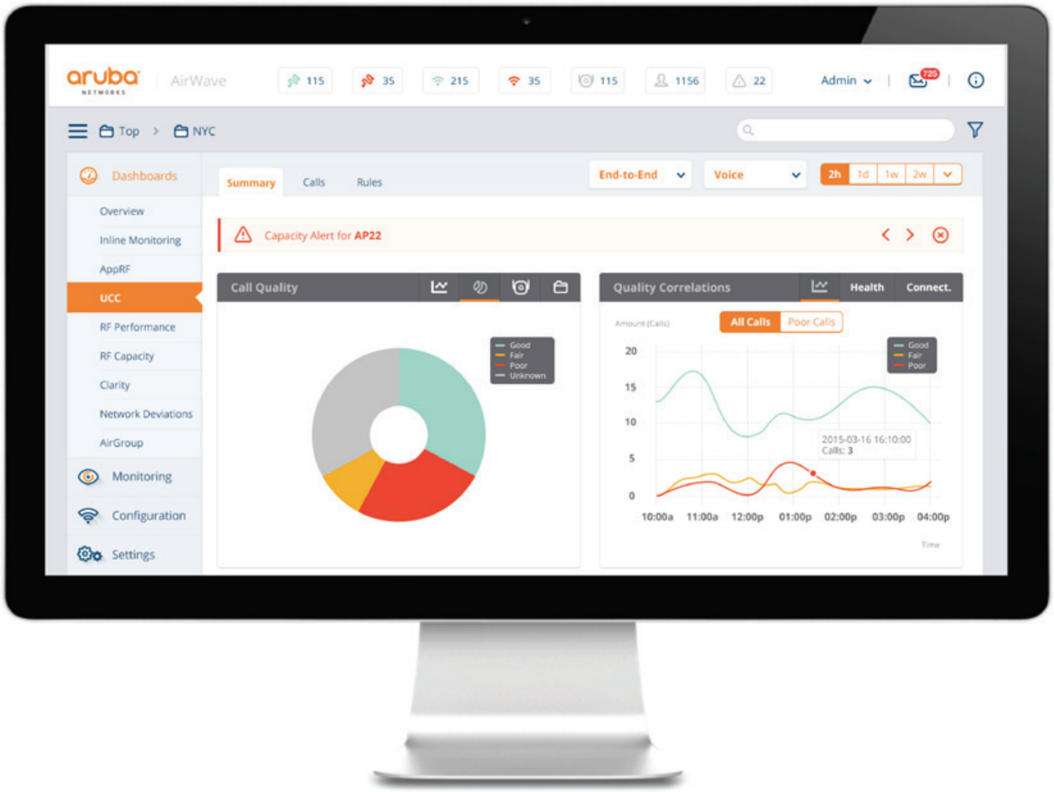
Goodput: 140.3 M Frames Dropped: < 1% (29/160 K)

Basic health monitoring for clients and access points

Solutions to these challenges
2. Gain Deeper Visibility into the End-to-End User Experience: Proactive vs. Reactive

Here is where application-level data collection enters the scene. It is important to have a full understanding of the commonly-used applications and web-traffic on a network, as they are the vital indicators of general usage patterns. From there, we can define mission-critical applications, create QoS policies, monitor QoS tagging, configure QoS queueing, and ultimately guarantee that all mission-critical applications are getting the bandwidth and priority access needed for a flawless user experience.

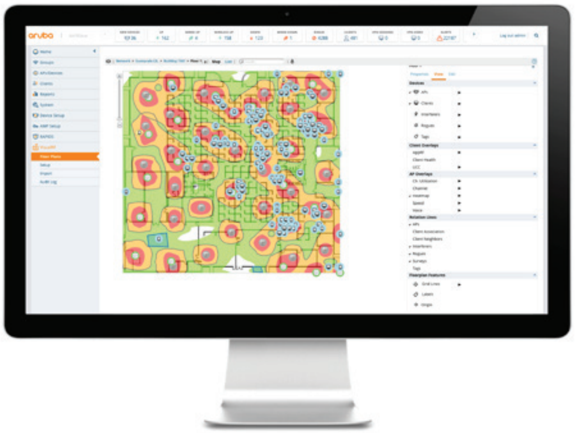
The application class that is most associated with #GenMobile is unified communication and collaboration (UCC), and accordingly, it deserves a special mention. UCC applications allow for voice and video communications as well as document sharing and collaboration and are key for raising productivity in a mobile-first workplace. Because UCC apps are real-time and require high levels of video quality, they place the highest burden on the network of any application. An organization that can deliver a UCC application to its employees on their mobile devices successfully meets the standards of a true mobile-first digital workplace.



Visibility into quality of mobile apps,
including unified communications

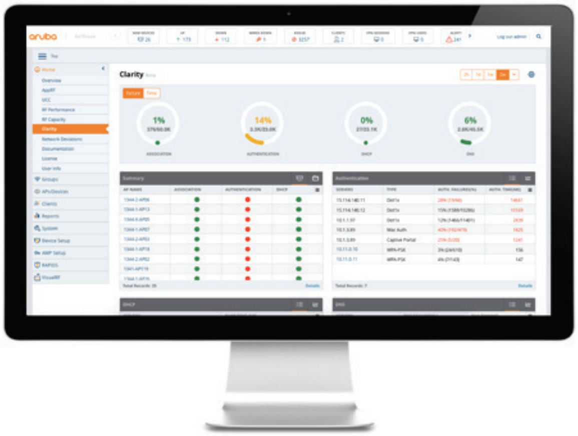
2. Gain Deeper Visibility into the End-to-End User Experience: Proactive vs. Reactive

Gone are the days of compiling network metrics in tables, spreadsheets or databases. Today's IT teams require easy-to-interpret visual maps where all the relevant data can be viewed on a single screen. Being proactive, rather than reactive, means being able to see a real-time view of the entire RF environment, as well as the underlying wired network, the location of users, their health and application performance at those locations, and any rogue devices or intrusion events.



Live monitoring of app usage, device density and air quality

To examine the true end-to-end user experience, we must look at the time it takes for a user to receive the first data packet upon first connect and after each roaming event. What matters most is the total time required to associate to a wireless network, authenticate to a Radius server, obtain an IP using DHCP, resolve host names using DNS, and transmit a first data packet. If we are not able to capture and follow each step of this process, it is somewhat akin to ignoring the weakest link in a chain and then wondering why it keeps breaking. Therefore, the next generation of monitoring tools must assist with evaluating this end-to-end performance. Additionally, if problems are discovered, those monitoring tools should allow us to use our APs as clients to run synthetic on-demand testing of the full user experience.



Predictive analysis of end-to-end user experience on the network

The final component of being proactive versus reactive pertains to notification. Once we can easily review metrics and define what is acceptable for the #GenMobile user and workplace, we need the ability to define thresholds and create alarms that notify the IT team before those limits are reached. In a true #GenMobile world, IT administrators are as mobile as the users, and so, notifications should go directly to mobile devices, triggering a response before the user even realizes there was a problem.

The same processes that will enable us to proactively solve network issues will also provide benefits for those occasions when an IT department has to react to an issue. With the vast amount of data we can collect, we can send issues to tier 1 help desk support rather than to higher level, and higher cost, solution teams. And, for those rare situations when a higher level of support is needed, the wealth of metrics we'll be able to provide will give that team a head start.

Recommendations Checklist

1. Collect information about app performance, in addition to basic Wi-Fi metrics
2. Enable forensics and trend analysis for deeper visibility into the end-to-end user experience
3. Have a method to synthetically simulate network performance and connectivity tests
4. Define threshold metrics and associated alerts for proactive response
5. Create a process for utilizing the tier 1 helpdesk when reactive response is required

Solutions to these challenges

3. Securely Support the Many Use Cases of BYOD and IoT

We have discussed how to design a reliable network, the importance of proactively monitoring the network, and the need to react efficiently when issues arise. The next steps for ensuring a positive user experience is securing the network. This requires three basic steps:

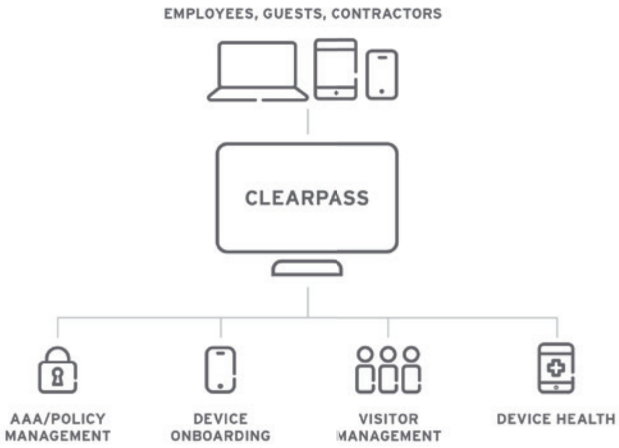
- Carefully author policies and rules.
- Inspect all requests for access against the policies.
- Deny or grant permissions accordingly.

With a wide range of device types, user types, and applications, network access control (NAC) must be designed on a case-by-case basis. Following are key elements for securing the mobile-first digital workplace.

Let's begin with the most common use case, which is granting network access to employees using a corporate-issued or BYOD device. The goal is to provide access to the wired, wireless, or VPN network as easily and seamlessly as possible, without multiple access methods, credentials, or login screens.

To enable this, a single NAC platform that is performing 802.1X-based authentication is becoming the standard, with EAP-TLS using certificates being the most secure methodology. Authentication is often based on a username and password and is tied to existing user stores such as an Active Directory or LDAP. For added security, some companies are implementing multifactor authentication, which might consist of a secret question, fingerprint, voice recognition, photograph, or physical location.

In addition to the user, the device itself can be included as part of the network access policy. For corporate devices, this security policy could be simply based on a MAC address, or it can include the presence of a mobile device management (MDM) software agent installed on the device. For BYO devices, it could be based on OS versions, device model and/or presence of a mobile application management (MAM) solution. Mobile device and app management solutions can segment personal data from corporate apps and data to keep the network secure, or it can be used to help build and enforce blacklists for certain apps or "unhealthy" devices.



Solutions to these challenges

3. Securely Support the Many Use Cases of BYOD and IoT

Another common use case scenario is when network access is requested for a guest who is seeking Internet, printing, and other basic services. These "non-employees" might be visitors, clients, contractors, business partners, shoppers, and so forth.

Providing access to these guest users must be done securely and efficiently. Registration options typically include portal-based solutions such as self-registration or employee sponsor, both of which reduce the IT administration burden. Once registered, users typically obtain credentials via email or text, and are able to login and gain access to a secure VLAN that gives them limited network access.

Yet another example of a guest access use case would be a high-capacity facility such as an airport, sports venue, or shopping mall. In this case a simple "acceptance of use" account could be used, or alternatively, a social media login could be required. In some cases, open authentication could also be an option. In all of these situations, the guest WLAN must be 100% secure from the corporate network, typically through the use of role-based policies, enforced with firewall security embedded within the network infrastructure.

Please login to the network using your username and password.

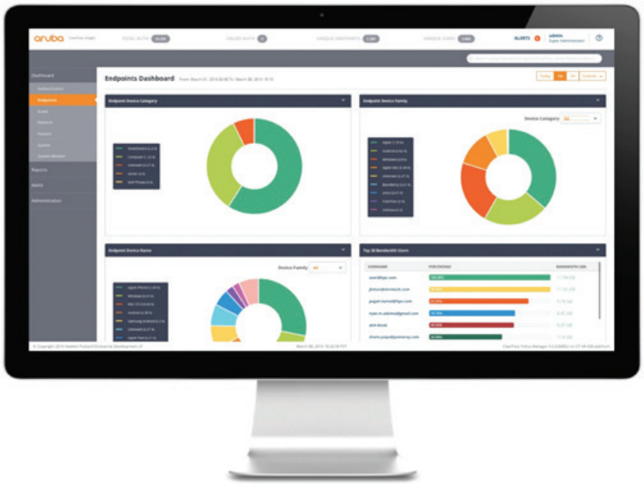
Contact a staff member if you are experiencing difficulty logging in.

Custom designed, user-friendly web portals to help users onboard their devices to the network

Solutions to these challenges
3. Securely Support the Many Use Cases of BYOD and IoT

The need for 'non-employee' network access is compounded by the growth of the IoT. While these devices are "headless", – meaning they are not manned by a human – they still require network access. Organizations must develop role-based policies for the IoT that are different than the policies for their employees and guest users. They may even need multiple policies to address the vast array of IoT devices that are connecting to the network.

Device profiling and fingerprinting, already important to network security, are measures that have become mission critical with IoT. Anytime a device attempts to connect to the network, there is a need to automatically profile it. This means knowing what type of device it is and what its function performs within your enterprise, allowing for the correct security policy to be applied. Should the network encounter a device that cannot be automatically profiled, that device should be quarantined until more information is obtained.



Automated classification of devices on the network

In addition to security issues relating to NAC, there are other security issues that must be accounted for in any network. Sitting at the top of that list is intrusion. Together, a wireless intrusion detection system (WIDS) and a wireless intrusion protection system (WIPS) assist in identifying potential threats to the AP infrastructure or associated clients.

A sophisticated, effective, yet easy-to-manage WIDS/WIPS solution should provide a network administrator the means to identify, assess, and defend against attacks while maintaining a seamless, uninterrupted, and secure experience for the #GenMobile user. What's more, the WIDS/WIPS must be highly customizable since the requirements and regulations that apply to each network can vary significantly, whether it be a conference facility, financial institution, or government agency.

Another prevailing security concern in networking is multi-stage malware or persistent attacks. These are threats where, once a person gains access to the network, they are able to remain on the network for a long period of time and launch multiple attacks, typically stealing data rather than crashing the network. Legacy firewalls and antivirus software are no match for these types of attacks. The solution is next-generation protection with seamless integration between multiple products that perform detection, mitigation, and prevention. This protection must be done on the application layer, as traditional port-based security is insufficient.

These new security systems should integrate with network access policy platforms to enforce real-time policies for both Wi-Fi and wired network access in case any internal and/or external attacks are identified. While traditional NAC solutions only worried about the initial connection for Wi-Fi and wired devices, next-generation policy management solutions need to take action against the increasing risk posture of connected devices as malicious activities are identified.

Recommendations Checklist

1. Create network access policies using a rich context of device type, health, user, time and location
2. Use device profiling to on-board IoT devices onto the network, and quarantine as necessary
3. Implement a single platform to handle control for wired, wireless and VPN network access
4. For employees, use 802.1X EAP-TLS coupled with multi-factor authentication
5. For secure guest access, enforce firewall policies within the network
6. Implement a wireless intrusion detection and/or prevention policy, procedure and solution
7. Integrate next-generation threat protection with the policy management platform

▸ Solutions to these challenges

4. Deliver Cloud Apps and Collaboration from any Location

The final piece in the end-to-end user experience is the application itself. Of course, no two networks or organizations have the exact same application needs. However, there are some fundamentals that apply to most scenarios.

The traditional client/server architecture is no longer suitable for the mobile-first network. This model was designed to deliver files and information from a single server to a PC that was connected on the same LAN, or occasionally WAN. While the PC was robust enough to support large applications stored locally, this is no longer the case with mobile devices. Which is why we now demand a streamlined and centralized delivery of applications.

Additionally, users are often not working on the same LAN as the server anymore. On a given Tuesday, a user might be working from home, and therefore needs to access an application on a tablet using a cable internet connection. On Wednesday, that same user might be traveling, or visiting customers, and needs to access that application on a smartphone using 4G cellular service. On Friday, that user might be checking on operations at several remote offices, where he needs to use the corporate WAN to connect securely to those applications.

Even though each of these scenarios requires its own unique network infrastructure design, the user requires their experience to remain consistent across all the potential combinations of access methods, device types, or locations. Satisfying that requirement involves moving apps to a centralized location and using virtualized servers -- a simple enough concept that delivers many advantages to the mobile-first network.

"Applications delivered from a centralized location" is the long way of saying cloud applications. Cloud applications are made possible by virtualized server farms and data centers, and can be delivered by the public or the private cloud. Private cloud applications are served from a data center that is owned and managed internally, and only users that have gained network access can use these applications. The clear advantage of using a private data center is the ability to maintain QoS and security protocols all the way from the client to application servers, while the distinct benefit of public cloud applications is cost-efficiency and easy access. With all these options at hand, each organization must decide what combination of public and private cloud application use fits their specific needs and budget accordingly.

When organizations want to explore new geographies for their business, the faster they move into their new locations and are connected back to corporate resources, the faster they can realize RoI. Network infrastructure cannot hinder the way folks do business at these remote sites.

Solutions to these challenges

4. Deliver Cloud Apps and Collaboration from any Location

IT organizations can use cloud-based tools to install infrastructure as quickly as you can enable a remote worker with a mobile device and connect them up to a cloud-based application. With the move to a digital workplace, organizations will likely have remote infrastructure components that they no longer need, such as expensive-to-maintain WAN routers that are no longer necessary if you move away from MPLS links to broadband at remote sites. Eliminating those components will produce savings that can be redirected to deploying integrated platforms that can offer WAN, LAN and WLAN services when connecting internet broadband at these branch locations.

Recommendations Checklist

1. Design a network template for home, small and branch office connectivity
2. Implement an easy-to-use system for road-warrior connectivity on 4G, LTE and Wi-Fi hotspots
3. Create a list of apps that will be delivered by public and private cloud for remote users
4. Clearly define network metrics that will satisfy user expectations and monitor them in real-time
5. Implement end-to-end QoS for your private cloud applications, primarily for unified communications
6. Carefully negotiate and understand service level agreements (SLAs) for public cloud apps

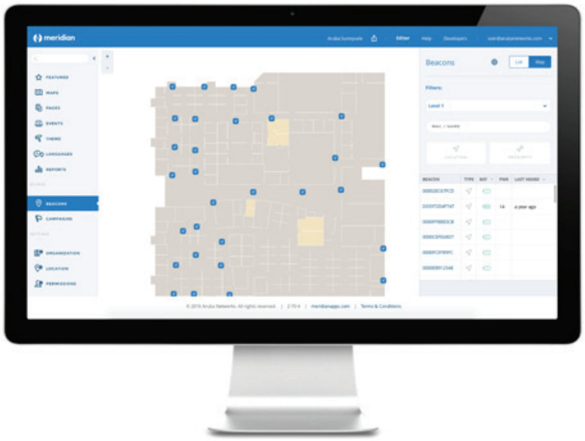
Solutions to these challenges

5. Leverage Bluetooth Low Energy (BLE) for In-venue Mobile Engagement

Location-based services and mobile engagement are an increasingly important aspect of the digital experience for #GenMobile. The ability to engage with customers and employees in a contextual manner via capabilities like targeted push notifications or turn-by-turn directions delivers a wide range of advantages for both the user experience and an organization's bottom line.

Bluetooth Low Energy (BLE) is the ideal technology for indoor location-based services. Operating on the 2.4 GHz frequency, BLE beacons have a typical range of about 200 feet and can provide location accuracy within a mere foot. When combined with a well-designed mobile app, installed on a tablet or smartphone can be used as the client-side device within a BLE beacon network. We believe that the value of location-based information will become virtually limitless as the interactions between smartphones and IoT continues to grow.

BLE beacons are simple to deploy and use, but large deployments can introduce operational challenges in terms of management, such a battery changes and adjustments to power levels, etc. To overcome these challenges, and eliminate the time and expense of manual management, organizations interested in BLE beacons should look for solutions that include sensors and other remote management capabilities.



Centralized management of BLE beacons

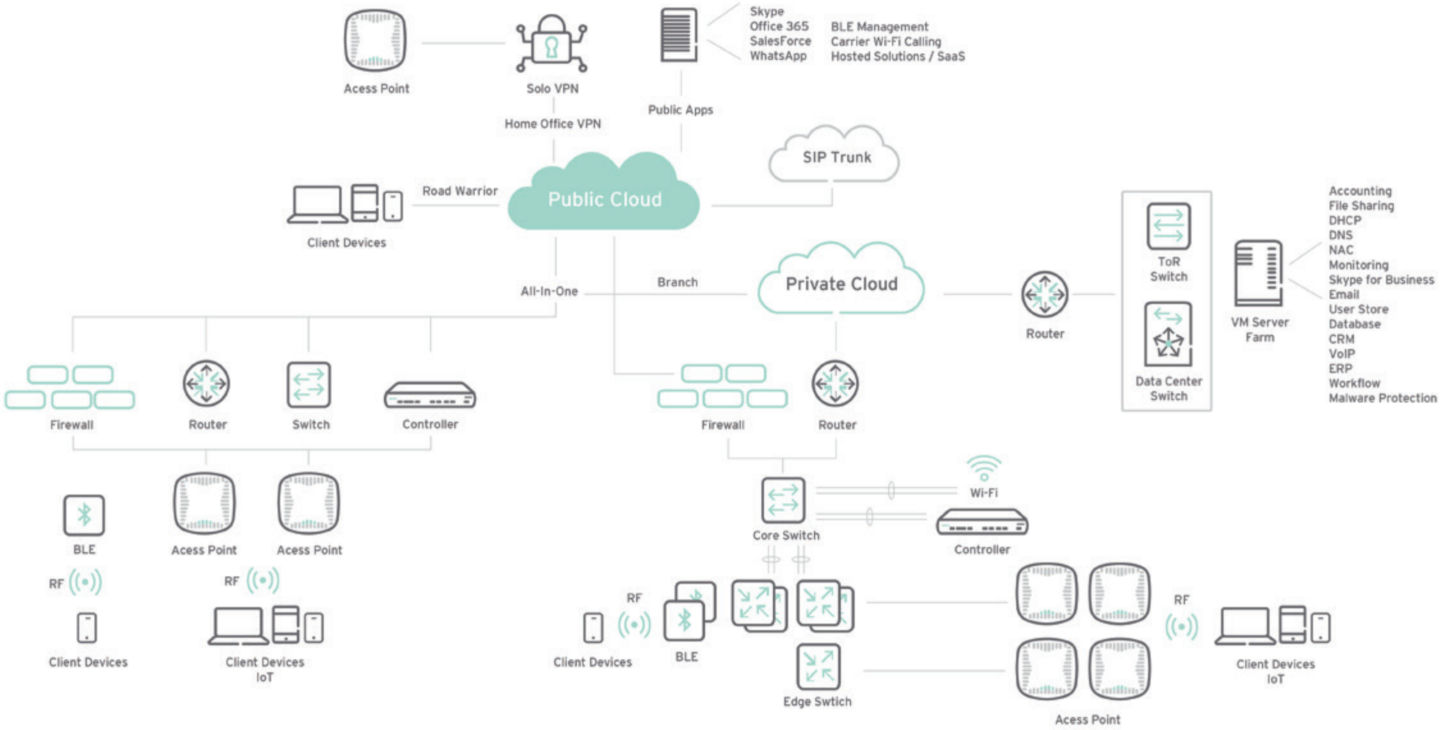
For organizations that lack the resources to develop their own mobile apps from scratch, there are a wide range of templates that can be used. For organizations that have an app but want to add location-based services to it, there are SDK add-ons for functionality such as navigation and context-aware marketing. Some of the common use cases for location-based services include:

- Deliver a "blue dot" experience on a map to help users navigate your facility with turn-by-turn directions
- Allow users to find friends and co-workers quickly and easily
- Allow customers to find employees easily when they need assistance
- Deliver push notifications to customers based on their current location and past shopping habits
- Provide automated check-out, room access, and temperature control for hotel guests
- Automatically turn lights and other utilities on and off as employees enter and exit rooms

Recommendations Checklist

1. Clearly define use cases for BLE beacons to enable location-based services
2. Start working with an app developer partner, with a laser focus on improving the end user experience
3. Create a plan and strategy for how your mobile app will interact with IoT devices
4. Use centralized management for BLE beacons to reduce operational cost

▸ What does a #GenMobile-ready network look like?



▶ Conclusion

No matter what type of business you are in, from financial services, government, healthcare to education, retail, hospitality, or manufacturing, #GenMobile is having an impact on the way you conduct business and the type of network infrastructure you need.

This document has outlined some of the challenges that #GenMobile and the move to the Digital Workplace is presenting to organizations across all vertical markets and it has reviewed some of the solutions to those issues. Forward-looking enterprises will take that information and will work with mobility specialists – network architects and engineers – to find detailed, customized approaches for their particular use cases. In so doing, they will enjoy benefits ranging from improved communication and collaboration to enhanced productivity and reduced capital and operating expenses.