ENTERPRISE WIRELESS VOIP

Answering the call for Wireless VoIP

Wi-Fi adoption is soaring. And wireless VoIP is the most talked about application after data usage. However, questions have arisen about whether voice is a realistic application over 802.11 networks today. This paper provides the answers. It explains the numerous places where wireless VoIP can go to work, why most offerings fail to make it work, and how only Foundry Network's IronPoint Mobility Series puts the power of wireless VoIP to work at enterprise-scale.

Wireless finally raises its voice

Wireless LANs (WLANs) are becoming a fixture in the enterprise and quickly proving their worth. At the same time, many enterprises are adopting voice over IP (VoIP) systems to benefit from lower costs. The two technologies together have given rise to an exciting application: wireless VoIP. Wireless VoIP significantly enhances the value of both technologies by delivering optimum mobility, productivity and ROI. Companies deploying VoIP are universally considering how WLANs can be integrated into the system. As voice over Wi-Fi becomes an increasingly viable option with the influx of new Wi-Fi enabled phones, including dual mode cellular/Wi-Fi phones, wireless VoIP looks even more promising.

While wireless VoIP has been available for a few years now, the current WLAN infrastructure on the market has lacked the scalability, quality and usability needed to support large-scale deployments.

Foundry's IronPoint Mobility Series makes wireless VoIP suitable for any environment. Patented technology overcomes a number of performance barriers to deliver unprecedented quality, scale, and usability for a converged voice and data network. Networks built with Foundry's IronPoint Mobility Series accomplish this with nothing more than industry standard Wi-Fi client devices.

Times, places and strong cases for wireless VoIP

In today's dynamic work environment, employees are always on the go. Commonly, organizations address the challenge of mobile voice communication by outfitting the workforce with cell phones. However, such solutions can be unreliable due to limited or non existent in-building coverage, expensive, or not practical. Fortunately, a new generation of Wi-Fi enabled phones is available, including dual mode phones that support both cellular and Wi-Fi. With the prevalence of Wi-Fi as an in-building wireless network, voice communications over the wireless LAN are a practical, low cost solution. Wireless VoIP becomes the most viable solution in a variety of environments.

Enterprise

For mobile workers in networked buildings, wireless VoIP is a great solution for enhanced productivity. In addition to accessing the network with wireless VoIP phones, soft-phones enable PDAs on a Wi-Fi network to function as phones. Prices of Wi-Fi client devices are dropping rapidly and giving rise to new generations of practical, productivity enhancing solutions. For example, wireless VoIP technology will also soon allow mobile phones to switch seamlessly between cellular and 802.11, even in the middle of a call.

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Healthcare

Doctors and nurses are the quintessential mobile workers. Unlike most other enterprises, it can be critical to reach the right person immediately in a life-threatening situation demanding the highest reliability in the communication system. However, most hospitals prohibit cell phones due to RF interference. Paging is riddled with delays. Wireless VoIP can provide medical teams immediate, reliable voice communications. Newly developed "voice badge" devices present a hands-free method for communication between health care workers, allowing them to keep their hands free for other tasks. Mobile healthcare professionals can exchange critical information and make more of their time to improve the quality of care they provide.

Warehouse/Retail/Hospitality

Effective customer service often requires communications between front-line and backroom employees. The service received in hotels, on cruise ships, at amusement parks, or airports, is often a function of how effectively widely disbursed employees can interact. In these and similar environments, wireless VoIP can provide a better means of communications between employees. WLANs can be implemented where wireline networks might be cost-prohibitive due to building design or rapidly changing physical environments such as in retail or conference centers. Highly intrusive intercom systems can be avoided. And connections can be made fast and effectively not only between employees, but also directly between customers and employees, improving service satisfaction.

Education

WLANs are changing the paradigm in education[1], allowing the Internet and networked resources to be used in many different places: the classroom, gym, lab, library, or dorm. Systems are cost-effective, easy to install, and ideal for open-plan schools or older buildings where hard wiring is difficult. Classrooms often do not have phones, and installing new phone lines is prohibitively expensive in the current economy. To fill that void, teachers often bring their own cell phones into the classroom. This not only places undue burden on the faculty member, the school remains haphazardly connected. Privacy concerns also make it inappropriate for teachers to provide personal phone numbers to coworkers and students' parents.

With wireless VoIP, students, teachers and staff can remain connected as they move about the campus.

Shortcomings of Traditional WLANs

To date, wireless VoIP has been problematic. The root of the problem: the 802.11 standards the application is based on weren't designed to support voice. Therefore today's common wireless VoIP infrastructure lacks the ability to deliver:

Scalability

The 802.11 standard includes a mechanism called carrier sense multiple access with collision avoidance (CSMA/CA), which poses a serious scalability problem for wireless VoIP. A look back at how the technology evolved helps clarify the issue.
Unlike 802.3 Ethernet systems, clients cannot automatically sense when they are within range of each other, and they may begin transmitting at the same time, causing collisions. To address this, IEEE developed the Carrier Sense Multiple Access/Collision Avoidance (CSMA/CA) protocol.

[1] Also see the Foundry Network s White Paper, *Wireless LANs in Higher Education*

This collision avoidance mechanism is a modification made to adapt Ethernet principles to wireless networking. The collision avoidance mechanism is contained within every wireless data packet and stations essentially do their best to listen for transmissions and avoid collisions.

The problem is the scheme is largely inefficient when applied in situations where multiple clients are active. Like the Ethernet hub, which will cause wireline performance to degrade considerably in well populated networks, current wireless LANs are subject to prohibitive scalability issues. When a large number of clients are active, typically five to ten, running either voice or data, the network bogs down as the stations constantly collide, back-off, and wait.

A common misconception is that increasing the WLAN bandwidth (say upgrading from 8021.11b 11 Mbps to 802.11g 54 Mbps) takes care of the problem; however the collision avoidance problem remains. Increasing network bandwidth doesn't prevent the transmissions from colliding. Without an access methodology capable of managing contention, your wireless VoIP "mileage" will vary. The simple fact is the infrastructures proposed by most wireless vendors are inherently unscalable.

Quality of Service

Voice services are very sensitive to digital transmission errors. When transmitted over data networks, lost packets and retransmissions due to heavy traffic loads increase "jitter" in the signal recovery thereby causing clicks, silent periods, and poor voice quality. Each packet lost results in more significant signal degradation.

Without an infrastructure that supports over-the-air QoS, predictable toll-quality voice is impossible to achieve. Some companies respond by deploying two separate wireless infrastructures, one dedicated to voice and the other dedicated to data access. Obviously, this approach is far more expensive for both up-front investments and recurring operating costs.

A new IEEE 802.11 standard, 802.11e, is being developed to address over-the-air (Layer 2) QoS in wireless networks. As it is currently being specified, 802.11e will be useful for home and small business networks, but insufficient for enterprise scale applications. WMM Quality of Service (or IEEE 802.11e EDCF) provides prioritization based on traffic classification from the wireless LAN access point to the client as well as from the client to the access point. This provides prioritized channel access on the upstream direction; however it does not scale up with large numbers of WMM voice clients. This is due to the fact that in a high voice density system with lower backoffs used for the high priority, the chance of a collision is actually worse than with standard non-WMM DCF.

Therefore, with high numbers of active WMM voice flows, this will create contention that can impact voice quality. Additionally on the downstream direction, since the access point would fall into the same WMM priority queue with lower backoffs for the voice flows, it will be contending equally with all of the voice clients that are sending upstream traffic.

In addition, it is important to note that this standard does not address several important areas. 802.11e does not provide Quality of Service on a per application basis. This means that if a laptop is simultaneously running a soft phone for a wireless VoIP call as well as checking email, the device receives the high priority assigned to it, not just the voice application. This situation worsens contention.

Usability

VoIP has gained popularity in the enterprise because it eliminates the need for two separate wired networks. With QoS and traffic management, voice and data can co-exist on a wired network. However, wireless VoIP presents three problems.

Installation and maintenance

Because typical WLANs cannot provide the QoS and contention management functionality to allow voice and data to co-exist, most vendors recommend a dual deployment solution. After planning RF coverage, power, and deployment for a wireless data network, the entire process must then be repeated for voice. Separate equipment is deployed and set-up to operate on different channels. Co-channel interference in wireless makes this process much more complicated. This approach creates the very problem VoIP was invented to eliminate: deploying and maintaining two separate networks.

Clearly, this is a step in the wrong direction. Managing and maintaining two networks instead of one is a big problem when dealing with the dynamics of the RF spectrum.

To install and maintain separate networks results in added complexity which increased equipment costs, and increased cost of ownership.

Handoff

In cellular voice networks, the network decides which cellular site the voice client is communicating with. Load is automatically balanced. However, in 802.11 wireless networks, the client controls the decision. This poses some major challenges when building a voice network, especially in an enterprise where multiple APs are deployed.

A client may choose to move to an access point that could deliver better reception, but the decision could backfire. The access point (AP) may be over-loaded with traffic and therefore provide poor voice performance. Additionally, when a client is between two APs it may experience a period of "indecision" where it is subject to a "ping-pong" effect caused by transmissions bouncing back and forth between APs. These issues result in poor voice quality and deployment hassles.

Delay is another problem associated with handoffs that affects voice network deployments. The process defined by 802.11 for de-association and re-association (the two steps involved in handing off) can take anywhere from 150 to 500ms. The maximum allowable delay in order to reconstruct a proper voice signal depends on the CODEC being used, but is typically 30ms or less. This is a major voice-quality issue that WLANs need to address.

Battery life

Battery life on client devices presents another serious problem. A typical cellular phone operates in a "sleep" or "standby" mode and "wakes" when it is time for transmission. The phone's battery therefore is capable of providing many hours of "standby" time (typically 4 to 8 days). When a cellular phone is in "talk" mode, handsets understand that voice packets will arrive very periodically (typically every 30ms). Because of this predictability, voice handsets are able to stay in "sleep" mode between packets and conserve power.

In an 802.11 voice network, clients need to be continuously awake. Given the unpredictable nature of transmissions with 802.11, handsets are unable to sleep between packets because there is no set time for the arrival or transmission of data. Because they are essentially "always on," wireless VoIP client devices have low battery life.

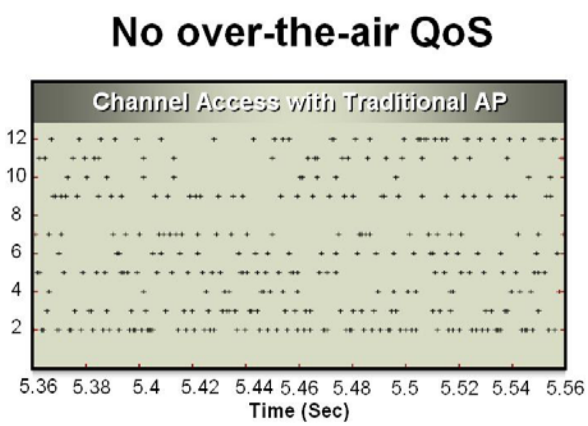
Foundry's IronPoint Mobility Series: Best in class performance for wireless VoIP

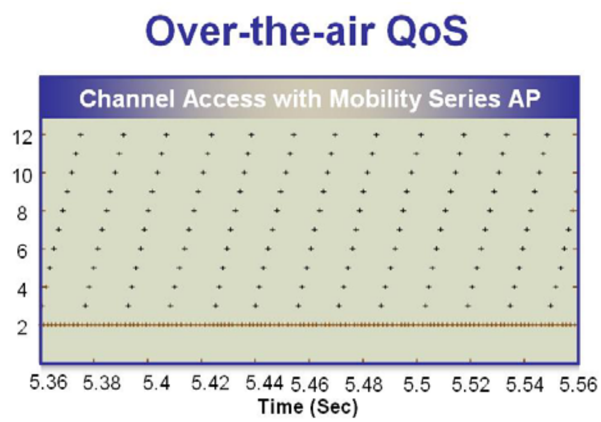
A number of companies in the WLAN market promote WLAN "switching" as a potential solution for deploying wireless to satisfy the requirements of data and real-time applications including voice. The reality is that the emerging switch-based architecture has proven effective in addressing some problems, particularly security and management. However, a switching architecture itself will not necessarily address the many QoS, scalability and usability problems discussed in this paper.

The good news is that a WLAN solution exists and provides the robust feature set required to support toll-quality wireless VoIP applications. Foundry Networks has developed an evolutionary, standards-based WLAN architecture featuring Over-the-air QoS. Over-the-air QoS breaks the technology barriers of 802.11 to provide the ideal platform for a wireless VoIP-enabled network.

Channel Access Compared

Depicted below are representations of channel access patterns for a single AP WLAN supporting twelve voice calls.





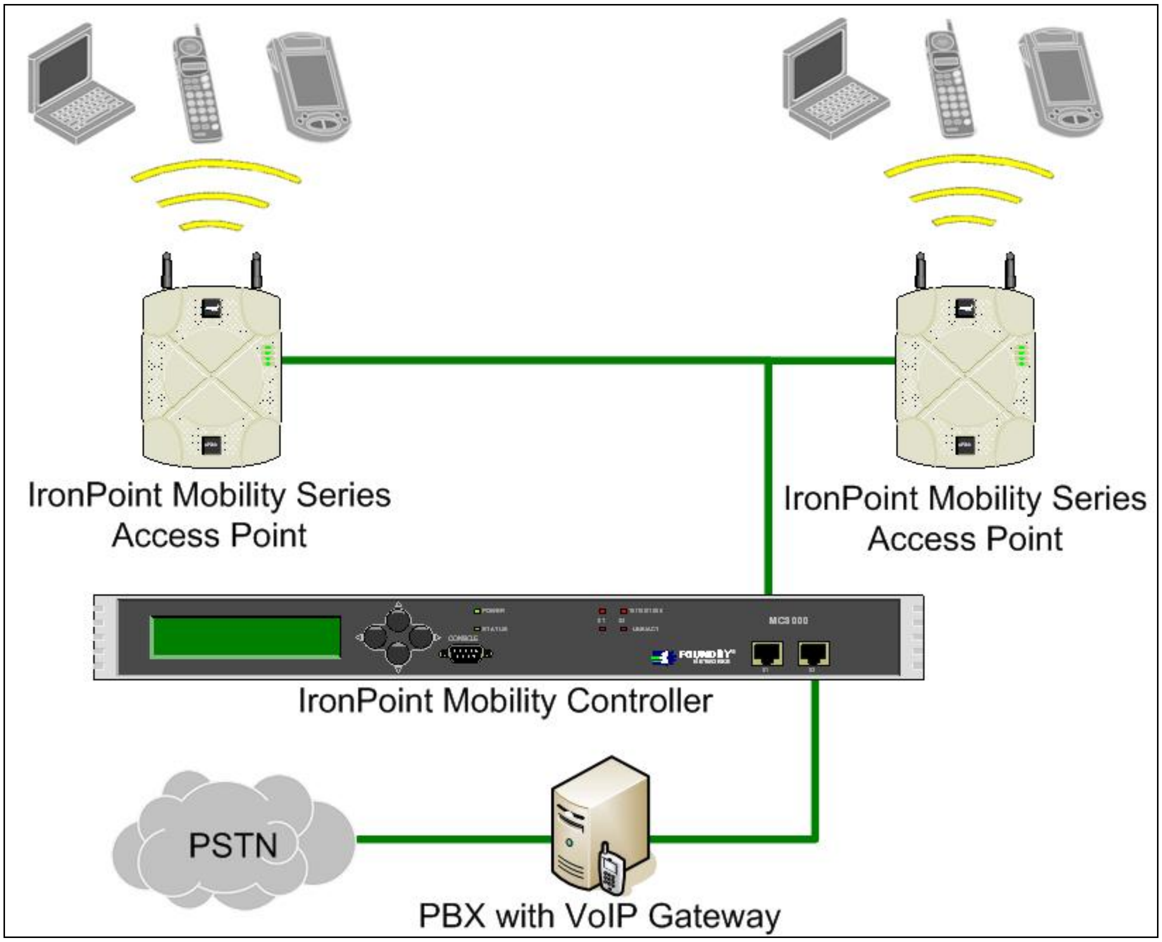
Because they're not capable of providing over-the-air QoS, traditional WLAN systems experience unpredictable latency and jitter as a result of random channel access. The AP is treated like any client and is therefore not allocated the bandwidth it needs.

Foundry's IronPoint Mobility Series overcomes latency and jitter issues by using near-deterministic channel access to deliver Over-the-air QoS. Traffic types are automatically detected to apply QoS policies for a dynamic mix of voice and data with support for up to five times more voice calls per AP.

The IronPoint Mobility Series provides the service quality, scalability and usability required for wireless VoIP implementations. Contention loss is eliminated. Jitter and latency are low and predictable. Handoffs are eliminated. Wireless VoIP clients gain the ability to sleep between beacons and between packets.

Wireless VoIP Architecture with IronPoint Mobility Series

The wireless VoIP architecture consists of the IronPoint Mobility Controller and IronPoint Mobility Series APs that leverage Over-the-air QoS. The IronPoint Mobility Series APs connect via any L2/L3 network to the IronPoint Mobility Controller and communicate with standard Wi-Fi clients. The IronPoint Mobility Controller delivers the highest level of security available, provides application flow-detection and QoS for SIP, H.323, Cisco Skinny Client Control (SCCP), Spectralink and Vocera protocols.



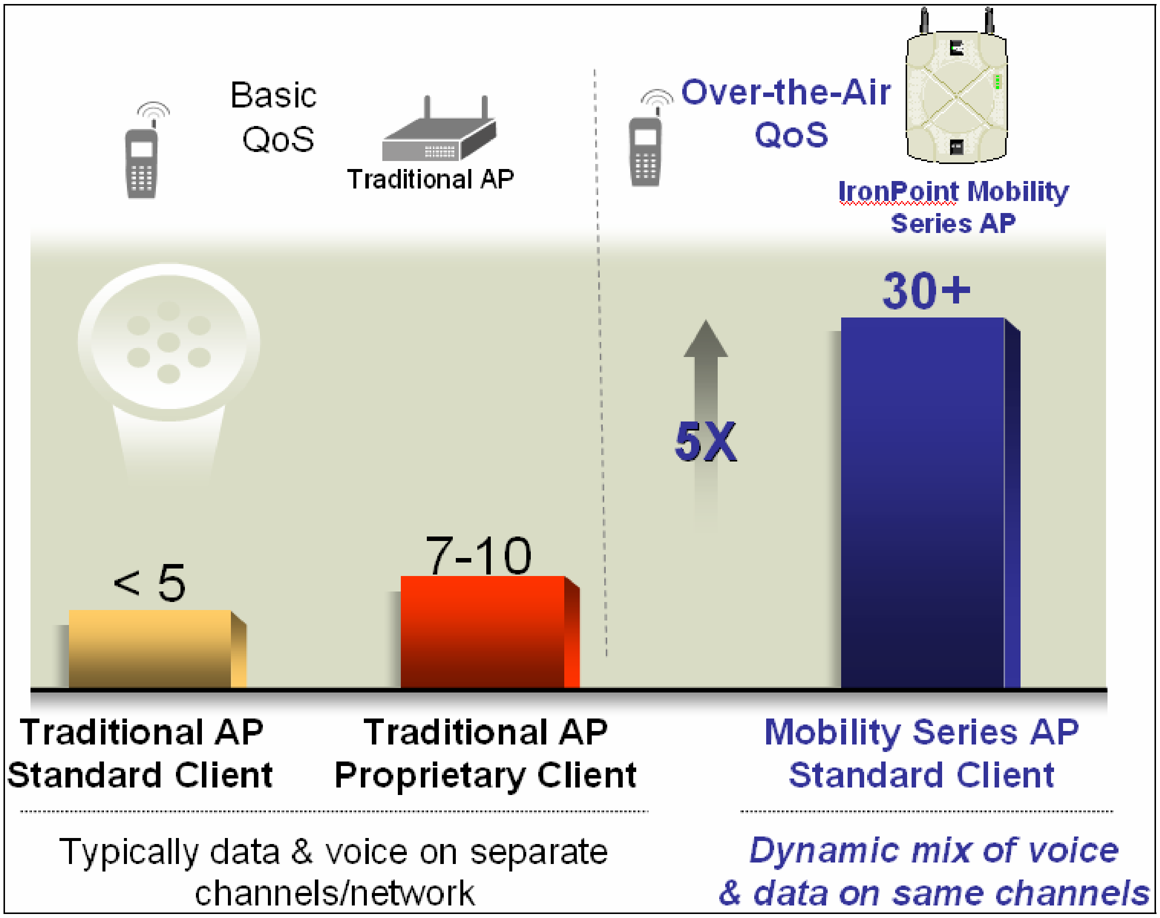
Scalability

With Foundry's IronPoint Mobility Series architecture, access is optimized to provide a constant, maximized throughput from each access point. Over-the-air QoS works at the 802.11 MAC layer to manage contention and effectively exert more control over client access (similar to a cellular network). This same technology establishes a time-based, near-deterministic channel access method, which divides the single large collision domain (air) into many, smaller, time-based collision domains. Under this governance, when a client needs to transmit, it is queued into a time slot for optimal throughput. The clients contend for the channel only at their designated time. If the client has no data to transmit, it is not assigned a time slot, increasing the effective channel usage.

With deterministic channel access methodology in place, a single access point can effectively handle over 100 active clients and maintain maximum throughput from the AP.

Quality of Service

Over-the-air QoS allows for non-blocking voice calls and real-time applications. By using Over-the-air QoS instead of putting a client into a time slot with multiple contenders, the infrastructure recognizes a voice call and creates a time slot in which there are no other contenders. During the time slot in which the voice call is transmitted, the infrastructure schedules other contenders to transmit at a different time and creates non-blocking access to the channel for the voice call. Under this methodology, Foundry's IronPoint Mobility Series is able to achieve 30 voice calls on a single 802.11b AP.



Foundry's unique channel access solution and ability to implement both upstream and downstream QoS result in unparalleled wireless voice quality. Independent tests have verified that calls made on the IronPoint Mobility Series achieve a Mean Opinion Score (MOS) of greater than 4.0 — the minimum score required to be considered true land-line quality.

The IronPoint Mobility Series is certified by the Wi-Fi Alliance for complete enterprise interoperability and works with any Wi-Fi Certified™ client or phone. The Over-the-air QoS mechanism is also compatible with the 802.11e standard, so it will deliver even higher performance in 802.11e networks.

Usability

Foundry Networks has created the only solution to address the numerous usability issues in deploying a wireless VoIP solution. Because the IronPoint Mobility Series solves the contention and QoS issues, a single network supports a dynamic mix of voice and data. The complexity, costs and management headaches associated with planning, deploying, and maintaining two separate wireless networks for voice and data are eliminated.

Deployment and management is further eased because the IronPoint Mobility Series' Virtual Cell[2] capability has full understanding of the RF spectrum and traffic load on the system. The system will adjust power levels so, upon installation, the APs recognize each other, create a single virtual cell, and optimize RF coverage. If an AP fails, the IronPoint Mobility Controller automatically

[2] Also see the Foundry Networks White Paper, *Virtual Cells: The Only Scalable Multi-Channel Deployment*

readjusts surrounding power levels to maintain continuous coverage until the problem is fixed. Because the network is self-configuring, self-healing, and has over-the-air QoS, there is no RF planning required. Nor is there ever any need to redeploy, upgrade or add equipment to support voice.

Handoff issues are resolved because IronPoint Mobility Series Access Points provide zero handoff delay. Clients see multiple IronPoint Mobility Series APs as one virtual cell, which takes control of handoff decisions. Therefore, handoffs occur with no-loss and the "ping-ponging" effect is eliminated. The IronPoint Mobility Controllers also balance traffic load across APs. If a single AP is overloaded, stations will be passed off to a less loaded AP so voice communication continues uninterrupted.

Lastly, power consumption issues are also resolved. Because channel access is predictable, the clients can operate in a "standby" mode and awaken only when it's time to transmit or receive data. The phone's ability to sleep between beacons extends standby time. Because of the predictable network access, handsets are able to sleep between packets — thereby extending talk time. With IronPoint Mobility Series in place, battery life is substantially extended, which enables the development and use of smaller, lighter handsets.

Conclusion

Though wireless VoIP has great promise to increase productivity and lower costs in the enterprise and across many vertical industries, today's common wireless VoIP infrastructure falls short of meeting the full set of requirements. The solutions most vendors are bringing to market lack scalability, fail to provide QoS, and do little to overcome the numerous usability issues.

The same cannot be said for Foundry Networks. Foundry has developed an evolutionary WLAN architecture to allow enterprises to finally realize the tremendous potential of wireless VoIP. The IronPoint Mobility Series provides the scalability, service quality, and usability required for wireless VoIP implementations. The IronPoint Mobility Series Access Points and Mobility Controllers deliver the ideal platform for robust, multi-service wireless VoIP networks, with simultaneous support for data.

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