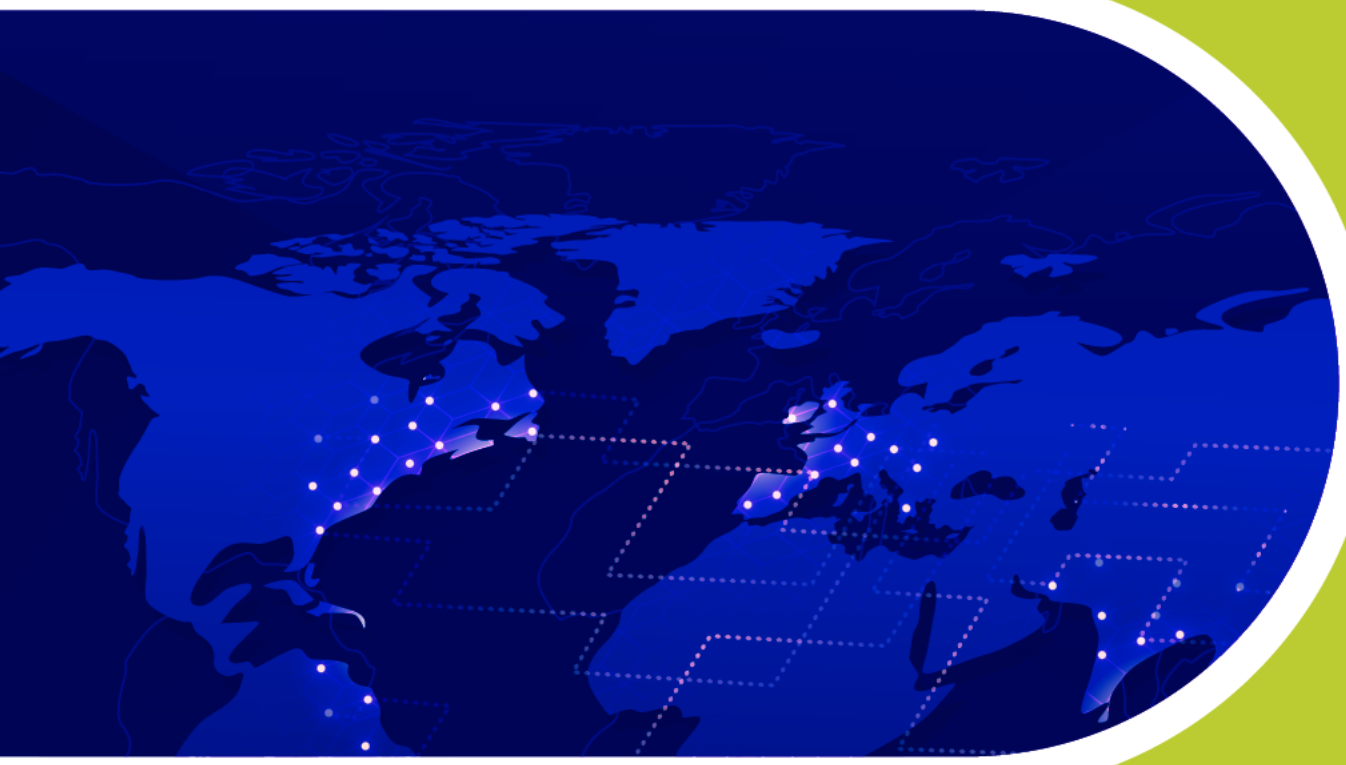

Lessons from the Assia Report on "Wi-Fi and Broadband Data"

October - 2021

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EXECUTIVE SUMMARY

ASSIA's State of Wi-Fi report provides real world measured data of the Wi-Fi traffic volume, the service latency as well as indications of the intensity of the spectrum use (interference and congestion).

In particular, the report suggests that:
· Wi-Fi mid-band traffic is approximately doubling every two to three years, in line with historical trends,
· Further increase of the intensity of the spectrum use would lead to degradation of the Quality of Experience (QoE).

It is reasonable to assume that the Wi-Fi mid-band traffic will keep on growing following historical trends and that by 2026 the Wi-Fi mid-band traffic will be spread equally among the 2.4, 5 and 6 GHz bands. Under these assumptions, it is straightforward to estimate the impact of the recent USA/Canada and European decision on opening the 6 GHz band, i.e. analyse when the current intensity of the spectrum use is likely to be met, taking into account the additional spectrum available. Such analysis suggests that:
· USA/Canada regulators adopted a 6 GHz decision (1200 MHz) that secures sufficient spectrum for Wi-Fi for the next 5 years.
· European regulators adopted a 6 GHz decision (480 MHz) that secures sufficient spectrum for Wi-Fi for the next 2 years.

ABBREVIATIONS

AP	Access Point
CAGR	Compound annual growth rate
DSA	Dynamic Spectrum Alliance
GB	Gigabytes
QoE	Quality of Experience
TSD	Traffic Spectrum Density

INTRODUCTION

The Dynamic Spectrum Alliance commissioned ASSIA in June 2020 to produce a report assessing the evolution of the Wi-Fi traffic and spectrum use. The State of Wi-Fi Report was presented by ASSIA during the Dynamic Spectrum Alliance (DSA) Global Summit on 8th June 2021.

The report presents direct measurement of Wi-Fi Key Performance Indicators measured millions of Wi-Fi connections in USA/Canada and Europe. As such, the Report is not intended to provide projection and analysis. Its aim is simply to gather the most accurate data possible about Wi-Fi Quality of Service and Wi-Fi spectrum usage, which is one of ASSIA's areas of expertise.

While precisely assessing the current State of Wi-Fi is in itself a significant contribution, the report does not provide projection on the likely evolution of Wi-Fi or analysis of potential consequences in 5 years. Such projection relies on assumptions and theoretical analysis and is by nature uncertain. It is therefore best kept separate from the State of Wi-Fi Report which is 100% factual (reporting past measured data).
Nevertheless, prediction of the evolution of Wi-Fi traffic and QoS is important for regulators who must make spectrum decisions now to ensure that future Wi-Fi QoS remains compatible with their regulatory goals and objectives.

DSA members conducted below a simple projection in order to provide regulators with insights on how the State of Wi-Fi Report informs them about future Wi-Fi traffic and QoS that should be expected in their region.

WI-FI MID-BAND SPECTRUM

AVAILABILITY IN EUROPE AND USA/CANADA

In order to predict the future spectrum use, it is necessary to determine the spectrum available today and the spectrum that will become available going forward. ASSIA's State of Wi-Fi Report currently focuses on 2.4 and 5 GHz bands which correspond to the vast majority of use cases today. Although Wi-Fi 6E equipment is available, use of the 6GHz band is currently limited and not yet tracked by the ASSIA report. Still, by 2025, it is reasonable to assume that most Wi-Fi equipment will leverage all three mid-bands, i.e. 2.4, 5 and 6 GHz bands. On the contrary, the mmW bands are likely to complement the mid-bands, not to replace them. While they offer wider BW, they also offer much more limited range. Therefore, it seems reasonable to assume that the 57-71 GHz band will be used for other types of applications and environments, but can be treated independently of RLAN in mid-bands.

Assumption 1: Projection focuses on mid-bands, i.e. does not take 57-71 GHz into account.
Assumption 2: The vast majority of the mid-band use is currently in 2.4 and 5 GHz bands, whereas by 2025, the traffic should be distributed between 2.4, 5 and 6 GHz bands.

Following Assumption 1 and Assumption 2, the mid-band spectrum available to RLANs is provided in Table 1.

Table 1: RLAN Spectrum availability in mid-bands

	2.4 and 5 GHz	6 GHz	Total
USA and Canada	83 + 580 = 663.5 MHz	1200 MHz	1863.5 MHz
Europe	83 + 455 = 538.5 MHz	480 MHz	1018.5 MHz

WI-FI MID-BAND TRAFFIC EVOLUTION IN EUROPE

ASSIA's State of Wi-Fi report provides the Wi-Fi traffic volume delivered by each Access Point (AP) per Day for the 2.4 and the 5GHz bands, as indicated in Table 2. The report also provides the corresponding Compound Annual Growth Rate (CAGR), also indicated in Table 2.

Table 2: Wi-Fi mid band traffic volume and CAGR

	Band (GHz)	Traffic (GB/AP/Day)	CAGR (% per year)
USA/Canada	2.4	7.5	4.4
	5	9.5	30.2
Europe	2.4	5.5	42
	5	7.6	42

ASSIA voluntarily did not include the bump in Wi-Fi traffic that occurred during the first months of COVID, but included measures from June 2020 onwards. The growth rates measured subsequently seem to correspond more to long term data increase trends.
Furthemore, the CAGR reported by ASSIA is comparable to growth rate previously reported by reports such as the CISCO VNI. For example, the CISCO VNI 2017-2022 predicted that mobile off-load traffic would grow from 13.4 exabytes/month in 2017 to 111.4 exabytes/month by 2022, corresponding to a CAGR of 50%.
There is therefore no reason to consider that this growth rate will change significantly going forward.

Assumption 3: The CAGR of Wi-Fi mid band traffic is assumed constant over 2021-2026

Assumption 3 leads to the projection of the traffic evolution in years to come detailed in Table 4.

Table 4: Mid-band RLAN traffic projection (GB/AP/Day)							
		2021	2022*	2023*	2024*	2025*	2026*
USA/Canada	2.4 GHz	7.5	7.8	8.2	8.5	8.9	9.3
	5 GHz	9.5	12.4	16.1	21.0	27.3	35.5
	Total	17.0	20.2	24.3	29.5	36.2	44.8
Europe	2.4 GHz	5.5	7.8	11.1	15.7	22.4	31.8
	5 GHz	7.6	10.8	15.3	21.8	30.9	43.9
	Total	13.1	18.6	26.4	37.5	53.3	75.6

*Measured Data *Projection based on ASSIA's measurements of traffic and traffic growth*

Projecting spectrum use

Detailed projection of exact band by band estimation of parameters such as latency, interference or congestion depends on many parameters such as technology market penetration, evolution of the deployment topology (if any) and traffic patterns evolution due to new applications.
On the other hand, a simple measure to assess how intensely the spectrum is used would be to estimate how much traffic is delivered per each Access Point (AP) per MHz per day (referred to in the following as Traffic Spectrum Density - TSD). TSD enables regulators to estimate the impact of spectrum allocation on the intensity of the spectrum use, all other aspects being equal.

The appropriate target TSD - how much GB per AP per MHz is appropriate before interference/congestion grows beyond acceptable - is essentially subject to discussion. More advanced technology and denser topology could increase the acceptable TSD, while more advanced apps may rely on better connectivity QoE and therefore lower the acceptable target TSD. While projecting how this value would evolve in the future goes beyond the scope of this whitepaper, it is straightforward to project when the combination of additional spectrum and traffic increase will lead to a TSD equivalent to what it is today.
Additionally, it is worth noting that ASSIA's State of Wi-Fi Report indicates difficulty linked with congestion occurring in USA/Canada with the current TSD, further suggesting that the current level of usage of the Wi-Fi band cannot be exceeded without negative consequences on the QoE.

Proposition: the intensity of the Wi-Fi spectrum usage will be estimated by the Traffic Spectrum Density, i.e. how many GB are expected to be delivered per day, per MHz, per AP.

Following this proposition, the traffic spectrum density measurement (2021) and estimation (2022-2026) are provided in Table 5.

Table 5: Traffic Spectrum Density measurement (2021) and estimation (2022-2026)

		2021	2022	2023	2024	2025	2026
USA/Canada	Without 6 GHz	0.026	0.030	0.037	0.044	0.055	
	With 6 GHz		0.011	0.013	0.016	0.019	0.024
	Without 6 GHz	0.024	0.035	0.049	0.070	0.099	
Europe	With 6 GHz		0.018	0.026	0.037	0.052	0.074

Opening the 6 GHz in USA/Canada (1200 MHz) means that, provided the traffic keeps growing at the same rate as it does today (in line with historical trends), the mid-band Wi-Fi spectrum will be as intensively used in 2026 as it is today. The 1200 MHz of additional spectrum are sufficient to cover 5 years worth of traffic growth.
Opening the lower 6 GHz in Europe (480 MHz) means that, provided the traffic keeps growing at the same rate as it does today (in line with historical trends), the mid-band Wi-Fi spectrum will be as intensively used in 2023 as it is today. The 480 MHz of additional spectrum are sufficient to cover 2 years worth of traffic growth.

ADDITIONAL NOTE

This study was conducted in USA/Canada and Europe, but please take into account that the state of the fixed infra plays a role in how quickly spectrum is required for Wi-Fi. The ASSIA report indicates that in USA, Canada and Europe, Wi-Fi is quickly becoming the dominant QoS weakest link. Depending on the quality of the Fixed Infrastructure, the point in time where the QoS of the Fixed Access surpasses the QoS of the Wi-Fi link may vary from the USA and Europe examples.

CONCLUSION

ASSIA's State of Wi-Fi Report provides precise information about the traffic delivered over Wi-Fi Access Points, as well as clear indication that further increase of the Wi-Fi traffic would lead to reduction of the Quality of Experience.
While technology advances and topology evolution can increase the QoS for a given traffic density over a given spectrum, more advanced applications may increase the QoS requirements and therefore lower the acceptable traffic density.

Based on the measurement reports of ASSIA's State of Wi-Fi Report and assuming that:

- **The 57-71 GHz band is complementary to the mid-band but will not impact the evolution of the Wi-Fi mid-band traffic,**

- **In 2021, the vast majority of the mid-band use is in 2.4 and 5 GHz bands, whereas by 2025, the mid band Wi-Fi traffic should be distributed between 2.4, 5 and 6 GHz bands,**

- **The CAGR of Wi-Fi mid band traffic is assumed constant over 2021-2026,**

It is possible to estimate the impact of the recent regulatory decision to open the 6GHz band to Wi-Fi in USA/Canada and Europe.

The USA/Canadian decision to open 1200 MHz in the 6 GHz band to Wi-Fi provides room for 5 years worth of additional traffic growth without degradation of the QoS. In other words, USA/Canadian regulators adopted 6 GHz decision securing sufficient Wi-Fi spectrum for the next 5 years.

The European decision to open 480 MHz in the 6 GHz band to Wi-Fi provides room for 2 years worth of additional traffic growth without degradation of the QoS. In other words, European regulators adopted 6 GHz decision securing sufficient Wi-Fi spectrum for the next 2 years.

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