White Paper

Wireless Ultrasound

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Introduction

Over the past fifteen years, the use of diagnostic ultrasound has seen a dramatic shift. This is particularly evident in the point-of-care (PoC) segment, where patients are imaged without the need for an appointment, such as for bedside diagnostics, traumatic evaluation, or guidance during a medical procedure. This trend has seen ultrasound systems get much smaller, going from 300lb push carts down to 10lb laptop-style devices. As the systems shrank, so did the prices: traditional radiology or cardiology systems can cost upwards of $150,000 to $200,000, while new PoC systems range from $25,000 to $50,000.

State-of-the-art PoC ultrasound still relies on traditional technologies, which have been miniaturized using new integrated circuit (IC) fabrication techniques, and use traditional coaxial cables to attach an imaging probe to a processing and display system. This model keeps costs relatively high and creates challenges for users, such as pocket portability and access to equipment. An ultrasound that has multiple probes attached is more susceptible to damage and cleaning issues, and often requires additional training because of operator console complexity. Current prices of PoC ultrasound are also prohibitive for many individual doctors and clinics who are unable to afford the up-front costs. For these reasons, much of PoC ultrasound has stayed in the hospital systems where capital budgets for ultrasound are easier to get, and where training programs are often put in place.

Clarius' ultra-portable technology helps bridge the new gap that PoC ultrasound has created by leveraging novel wireless and System-on-Chip (SoC) technology to drive down costs while keeping a standard of imaging that is comparable to or better than many of the mid-range PoC systems on the market today.

Fig. 1
Trend of increasingly smaller ultrasound systems, moving from cart-based to laptop to handheld

Cutting the Cord

Over the past several years, as smartphones became a cornerstone technology, one of the most common questions asked by doctors using or wanting to use ultrasound is, “When will I be able to use my iPhone to perform an ultrasound?”. As many PoC systems use customized tablet devices, it’s natural to progress using ultrasound on a smartphone. Unfortunately, these tablet systems contain a lot of customized electronics which do not lend themselves well to simply plugging into a smartphone. Clarius’ model of wireless ultrasound completely negates the need for any smart device or tablet to have specialized electronics to perform an ultrasound.

An ultrasound powered through a cable attached to a smart device has to adhere to limitations such as data transfer speeds and power consumption. This makes it challenging to develop an ultrasound that plugs into an iPhone. Clarius’ technology uses wireless transmission to stream to any smart device by taking advantage of standard built-in Wi-Fi and Bluetooth capabilities. Powered through a rechargeable battery, Clarius scanners do not draw power from the smart device itself, which would drain its battery more quickly, and being cordless means scanning can be performed anywhere within an examination room, even if the smart device is mounted on a wall opposite from the operator.

Quality of Service

Wi-Fi signals are typically reliable when set up properly, but having too many in one place, or being out of range from a hotspot can yield poor performance, leading to inconsistency in quality-of-service (QoS). When using ultrasound over Wi-Fi, some of the potential pitfalls are:

- Line of sight problems due to range or obstructions
- Reduction of frame rate due to network traffic or latency
- Reduction of image quality due to lossy compression to move data more reliably

Clarius addresses these problems by using a dedicated Wi-Fi Direct mode where only a lossless compressed ultrasound image is streamed over the channel without worrying about other network traffic. Another advantage of Wi-Fi Direct mode is that it can be used when there are no Wi-Fi access points available. The scanners perform 99% of the processing on the ultrasound unit itself, with only some minimal geometric reconstruction happening on smart device. This enables highly compressed images for bandwidth optimization over the wireless channel. Test results have shown that an ultrasound image can be streamed simultaneously on a single network to up to ten smart devices using ClariusCast technology.

With WiGig and Bluetooth, line of sight can often interfere with wireless signals, resulting in reduced QoS if there is an obstacle between the ultrasound and the smart device. By using 5GHz Wi-Fi technology, Clarius' signal is strong enough to pass through most barriers and provides enough bandwidth for streaming images in real-time.

Another challenge is co-existence, as many Wi-Fi networks that exist within the same physical space can end up competing for a given frequency. Network equipment like wireless routers use real-time frequency-hopping to help minimize frequency overlap, and Clarius scanners use a similar method when booting up to choose the best channel or frequency with the least amount of competition. With 5GHz Wi-Fi, the 802.11 standard ensures that there are always at least eight channels to choose from, and it is extremely rare that all channels have competition with high levels of traffic that may affect signal quality. Even at large trade-events where hundreds of Wi-Fi networks co-exist, Clarius devices perform with little to no performance degradation.

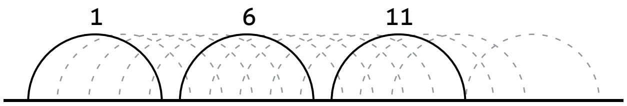


Fig. 2
The 2.4GHz spectrum, which has only 3 non-overlapping channels

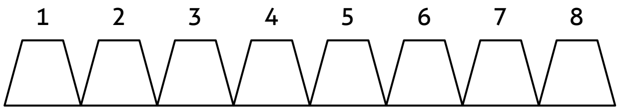
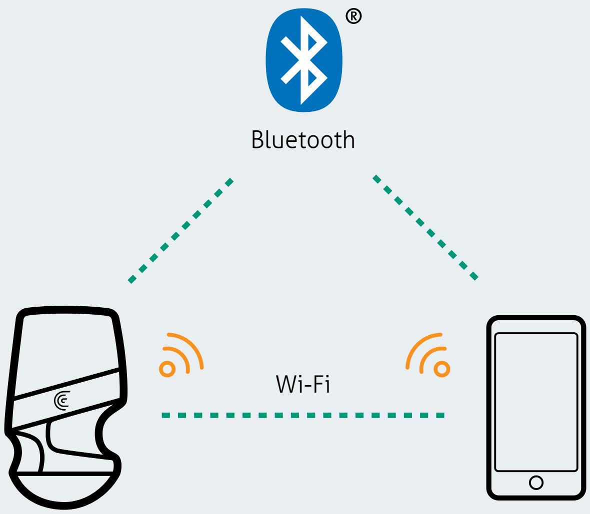


Fig. 3
The 5GHz spectrum has 8 non-overlapping DFS channels

The Role of Bluetooth

Bluetooth plays an important role for Clarius scanners by allowing each device to be in a low power state while the battery is attached. When users open the Clarius App on their smart device, they'll immediately see any ultrasound scanners that are available for use through Bluetooth Low Energy signals, similar to a Bluetooth headset or speaker that makes itself available to connect to. Once a scanner is selected, the scanner then boots to a higher power mode to begin imaging, and the Bluetooth connection provides an out-of-bounds (OOB) method to configure Wi-Fi, so that an existing network or Wi-Fi Direct can be chosen, depending on the use model.

Fig. 4
Bluetooth network



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