

Contribution analysis on Wi-Fi 4 to 7

1. What is Wi-Fi

Today, Wi-Fi is available at home, office, school, restaurants and stores as a matter of course, and Wi-Fi is a well-known technology for everyone.

Wi-Fi standards are set by IEEE (Institute of Electrical and Electronics Engineers), and alphabets after "IEEE 802.11" indicate the generation of the Wi-Fi standards. IEEE 802.11n, IEEE 802.11ac, IEEE 802.11ax, and IEEE 802.11be correspond to Wi-Fi 4, Wi-Fi 5, Wi-Fi 6/6E, and Wi-Fi 7, respectively. "Wi-Fi" is the brand name used by the Wi-Fi Alliance, an industry group that aims to promote Wi-Fi. In this report, Wi-Fi 6 and 6E are collectively called as Wi-Fi 6.

Note that the Wi-Fi Alliance does not define Wi-Fi 1 to 3, which are generations prior to Wi-Fi 4, and correspond to IEEE 802.11a, IEEE 802.11b and IEEE 802.11g, respectively.

IEEE 802.11be called Wi-Fi 7 is the latest Wi-Fi standard in practice, and Wi-Fi 7 technology offers the following benefits:

- Higher data transmission rate and a lower latency than the Wi-Fi 6.
- Support throughput of up to at least 30Gbps, almost 3x Wi-Fi 6.
- At most 320 MHz bandwidth, 4096-QAM, Multi-RU, Multi-link operation, and so on.
- Wide range of use cases, for example, video stream, video/voice conference, online gaming, real-time collaboration, cloud/edge computing, industrial IoT, Immersive AR/VR, open roaming and Wi-Fi sensing.

2. Wi-Fi 7 standardization activities in IEEE

Fig. 1 shows the standardization activities for Wi-Fi 7 in IEEE. In May 2018, IEEE 802.11 set up an EHT (Extremely High Throughput) Topic Interest Group (TIG). In July 2018, the EHT TIG was transformed into the EHT Study Group (SG). The EHT SG defined the scope of the new project and identified the list of candidate features of Wi-Fi 7. In May 2019, the EHT SG transformed into Task Group be (TGbe) that is developing IEEE 802.11be amendment. We are writing our report in the timing that Draft 3.0 will be published in November of this year. The final version is expected to be published by middle 2024.

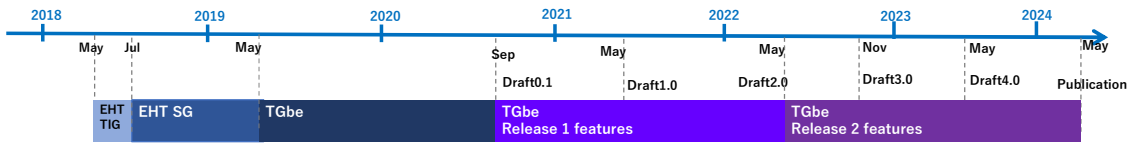


Fig. 1 Wi-Fi 7 standardization activities in IEEE¹

3. Contribution analysis of IEEE 802.11n/ac/ax/be

To understand key players in the Wi-Fi contributions for the Wi-Fi 4, 5, 6 and 7, we analyzed the number of contributions in each Wi-Fi standard by using the IEEE official website². If there are multiple versions in a single contribution, the multiple versions were counted together as one contribution. The number of contributions submitted to each Wi-Fi standard was calculated by summing the number of contributions submitted to the following groups (TG, SG, and TIG).

Wi-Fi 4: HT SG, TGn

Wi-Fi 5: VHT SG, TGac

Wi-Fi 6: HEW SG, TGax

Wi-Fi 7: EHT TIG, EHT SG, TGbe

Fig. 2 shows the number of contributions in Wi-Fi 4 to Wi-Fi 7. The contribution submissions to Wi-Fi 7 began in 2018, showing that the highest number of contributions were submitted in 2021 at the moment.

¹ https://www.ieee802.org/11/Reports/tgbe_update.htm

² <https://mentor.ieee.org/802.11/documents>

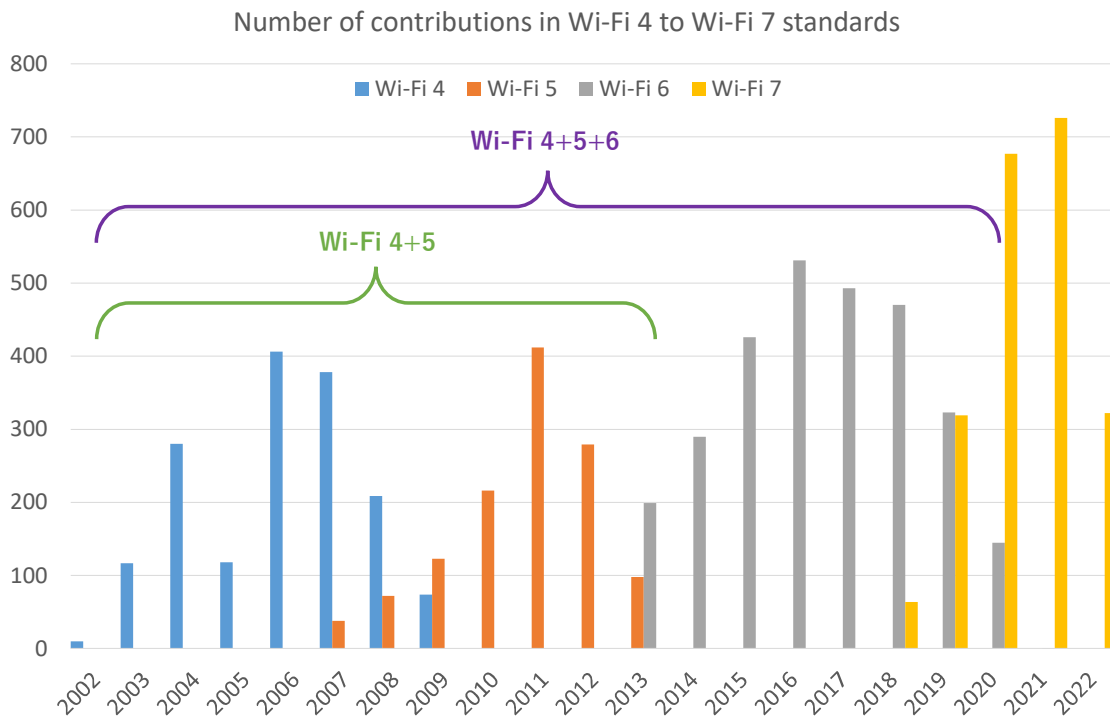


Fig. 2 Number of contributions in Wi-Fi 4, 5, 6 and 7 standards

4. Key players of Wi-Fi 4 to 7

Figs. 3 to 6 show the number of contributions of top 20 contributors in “Wi-Fi 4 and 5”, “Wi-Fi 4, 5 and 6”, “Wi-Fi 6” and “Wi-Fi 7”, respectively. These figures show how the top technology standard contributors have changed their contributions level across the different generations. Since Qualcomm acquired Atheros in 2011 when the Wi-Fi 5 was under discussion, the number of the Qualcomm's contributions in Wi-Fi 5, 6 and 7 includes the number of the Atheros's contributions in Wi-Fi 5, 6 and 7, if any.

According to a Wi-Fi NOW article³, in 2018, Wi-Fi 4 and 5, were main Wi-Fi shipments, and the penetration rate of Wi-Fi 4 and 5 was close to 100%. Fig. 3 shows the top 20 contributors in Wi-Fi 4 and 5. As shown in Fig. 3, Intel (500 contributions / 17.7%), Qualcomm (298 contributions / 10.5%), and Broadcom (264 contributions / 9.3%) are the top three contributors.

³ [Wi-Fi 6 enters steep growth phase far outpacing 5G, says IDC - Wi-Fi NOW Global \(wifinowglobal.com\), link: https://wifinowglobal.com/news-and-blog/wi-fi-6-enters-phase-of-steep-growth-far-outpacing-5g-says-idc/](https://wifinowglobal.com/news-and-blog/wi-fi-6-enters-phase-of-steep-growth-far-outpacing-5g-says-idc/)

According to the Wi-Fi NOW article, it was expected that in 2021, Wi-Fi 4, 5 and 6 were main Wi-Fi shipments, and the penetration rate of Wi-Fi 4, 5 and 6 was closed to 100%, and Wi-Fi 6 shipments were growing from 2019 to 2021. Fig. 4 shows the top 20 contributors in Wi-Fi 4, 5 and 6. As shown in Fig. 4, Intel (787 contributions / 13.8%), Qualcomm (758 contributions / 13.3%), and Huawei (519 contributions / 9.1%) are the top three contributors.

According to the Wi-Fi NOW article, in 2022, it was expected that Wi-Fi 6 becomes dominant Wi-Fi shipments in 2022 and 2023, and Wi-Fi 7 shipments appear in 2023.

Fig. 5 shows the top 20 contributors in Wi-Fi 6 which is the most prevalent Wi-Fi standard today. As shown in Fig. 5, Qualcomm (460 contributions / 16.0%), Huawei (344 contributions / 12.0%), and Intel (287 contributions / 10.0%) are the top three contributors.

Fig. 6 shows the top 20 contributors in Wi-Fi 7 which is the upcoming Wi-Fi standard, Huawei (482 contributions / 22.9%), Qualcomm (320 contributions / 15.2%), and Intel (200 contributions / 9.5%) are the top three contributors.

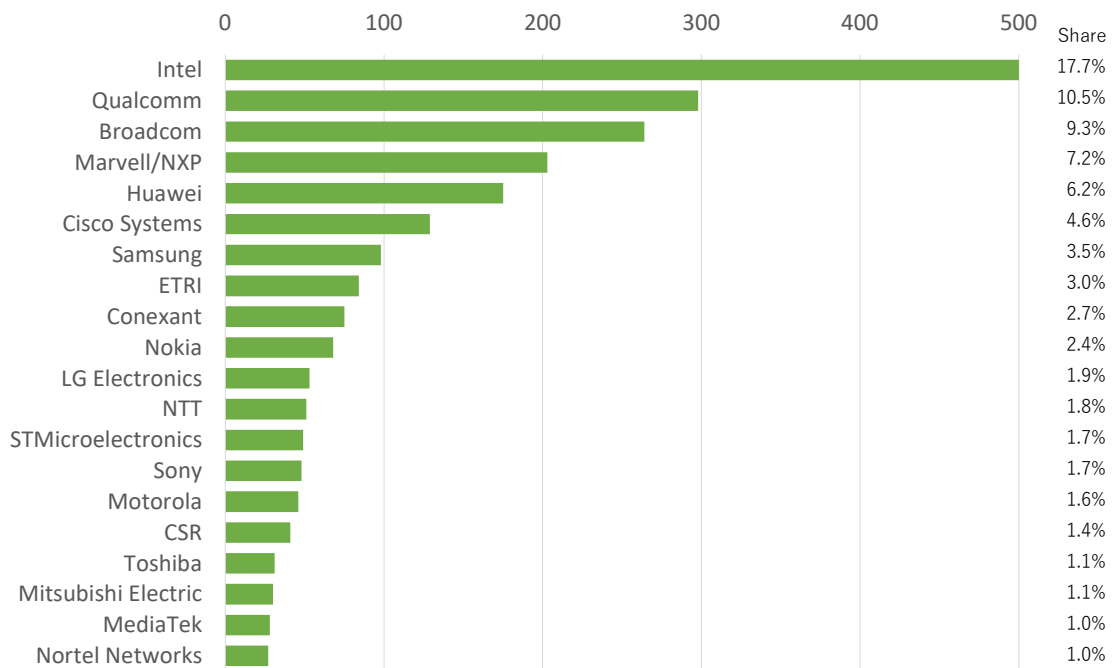


Fig.3 Number of contributions in Wi-Fi 4 and 5 standards: Top 20 contributors

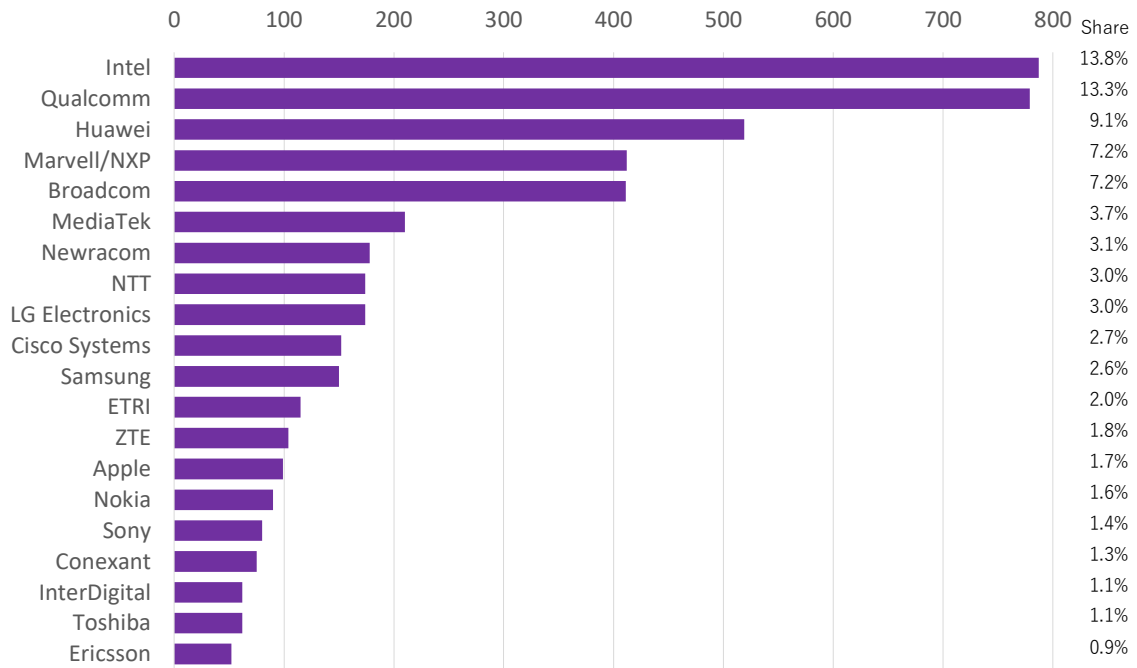


Fig.4 Number of contributions in Wi-Fi 4, 5 and 6 standards: Top 20 contributors

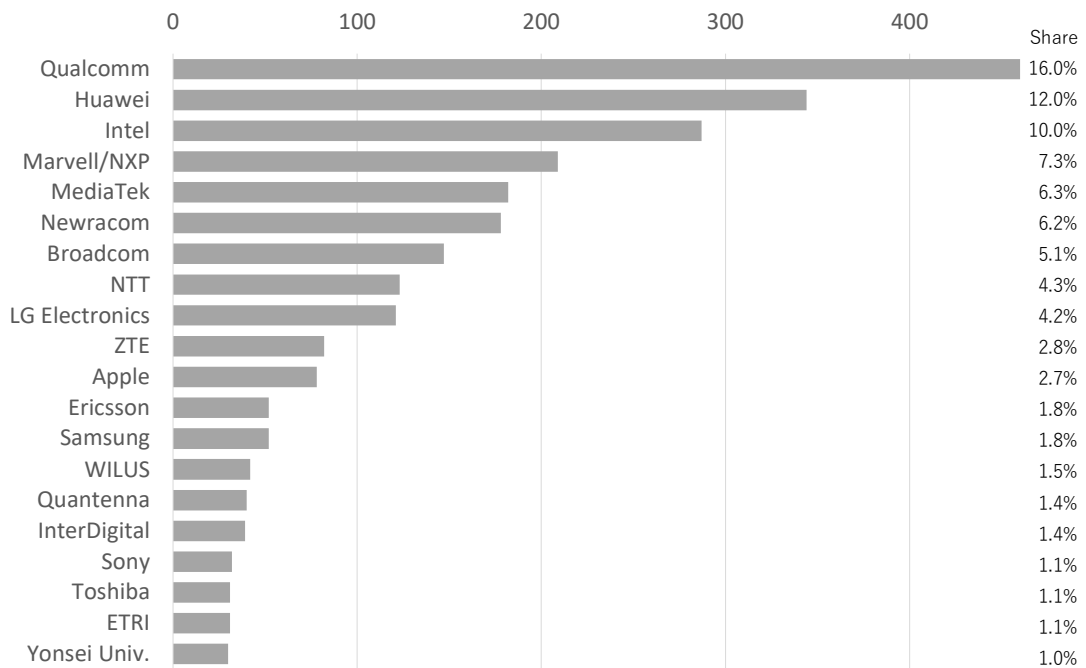


Fig.5 Number of contributions in Wi-Fi 6 standard: Top 20 contributors

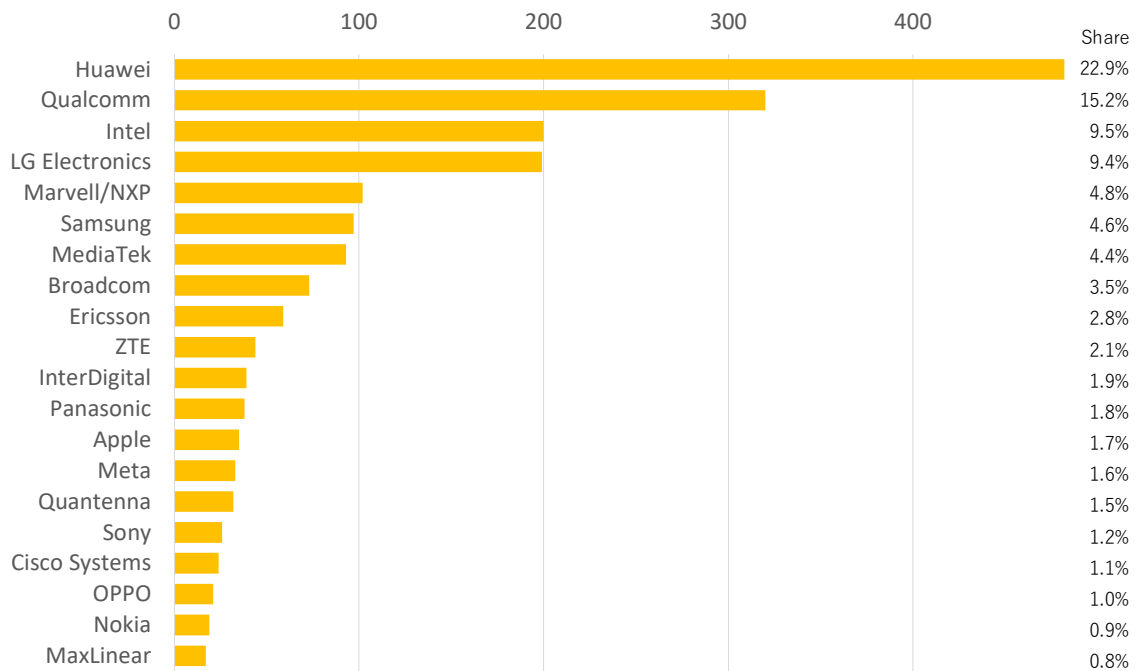


Fig.6 Number of contributions in Wi-Fi 7 standard: Top 20 contributors

5. Takeaways

What we have learned from this analysis is as follows:

1. Intel, Qualcomm and Huawei are the top three contributors in Wi-Fi 4, 5 and 6, which would be main Wi-Fi shipments in 2021.
2. Qualcomm, Huawei and Intel are the top three contributors in Wi-Fi 6, which would be dominant Wi-Fi shipments in 2022 and 2023.
3. Huawei, Qualcomm and Intel are the top three contributors in Wi-Fi 7, which is the upcoming generation.

We have seen a tendency that the number of contributions correlates with the number of standard essential patents, based on our experience. In the near future, we may conduct an essentiality analysis for Wi-Fi 7.

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