white paper

December 2014

Wi-Fi Calling Goes Mainstream

USING SMART WI-FI TO DELIVER A CARRIER-CLASS VOICE OFFERING

Introduction

Everything that Apple does is big news in the mobile world, as they are at the top of the food chain. The announcement in September of 2014 that they are supporting Wi-Fi Calling on the iPhone sent shockwaves throughout the industry, and it certainly reinforces Wi-Fi's position as a cornerstone technology in the mobile world. Apple didn't invent Wi-Fi calling as it's been around in various forms for many years (Skype, Lync, UMA, etc.), but they have made it a mainstream technology by integrating it into their smartphones. Wi-Fi already carries close to 80 percent of smartphone data traffic according to the latest reports from Mobidia. Now with carrier-class Wi-Fi Calling, we can expect a great deal of smartphone voice traffic to also move over to Wi-Fi. This announcement does not bode well for voice-centric technologies like femtocells, which have always been a struggling market.

Figure 1: Mobidia Survey on U.S. Data Usage of Wi-Fi on Smartphones

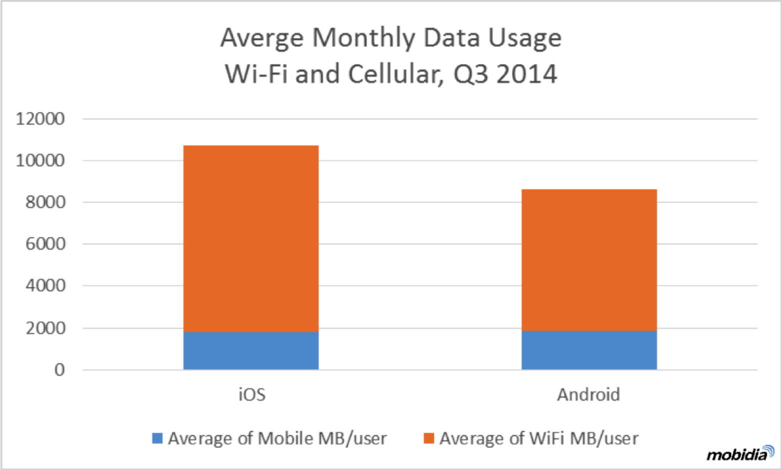

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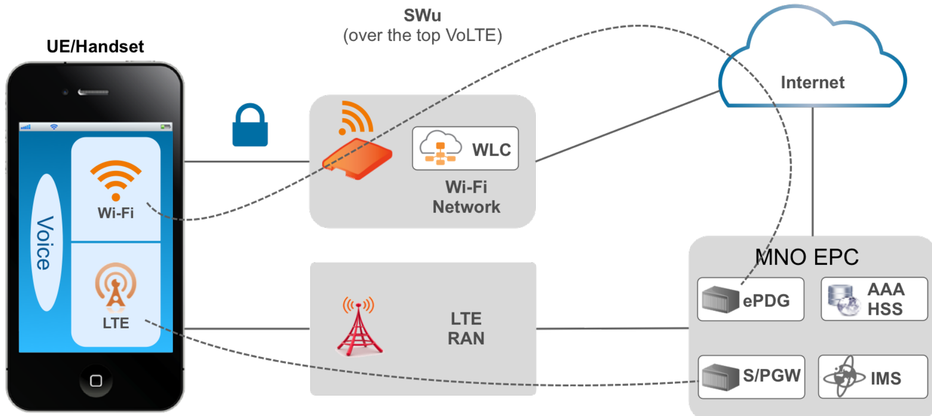
Figure 2: Tunneling Wi-Fi Calling Traffic into the Evolved Packet Core



So what exactly is Wi-Fi Calling as defined by Apple? It is the ability to place a cellular voice call using a cellular voice stack in a smartphone (in this case LTE) over a Wi-Fi network and then terminating it on the IP Multimedia Subsystem (IMS) complex in the mobile network operator's data center. This is very different from over-the-top services like Skype, because it is native to the smartphone (not a 3rd party app), and it works in exactly the same way that a voice call over LTE would work. It also supports seamless handoff as the user moves between Wi-Fi and cellular coverage areas.

So what is required for a MNO to support Wi-Fi Calling? The Apple solution utilizes the GSMA's IR-92 Profile for VoLTE (Voice-over-LTE), which has an option that allows the entire LTE stack to be tunneled over Wi-Fi using IPsec. This is very similar to unlicensed mobile access (UMA), which tunnels the entire GSM voice stack over Wi-Fi using IPsec. In both cases, the voice stack is encrypted in the handset before being sent across the Wi-Fi network. The payload then needs to be decrypted in the MNO data center using an ePDG Gateway (and vice versa for traffic going the other way). The ePDG is a massively scalable IPsec concentrator that then tunnels this traffic into the evolved packet core using the GPRS tunneling protocol (GTP).

Since all VoIP traffic is encrypted, the Wi-Fi access network can't see the payload and has no idea what is going on here… almost. Ruckus has the ability to prioritize Wi-Fi Calling traffic by looking at the TOS (type of service) bits set by the smartphone in the IP header, or by using heuristics. In the latter case, Wi-Fi Calling traffic is detected by looking at the size and frequency of packets in a flow (even an encrypted flow). This combination of capabilities in a Ruckus Zoneflex access point is known as SmartCast(™). When this is combined with Ruckus' Adaptive Antenna Technology, the result is a very compelling Wi-Fi Calling experience in almost any situation. Adaptive antennas can increase the signal gain as seen by the user's device, which of course leads to a much better voice experience. This combination of technologies is essential to the delivery of a true low-latency, low-jitter carrier-class Wi-Fi Calling experience. Since this is a carrier-class offering, MNOs can charge for this service in much the same way they charge for voice-over-LTE calls. It also enables the MNO to provide a much better overall voice experience by leveraging both LTE and Wi-Fi radio access networks, and there will always be situations where Wi-Fi simply provides a better signal.

So what else must an MNO do to implement Wi-Fi Calling besides deploy an ePDG? They need an evolved packet core to terminate traffic coming from the ePDG and they need an IMS complex, as VoLTE is only defined for IMS. Can a non-MNO also provide a Wi-Fi Calling service using IR-92? The answer here is yes, if they have an EPC, an IMS complex, smartphones, SIM cards, and an HLR to authenticate the user. A non-MNO can always provide the Wi-Fi access network that is used to tunnel Wi-Fi Calling traffic from the user back to the MNO's home network, and it can enhance that experience by prioritizing voice packets. As with other Wi-Fi Calling solutions, IR-92 based implementations can be used to eliminate voice roaming charges when placing calls from anywhere in the world.

Preparing the Network to Offer a Carrier-Class Wi-Fi Calling Experience

So what must service providers do to insure that their Wi-Fi network is ready to support a carrier-class Wi-Fi Calling experience? There are several elements to a successful deployment.

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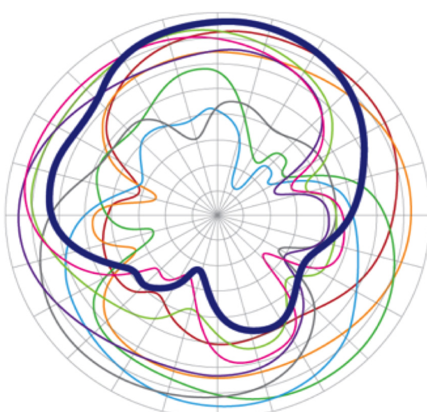
On the Importance of a Strong Radio Signal

Everything starts with a really strong radio signal. To this end, Adaptive Antenna Technology was developed for the transporting of delay-sensitive video and voice traffic over Wi-Fi.

Adaptive Antenna Technology provides a much stronger signal as seen by the user's smartphone, which equates to a better modulation and coding scheme (MCS). A better MCS means higher data rates, and a higher data rate means it takes less time to send a specific amount of data (or voice) allowing client stations to spend less time accessing or fighting for access to the Wi-Fi medium. It also reduces contention for the RF channel, as well as reducing the likelihood of collisions (increased jitter), frame loss, or packet retransmissions (increased latency). In other words, providing a stronger signal at the smartphone increases the overall airtime efficiency of the device for sending voice as well as other types of traffic.

Figure 3: Enhancing Downlink Performance with BeamFlex Adaptive Antenna Technology

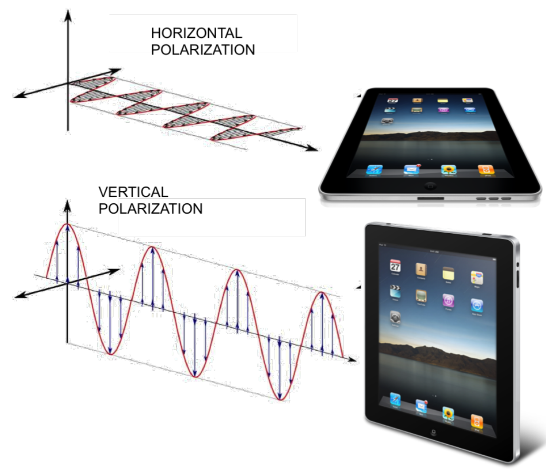


Adaptive Antenna Technology does this by dynamically adjusting the antenna pattern for each and every packet transmitted. This is under the control of sophisticated software and has the result focusing RF energy towards the intended receiver. This results in up to 6 dB of additional signal gain as seen by the user's device.

In addition, smart antennas help mitigate interference by only directing RF energy towards the intended receiver and not simply blasting it everywhere. The impacts from the increased receiver gain and interference mitigation are cumulative and quite pronounced in dense deployments, such as office buildings or high-capacity public venues.

Another important innovation benefiting Wi-Fi Calling is the ability to enhance the uplink signal from the client to the AP by receiving the client's signal on both horizontally and vertically polarized antenna elements. When polarization diversity is combined with maximal ratio combining (PD-MRC), the end result can be up to 5 dB of additional gain. This is especially important when considering single stream/single antenna mobile devices (the vast majority of smartphones and tablets, including all models of the iPhone), which transmit with a single polarization.

Figure 4: Enhancing Uplink Performance with Polarization Diversity



Adaptive smart antenna technology is able to effectively extract or construct the strongest possible Wi-Fi signal regardless of the client's orientation relative to the AP. Because real-time voice is inherently bidirectional, it is important that both the downlink and uplink support the best possible MCS and highest possible data rates.

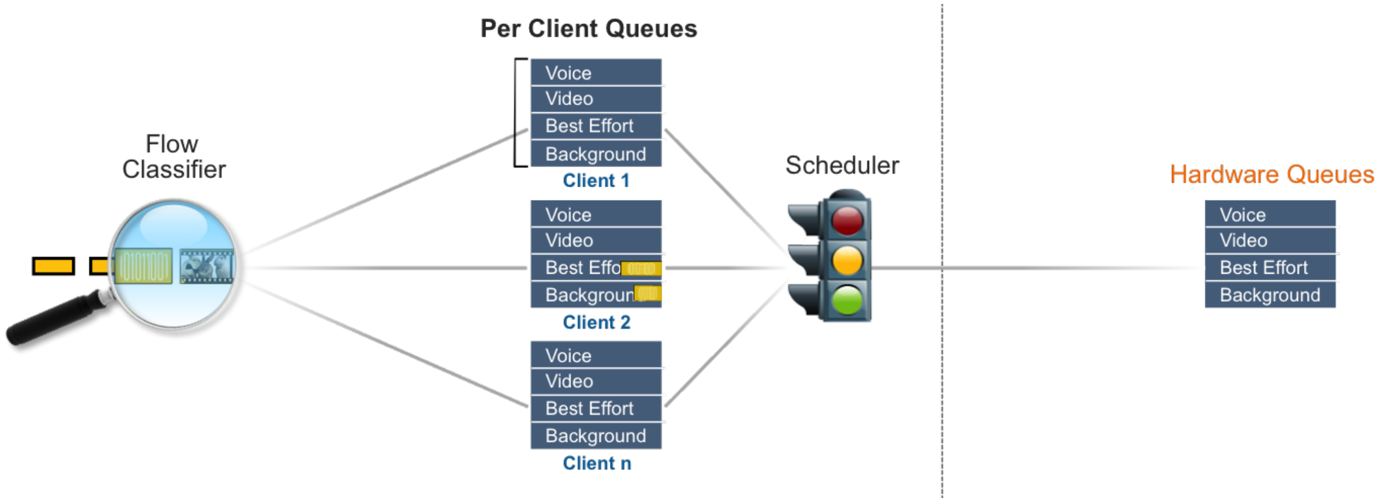
Prioritizing Voice Traffic with SmartCast

Getting a strong signal is only the first step -- next comes prioritizing flows through the Wi-Fi access network. There are several methods by which an encrypted flow can be prioritized so as to guarantee a high-quality voice call and they are all part of the Ruckus SmartCast feature.

At the heart of SmartCast is a sophisticated traffic inspection, classification, and optimization engine that works in software to provide per-client, per-traffic-class queuing.

The SmartCast quality-of-service (QoS) engine inspects each packet and automatically classifies it into one of four queues — voice, video, best effort, and background. SmartCast can inspect

Figure 5: SmartCast Smart Scheduling of Low-latency Voice Traffic



a variety of headers including those of Ethernet frames (both TCP and UDP), VLAN tags, and IPv4 and IPv6 packets.

If the type-of-service (TOS) or 802.1p priority field is used, SmartCast maps packets to an equivalent internal field. If no tag is provided, SmartCast employs heuristics to classify traffic. With heuristics based quality-of-service techniques, Wi-Fi Calling flows can be detected by looking at the size and frequency of packets in a flow, even an encrypted flow.

Once classified and queued, traffic is scheduled using a weighted round robin method based on airtime and throughput potential as well as prioritization defined for the WLANs. Rate limits can also be applied on a per-WLAN basis for every client.

The net result is that SmartCast can maximize the reliability and performance of delay-sensitive Wi-Fi Calling traffic by minimizing jitter and latency.

Fast Handoff

Fast Handoff emulates a wonderful feature of cellular networks, which is the ability to rapidly handoff a user as they move from AP to AP in the coverage areas. There is no need to re-authenticate since their credentials follow them as they move. This is an especially useful feature when using Wi-Fi Calling while on the move, as any significant delay in the handoff will be noticeable.

Call Admission Control

Capacity Based Call Admission Control is designed to block new users from associating when there isn't enough network capacity to support them. This is important for Wi-Fi Calling applications that must have access to the airlink in a timely fashion in order to function properly.

Conclusions

Wi-Fi Calling has been around for many years, and in many flavors, but now with Apple's commitment to IR-92 based Wi-Fi Calling, it has finally become a mainstream carrier technology. The key to enabling a true carrier-class service is to make use of a carrier class Wi-Fi network infrastructure. This requires Adaptive Antenna Technology to guarantee that the user's device gets the strongest possible signal, mechanisms to prioritize voice traffic even when it's encrypted, fast handoff to keep users talking while they move around in the coverage area, and call admission control to limit the load. With Ruckus Smart Wi-Fi technology, carrier-class Wi-Fi Calling is now a reality.

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