

60GHz – a critical frequency: some working notes

One factor that has slowed the spread of 5G is that Apple has so far not announced a 5G iPhone. Last year, a late 2020 launch was rumoured in the Japanese press, but not in the USA.

However the rumour mill is worth watching, as some commentators advance evidence that Apple will launch an iPhone with capability for both 5G (licensed frequency) and 60GHz (unlicensed in the UK).

60GHz wireless signals are also referred to as V-band and the wireless standard IEEE 802.11ay. ('WiGig', which confusingly has also been used as the name of a promoter organisation and an earlier wireless standard IEEE 802.11ad).

These notes cover a cross-section of reports and perceptions of:

Apple iPhone rumours and issues

Technical capabilities and links for 60GHz

Examples of creeping 60GHz in the health sector

Material investigating a health impact from 60GHz, above general concerns on polarised and pulsing microwave radiation.

They are not exhaustive and do not attempt to verify the accuracy of the technology reports and 'benefits' claimed.

Say No To 5G campaign (Hammersmith & Fulham), April 2020, (updated Sept 2020)

1. IPHONE RUMOURS AND ISSUES

NB regular rumour mills on <https://www.macrumors.com/> and <https://www.macworld.co.uk/>.

<https://www.forbes.com/sites/gordonkelly/2020/03/28/apple-iphone-12-upgrade-release-date-price-cameras-design-everything-we-know-so-far/>

What is certain is 5G will feature across the range with support for both mmWave and sub-6GHz bands. ...

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Apple is focusing this sensor on **Augmented Reality (AR)** and the results look astonishing
LINK

<https://www.forbes.com/sites/gordonkelly/2019/11/21/apple-iphone-2020-design-5g-upgrade-cellular-iphone-11-pro-max-update/>

In a new research note attained by the ever-excellent 9to5Mac, acclaimed Apple insider Mind-Ch Kuo has reiterated his claim that Apple will introduce 5G across the 2020 iPhone range while revealing it will not be any old 5G implementation.

<http://www.iphon hacks.com/2020/02/iphone-12-short-range-60ghz-wi-fi-ay-apple-glasses.html>

Apple has long been rumored to be working on AR (Augmented Reality) glasses, but the device hasn't made it to the market yet and some reports stated that the project was terminated. Now, a feature has been surfaced in the company's upcoming iPhones, which points towards Apple Glasses once again.

Recent reports have suggested that the iPhone 12 might feature short-range, Wi-Fi 802.11ay wireless connectivity that operates at the 60GHz frequency. While some might wonder as to why Apple might equip its upcoming smartphones with the relatively unpopular version of Wi-Fi, it could be a great idea for two things: **short-range data transfer between iPhones and AR glasses.**

<https://www.playerzdominance.com/iphone-12-may-have-60ghz-wigig-for-super-fast-wireless-connections/>

Higher data transmission speeds are vital for an immersive experience. Wi-Fi ay operates at 60GHz frequency and can transfer data at speeds of as high as 44Gbps. Four streams can be bonded to reach speeds as high as 176Gbps, which is more than enough to **transfer huge amounts of data with very low latency.**

This technology might also be used for an even faster version of AirDrop that Apple could use in its future devices. Why would you need faster AirDrop? Well, for starters, we all know that 4K videos have huge file sizes and with 8K video recording that could be coming to future iPhones, file sizes could go even higher. This is where the 60GHz-based AirDrop feature could be quite helpful.

[Apple's onetime chip partner Qualcomm has made moves in the direction of 60GHz.]
<https://www.cbronline.com/news/60ghz-chipset-qualcomm> (2018)
<https://www.qualcomm.com/news/releases/2018/10/16/qualcomm-dramatically-extends-wi-fi-experiences-5g-era-60ghz-80211ay>

QUALCOMM (AND FACEBOOK)

<https://www.cbronline.com/news/60ghz-chipset-qualcomm> 181018

Qualcomm and Facebook have been working in collaboration to deliver high-speed internet connectivity by developing a multi-node wireless system using the QCA6428 and the QCA6438 chipsets.

Facebook's connectivity lab has been working on a project named Terragraph which is a multi-node wireless system operating on the 60 GHz spectrum. Designed to be able to deal with **high data usage with a low-cost production** the system is built with off-the-shelf components. Terragraph then uses cloud services to handle any increase in data traffic and processing.

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Due to the fact that the **60 GHz signal has problems traveling over any kind of distant**, [sp] Facebook's Terragraph system designed for cities will have distribution nodes placed every 250 meters to carry the signal along, thus **allowing the signal to manoeuvre around buildings and any other obstacles** that can be found in urban settings.

Terragraph was reported as being targeted for launch in summer 2020.

<https://www.ispreview.co.uk/index.php/2020/06/facebook-prep-new-60ghz-terragraph-wireless-broadband-tech.html>

<https://www.qualcomm.com/news/releases/2018/10/16/qualcomm-dramatically-extends-wi-fi-experiences-5g-era-60ghz-80211ay> 161018

Qualcomm Technologies is the first-to-market with a 60GHz Wi-Fi solution with optimizations based on the 802.11ay specification,

As we lead the world to 5G, we envision this next big change in cellular technology spurring a new era of intelligent, connected devices and enabling new opportunities in connected cars, remote delivery of health care services, and the IoT — including smart cities, smart homes, and wearables.

2. TECHNICAL CAPABILITIES AND LINKS FOR 60GHz

A useful summary, aided by the CMO of Bristol trials company Blu Wireless Technology

<https://www.thinksmallcell.com/System/wigig-threat-or-opportunity-for-small-cells.html> 221112

WiGig (pronounced Y-Gig) is an organisation promoting the new 802.11ad wireless standard, one of many in the 802.11 series better known to most people as Wi-Fi. WiGig is similar to Wi-Fi except it operates at astounding speeds of between 1 and 7 Gbit/s over short range – typically 10m or so. As part of the 802.11 family of standards it is also backward compatible with the mainstream Wi-Fi bands at 2.4GHz and 5GHz, but it uses the much higher 60GHz band where the highest data rates are possible.

Many countries have assigned 7GHz or more of spectrum in the 60GHz band, and this is either unlicensed (like Wi-Fi at 2.4GHz today) or lightly licenced. For example, **in the UK and US, the 57 to 64GHz band is licence exempt**. The 64 to 66GHz band is lightly licenced in the UK, meaning that users should notify the regulator where and when they use the frequency but there is no fee for doing so. It simply allows awareness of existing use prior to installation and resolves potentially unusual cases of interference.

Transmissions at this frequency are inhibited due by oxygen (16 dB/km) and by any moisture in the atmosphere. The signal at these frequencies won't go through walls and probably won't even go through your body, so is really of greatest use for high speed transmission when in very close proximity. Think of WiGig as a wireless replacement for USB3.0 or Thunderbolt cables, allowing HD video to be streamed and enabling very fast data backups and/or sync between devices.

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Short range is an advantage after all

While the very short range of 60GHz spectrum might at first appear to be a disadvantage, the benefit is that the same frequencies can be reused close by. **Unlike Wi-Fi, you shouldn't expect to pick up your neighbour's WiGig signals** and can use it simultaneously in multiple rooms in your own house for different applications.

For the technically minded, where the line of sight link budget falls off by 34dB within 1 metre for 2.4GHz Wi-Fi, the same transmission at 60GHz WiGig is attenuated at 68dB – simply due to the higher frequency.

Therefore, the technology is great for short burst, high throughput transmissions. **You could download a full (30 Gbyte) HD video in less than 60 seconds. This makes it ideal for synchronising devices or downloading purchased content very quickly at a point of sale.** For example, at a major sports or entertainment event, you could download the "event program" (more likely to be a full HD app with all the bells and whistles than a paper leaflet) when buying your ticket at the door

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But wouldn't consumers using Wi-Gig interfere with metrocell backhaul if they operate at the same frequency?

That's not the case, says Mark Barrett, CMO of Blu Wireless Technology, who cites the substantial difference in performance between the two applications. "Metrocell backhaul would use high gain antennas with greater than 30dB of gain and less than 5 degree beam width, so that the probability of interference is already low. They will be scaled down to run at hundreds of Megabits over several hundred metres, where consumers will [be] passing Gigabits over one or two meters. "Interference from these short range transmissions will be insignificant when more than a few metres away.

"In the UK, the lightly licenced 64-66 band may be used for backhaul and other commercial use, **leaving the licence exempt 57-64 band for mass consumer use.**

"Furthermore, **mass market consumer takeup of WiGig will drive the cost of the technology down** substantially. This will enable very cost competitive WiGig backhaul. Of course, it will still require an antenna, specialist RF front end circuitry and additional management software which will add to the cost.

"A further enhancement being worked on is looking at how to avoid the need for manual alignment of the antenna. This is similar to the alignment required to install a broadcast satellite TV dish, manually adjusting the physical tilt and azimuth of the antenna. A scheme which automatically aligns the beam without manual intervention would simplify installation. It would also allow later realignment, even to a different hub, by remote control." (Readers will have spotted that another radio link will be required to remotely control it during this process, but that might be made through a nearby macrocell or even another nearby metrocell).

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The effects on mobile networks will be two-fold:

- a. **Offloading very high data transfers, which can be deferred to happen quickly when very close to a WiGig point, typically at home.** This will relieve high traffic load from the cellular network.
- b. Enabling **lower cost short range wireless backhaul** for metrocells, with rates of hundreds of Megabits at distances of hundreds of metres. **This is very much line-of-sight transmission**, but ideal for many urban city centre applications.

The huge amount of unlicensed or lightly licensed spectrum at 60GHz – with more than 7GHz bandwidth available – at virtually zero cost makes this an attractive option for the future.

WIGIG

<https://en.wikipedia.org/wiki/WiGig>

The name WiGig comes from Wireless Gigabit Alliance, the original association being formed to promote the adaption of IEEE 802.11ad, however it is now certified by Wi-Fi Alliance.[6]

<https://www.wi-fi.org/>

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WiGig, alternatively known as 60GHz Wi-Fi,[1] refers to a set of 60 GHz wireless network protocols.[2] It includes the current IEEE 802.11ad standard and also the upcoming IEEE 802.11ay standard.[3]

<https://www.itproportal.com/2016/03/14/the-wireless-technology-competing-for-wifis-crown/> 140316

WiGig is not perfect however. It turns out that the **60-gigahertz signals are blocked by walls, ceilings, and floors so for now it is aimed at devices communicating within the same room.** In 2016, TP-Link unveiled the world's first WiGig router which also supports the usual 2.4GHz and 5GHz WiFi protocols. The idea is that when you are in range for WiGig, it will use WiGig and failing that it will fall back to the slower links WiFi. The Talon is capable of up to 800Mbps on 2.4GHz, 1733Mbps on 5GHz, and 4600Mbps on WiGig.

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https://www.theregister.co.uk/2016/10/25/intel_qualcomm_get_to_peel_the_back_off_the_wigig_stick_er/ (2016)

"The WiFi Alliance reckons it's bestowed on a waiting world the first hint of what 5G will look like, and apparently it's a radio link that can manage 8 Gbps over 10 metres. The big advantage the 60 GHz band offers over what we're familiar with for Wi-Fi – 2.4 GHz or 5 GHz – is that there's plenty of room for extremely wide channels that provide multi-gigabit per second capacity.

The short range of 60 GHz WiGig makes it **most suitable for applications like docking and in-room device-to-device interconnect – file transfers, multimedia streaming, and (if enough people eventually care about it) virtual reality headset connections.**

In a crowded environment, beamforming on its multiple-in, multiple-out antennae should **cut down interference.**

Where devices support operation across all the Wi-Fi bands, the standard stipulates the ability to keep sessions intact while switching between 2.4 GHz, 5 GHz or 60 GHz frequencies.

Stretching the use-case out to the 5G business, a Wi-Fi alliance bod told LightReading that with a cantenna long-range directional <http://www.lightreading.com/gigabit/wireless-satellite/wi-fi-alliance-ushers-in-wigig-era/d/d-id/727225> antennae WiGig's range could be extended to distances sufficient to provide **cellular base station backhaul"**

[60GHz believed to be currently used for backhaul with 4G]

FREE PASS FROM OFCOM

https://www.ofcom.org.uk/_data/assets/pdf_file/0017/115631/statement-fixed-wireless-spectrum-strategy.pdf

Our decisions and planned forward work programme

We have decided to implement our findings as follows:

1.7 In order to enable new technologies and facilitate new use cases in the 60 GHz band, we are taking immediate steps to enable licence exempt access to 14 GHz of spectrum by making changes to the regulatory regime in the 57-66 GHz range as well as making new spectrum available at 66-71 GHz. 66-71GHz spectrum can support new 5G use cases for mobile/portable equipment.

EXAMPLE OF USE, CITY OF LINCOLN

<https://www.siklu.com/press-release/city-of-lincoln-council-u-k-selects-siklus-high-capacity-wireless-links-for-its-smart-city-surveillance-network/>

Videcom installed Siklu's 60GHz V-band frequency radios to connect 300 cameras at the street level including city wide Urban Traffic Cameras.

[Also talk of wider wireless network, with surveillance and smart cities functions]

USE IN 5G TRIALS

Bristol 2015-18

<https://www.electronicsspecifier.com/products/5g/ultra-fast-video-streamed-through-central-bristol>
<https://www.bluwireless.com/insight/blog/5g-infrastructure-to-be-examined-by-e7-3m-5g-xhaul-project/>

Millbrook CAV

<https://www.millbrook.co.uk/5g/>
<https://www.bluwireless.com/insight/the-hidden-5g-technology-behind-tomorrows-connected-cars/>

3. 60GHz IN THE HEALTH SECTOR

LIVERPOOL 5G

<https://www.sensorcity.co.uk/guest-blog-liverpool-5g-consortium/>

We plan to connect The Royal Liverpool and Broadgreen Hospital and Sensor City with the new accelerator, which is in the Knowledge Quarter. Our work will also extend into parts of Kensington. Blu Wireless Technology is using mmWave 60GHz technology to bring gigabit connectivity to these communities. **Health and social care professionals will deliver care at patients' homes**, enabling us to show how fifth generation networks can support the benefits of home care and health/social care consultation.

<https://insight.bluwireless.com/news/blu-wireless-wins-uk-dcms-healthcare-and-transport-bids>

As part of the Liverpool 5G testbed, around 50 inpatients in the Royal Liverpool and Broadgreen University Hospitals NHS Trust (RLBUHT), as well as 150 users of Liverpool Adult Social Services, will have access to applications based on the high-bandwidth broadband network.

These applications include **video monitoring, augmented by artificial intelligence based analytics which can spot behavioural anomalies or emergency incidents like falls in the home.**

Teleconferencing to help patients connect with their practitioners will also be enabled, for cost-effective remote healthcare and **to combat loneliness in older adults** – a serious problem in an ageing population.

[NB tackling loneliness is a justification for 5G advanced by Greg Hands MP]

QUEEN MARY, UNIVERSITY OF LONDON 2020 - MOCK HOSPITAL ROOM

<https://antennas.eecs.qmul.ac.uk/facilities/antenna-measurement-laboratory/body-centric-wireless-sensor-lab/>

Body-Centric Wireless Sensor Lab

The Body-Centric Wireless Sensor Lab provides a mock hospital room and all necessary equipment to simulate real-life scenarios when investigating wireless sensor networks. The lab has the capability to enable research expansion into **implantable devices measurement, compact sensor manufacturing and extensive radio propagation characterisation and modelling.**

The lab currently includes:

Portable VNAs up to 6 GHz;

UWB Received Signal Strength Indicator (RSSI) measurement system;

60 GHz on-body transceivers;

Physical human phantom;

Mock hospital suite

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4. MATERIAL INVESTIGATING A HEALTH IMPACT FROM 60GHz above general concerns on polarised and pulsing microwave radiation.

OXYGEN, HAEMOGLOBIN

60Ghz spins oxygen molecules. Some query whether this would affect oxygen take-up by haemoglobin in the blood and cause respiratory difficulties.

More info here <https://www.rfglobalnet.com/doc/fixed-wireless-communications-at-60ghz-unique-0001>

<https://pubs.acs.org/doi/pdf/10.1021/acsomega.8b00879>

Spin-Dependent O₂ Binding to Hemoglobin
Kurokawa et al, 2018 [very very technical]

COMMENT FROM AN ARTICLE READER (OF UNKNOWN TECHNICAL AUTHORITY)

<https://physics.stackexchange.com/questions/534128/what-happens-to-oxygen-during-atmospheric-absorption-of-radiation-with-a-peak-at>

Thank you for the answer. From the answer I deduce that there's **no chemical change to the air around the antenna**.

You also don't mention heat (however slight), so for all intents and purposes, nothing happens to the air we breathe when 60GHz RF is radiated through it.

– opyate Mar 2 at 19:49

@opyate yes. The two states are for all intents and purposes identical and **absorption of the 60 GHz photon makes no difference to the behaviour of the oxygen molecule**.

[ASIDE: Some have speculated whether COVID-19 effects are also 60GHz effects]

COVID-19: Attacks the 1-Beta Chain of Hemoglobin and Captures the Porphyrin to Inhibit Human Heme Metabolism

https://chemrxiv.org/articles/COVID-19_Disease_ORF8_and_Surface_Glycoprotein_Inhibit_Heme_Metabolism_by_Binding_to_Porphyrin/11938173/5?fbclid=IwAR1K50u0wRWWhOCv0_rxS2_bYk7p3mT-QWX08GXaa0Tm13bzT8WI8MYfTAI8

Canadian scientist Magda Havas PhD has studied possible evidence but feels that it is not yet proven that 60GHz microwave radiation makes oxygen unusable to blood cells. However she usefully documents health effects, including of EMFs on **red blood cells** (“**Rouleau**”) which could affect respiration.

<https://magdahavas.com/5g-and-mm-waves/corona-virus-and-5g-is-there-a-connection/>

60GHz TESTED ON LAB RODENTS, INJURIES FROM HOT AIR OR DIRECT PENETRATION?

Acute ocular injuries caused by 60-Ghz millimeter-wave exposure. 2009

<https://www.ncbi.nlm.nih.gov/pubmed/19667804>

[PRIVATE CORRESPONDENCE ON 5G GENERALLY]

(in Italy). There is, apparently also evidence that 5G reacts with blood thinner drugs and this is being analysed by the scientist who sent me this last night. Many elderly are on blood drugs.