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Editorial

Wi-Fi 7: A Wireless Networking Booster for Rigorous Analysis of Microbes and Infectious Diseases Using *In Silico* Technologies

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Rigorous analysis of microbes and infectious diseases using *in silico* technologies relies on sophisticated hardware and software, and in this connection, an efficient networking system is indispensable [1]. For example, to perform multiple sequence alignment of SARS coronavirus 2 spike protein sequences using our recently developed Mx. BIOME platform, it involves downloading the sequences from the NCBI Virus database (https://www.ncbi.nlm.nih.gov/labs/virus/vssi/#/, accessed on 5 May 2025), accessing the Mx. BIOME platform (http://mxbiome.nchu.edu.tw, accessed on 5 May 2025), choosing "Sequence Analysis" and then "Sequence Alignment", clicking "Clustal Omega" to access the European Bioinformatics Institute (EBI) website, pasting the downloaded spike protein sequences to the input box, choosing FASTA as the output format, clicking "Submit" to initiate the alignment, and finally viewing the aligned sequences by selecting "View Results" and "Alignments", with an option to download the results from the "Results Files" page [2]. Among all these steps, downloading the sequences from the public database and accessing Clustal Omega for online multiple sequence alignment requires networking between the computer of the end-user and the NCBI and EBI servers. Traditionally, networking was achieved through direct cable connections, or wired networking, which provided end-users with an efficient and stable link to the internet.

In the last two decades, wireless networking of computers, particularly laptops, tablets, and smartphones, has become increasingly popular in many settings. The convenience and mobility afforded by wireless networking have also made it a preferred mode for microbiology and infectious disease research. For example, it has become a common practice for many scientists and research students to connect to the internet and analyze their next-generation sequencing and microbial multi-omics data using their laptops in libraries, coffee shops, and other public areas, where quite a large number of users are concurrently connecting to the same hotspot in a wireless manner [3,4]. With the advancement of artificial intelligence technologies, clinicians have started to consult chatbots (e.g., ChatGPT, Perplexity, Claude, Copilot and Gemini or their subscribed versions) for readily available knowledge at the bedside in order to facilitate clinical problem solving [5–7], whereas laboratory scientists can also use machine learning based software applications for pathogen identification through image recognition [8,9]. In many circumstances, the speed of wireless networking is one of the rate-limiting steps of the whole process. For wireless networking, information is exchanged via radio signals. In the USA, the Federal Communications Commission (FCC) is responsible for regulating how the different portions of the radio signal spectrum may be used. The FCC has separated the radio spectrum into dozens of small ranges, called bands, and restricted specific uses to the different bands.

One of the most widely known wireless networks is Wi-Fi (Wireless Fidelity), and a Wi-Fi router is the device that provides wireless connection, allowing multiple devices (e.g., laptops, smartphones) to share the internet connection. The original Wi-Fi standard (IEEE 802.11) was released by the Institute of Electrical and Electronics Engineers (IEEE) in 1997. Old single-band Wi-Fi routers, based on standards like IEEE 802.11g and IEEE 802.11n, transmitted data using a single frequency 2.4 GHz band. Since the 2.4 GHz band was used by a lot

of other devices, such as microwave ovens, cordless phones, and Bluetooth devices, signals could become overcrowded and interfere with the Wi-Fi signal, which would slow down the Wi-Fi speed, and sometimes might even loss connection to the Wi-Fi routers. Over time, newer versions, such as Wi-Fi 5 (IEEE 802.11ac) and Wi-Fi 6 (IEEE 802.11ax), have been adopted. In addition to the standard 2.4 GHz band, Wi-Fi routers based on these newer standards could transmit data using an additional 5 GHz band. These dual-band Wi-Fi routers are much less prone to interference than the single-band ones and therefore could transmit data at a much higher speed of up to 9.6 Gbps for Wi-Fi 6.

Wi-Fi 7 (IEEE 802.11be), also known as the next-generation wireless networking and dubbed as extremely high throughput (EHT), has emerged in 2023/2024. It has enabled the maximum speed of data transmission to reach 46 Gbps, which is comparable to that of wired networking and five times more than that (9.6 Gbps) for Wi-Fi 6. Such a high speed of data transmission is achieved through several features of Wi-Fi 7. First, in addition to the 2.4 GHz and 5 GHz bands, Wi-Fi 7 uses a new 6 GHz band, which opens up an additional 320 MHz bandwidth channel that is not available in the 2.4 GHz and 5 GHz bands. This 320 MHz bandwidth channel is a wider channel that allows more data transmission than the narrower ones, hence increasing the data transfer capacity to the various Wi-Fi devices. It also has more private bands and hence less interference. Second, Wi-Fi 7 utilizes 4K-QAM (4096-QAM), a higher-order Quadrature Amplitude Modulation (QAM) scheme compared to Wi-Fi 6's 1024-QAM. It allows 20% more data to be packed into each signal transmission. Third, Wi-Fi 7 utilizes MLO (Multi-Link Operation). In contrast to previous standards, which the devices can connect to only one band at a time, MLO allows Wi-Fi 7 devices to connect to multiple bands simultaneously, hence increasing data throughput and reducing latency. Fourth, Multi-RU Puncturing ensures that if interference occurs, it does not affect the entire channel. Fifth, Wi-Fi 7 uses the 16 × 16 MU-MIMO (multi-user, multiple input, multiple output) technology. Prior to Wi-Fi 5, wireless networks primarily operated on a single-user, time-division multiplexing (TDM) approach, where each device had to wait for its turn to access the network, which could lead to bottlenecks and reduce overall performance, especially in busy environments. MU-MIMO is a wireless technology that was introduced in Wi-Fi 5. It breaks up the internet bandwidth into individual streams, which allows multiple devices to communicate with the router at the same time.

After its emergence in 2023/2024, Wi-Fi 7 has gained broader adoption in 2024/2025 as more compatible hardware (e.g., Wi-Fi router, laptop) became available. However, it is important to note that advancement in wireless networking technologies has to be accompanied by improvement in other associated gears. For example, a faster Wi-Fi router alone does not make the internet speed faster or a laptop run more efficiently. Advancement in all fronts is essential in order to achieve a robust pipeline for rapid, efficient, and timely analysis of microbes and infectious diseases using *in silico* technologies.

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Conflicts of Interest

The author declares no conflict of interest.

Use of AI and AI-Assisted Technologies

No AI tools were utilized for this paper.

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