Overloaded spectrum

With the rising number of connected devices, how do we hold onto good Wi-Fi performance? **Bethan Grylls** investigates

The number of connected devices is increasing and with this comes the problem of an overcrowded network, threatening the user's connectivity experience and device performance. The industry is hoping a new Wi-Fi Standard, known as 802.11ax, will provide an answer.

"This rise in connected devices will strain the network in terms of the number of devices that need to be supported simultaneously, the need for more capacity, and the need to provide coverage everywhere – near the Access Point (AP)/basestation, or cell edge," comments Qualcomm's Vice President, Connectivity Networking BU, Irvind Ghai.

Currently, most Wi-Fi solutions are based on 802.11ac – a wireless networking standard developed by the IEEE Standards Association. This provides wireless local area networks (WLANs) on two frequency bands – 2.4GHz and 5GHz.

The 2.4GHz band is used mostly by older devices and allows data rates to travel a farther distance than 5GHz, however, it's an extremely crowded channel. By contrast, 5GHz offers faster speeds, but is restrained by range restrictions. This particular predicament gave rise to Dual-band, offering access to both channels.

Most APs are currently 4x4 802.11ac, supporting multiple input multiple output (MIMO) that allows transmission or reception of data on all four antennas at any given time and improves range and reliability.

With the second wave of 802.11ac, came the addition of multi-user (MU) MIMO, allowing multiple clients to be serviced simultaneously and a 2.5x capacity boost. A quality which helped with the Wi-Fi experience and performance, but hasn't exploited their full potential.

According to Ghai, the problem lies in the fact that with 802.11ac, the radio has to use the entire spectrum available in a channel to transmit or receive data at any given time slot.

Now, the Wi-Fi standard is moving to 802.11ax – which has not yet been ratified, but is already being implemented by the likes of Qualcomm. With its focus on both the APs and client devices, Qualcomm's 802.11ax portfolio includes the IPQ8074 System-on-Chip (SoC) for network infrastructure and WCN3998 11ax-ready client platform.

Connected experiences

The goal is that an 802.11ax system will improve connected experiences, delivering up to 4x greater capacity to make Wi-Fi traffic more efficient, improve coverage and offer longer battery life for Wi-Fi devices.

Above: Marvell Semiconductors is introducing an 802.11ax solution for connected cars, featuring 2x2 plus 2x2 concurrent dual Wi-Fi, dual-mode Bluetooth (BT) 5/BT Low Energy and 802.11p

According to Ghai, it supports 12 streams (eight 5GHz and four 2.4GHz), 8x8 Mu-MIMO which offers advanced 8x8 sounding mechanism – the ability for multiple antennas to act concurrently – as well as 802.11ax 80MHz channel support.

"For a 1x1 client that is typically challenged on the uplink," Ghai says, "an 8x8 can also provide 3dB better sensitivity over a 4x4 802.11ac AP due to twice as many antennas. In addition, improvements in radio design has further boosted receive sensitivity of the receiver, resulting in an overall 5-6dB improvement."

Ghai describes 802.11ax as a technology that "builds upon the foundations ac has laid," through the inclusion of uplink (UL) MU-MIMO, Orthogonal Frequency Division Multiple

Access (OFDMA) support and traffic scheduling.

"OFDMA is the way in which the spectrum is being used and this is the first time a cellular-feature like this has been brought into the Wi-Fi standard," he explains. "It means the channel can be 'broken' into smaller bits – allowing for up to 37 clients be serviced at any given time, resulting in a more efficient use of spectrum."

802.11ax also brings in a managed approach of resource allocation, optimising wake-up time and reduces Wi-Fi power consumption by two thirds, resulting in extended battery life without adverse effects on performance.

"Qualcomm is focused on making the 8x8 architecture that meets the customer's system cost and power requirements," Ghai says. He points to Power over Ethernet (PoE) as the key. But, this can be a challenge as 8x8 naturally consumes more power. "We can overcame this," he continues, "by moving the silicon to a 14nm process and implementing power save modes. So, for example, when a certain core is not in use, it can be shut down to save on power dissipation and improve the overall thermal characteristics."

Qualcomm is working towards architectures on even more advanced process nodes. At The Small Cells World Summit earlier this year, it announced the "industry's first" 5G NR solution targeted for small cells and remote radio head deployments (FSM100xx).

"The 5G small cell is 10nm and even further advanced," Ghai contends.

"Shrinking the node means we can pack more functionality in a form factor and power envelope that can be used in carrier gateway or enterprise AP," he says. "Particularly, many enterprise APs are PoE, and, as a result, have strict power budget requirements. Going to 14nm has allowed us to add quad core ARM processors, offload engine, 10G interface and 12 chains of 802.11ax - all in a single chip.

"The challenge lies in leading the industry transitions and making the required investment in innovation and R&D. Fortunately, Qualcomm has been a leader in going to new process nodes on modem and application processor for smartphones. We are able to leverage that R&D investment to provide the same benefit to connectivity and networking products."

Building upon its original FSM for 3G and 4G small cells, this new technology aims to support 5G NR in both mmWave and sub-6GHz spectrum and is designed to allow OEMs to reuse software and hardware designs across these types two of products.

Cell densification

According to Qualcomm, small cell densification will be vital for 5G networks as a means of supporting outdoor and indoor deployments – the latter of which supports the majority of data consumption. The higher frequencies of 5G NR result in a solution needed to support delivery of uniform 5G experiences everywhere – both indoors and outdoors, and the FSM100xx has been designed to address these needs with MIMO implementation and multi-gigabit throughput, compact form factor and PoE support.

5G NR small cells allow the operators to provide capacity and coverage surgically at the location where it is needed. "This is more cost-effective and scalable way to provide capacity for ex: it is easier to deploy a 5G NR small at a 'hotspot' location where most of the data is consumed as opposed to rely on expensive macro solution that also require site acquisition delays," Ghai adds.

"To solve the over-crowded network, we must rely on advanced techniques such as 802.11ax or 5G-NR which can support multiple devices simultaneously" Irvind Ghai

To combat the strain on the spectrum, Qualcomm has designed a solution to support multiple and simultaneous connectivity

Qualcomm isn't alone. Marvell Semiconductors is also introducing a 11ax solution. Designed specifically for vehicles, it features 2x2 plus 2x2 concurrent dual Wi-Fi, dual-mode Bluetooth (BT) 5/BT Low Energy and 802.11p for connected vehicles.

With 802.11ax expected to be rolled out in mobile phones as early as next year, Jeff James, Senior Director of Business Development at Marvell, says: "Delivering vehicles with the same capabilities is vital because customer expectations are increasing. They expect the same performance, security and reliability in all devices, including their cars. We're building the car for the future."

"The 802.11ax provides 40% higher throughout vs 802.11ac with 1024QAM, improves range by up to 50% through the use of dual carrier modulation and extended range, along with improving latency with OFDMA by ~6x," adds Avinash Ghirnikar, Director of Systems and SW, Marvell.

"To solve the over-crowded network, we must rely on advanced techniques such as 802.11ax or 5G-NR which can support multiple devices simultaneously," Ghai contends. "Alternatively, we can use advance MU-MIMO techniques in 5G-NR or 11ax to improve experience of every users by providing multi-gigabit throughput."

With the advent of technology like 802.11ax, industry is looking to resolve the problems associated with a crowded network. But, as advancements emerge, it's inevitable other problems will evolve too, and as James alluded to, as advancements develop, customer expectations will only increase further.