



# Wi-Fi Advancements and 6 GHz: Connecting to the Future

May 2023

# Topics for discussion

- Introduction
- Trends
- Considerations
- Upcoming Wi-Fi advancements
- Conclusions



# Introduction

Wi-Fi Alliance® Vision:  
Connecting everyone and  
everything, everywhere



# The principles that drive us



# Wi-Fi Alliance: A network of 900+ member companies that brings you Wi-Fi®



# Wi-Fi Alliance membership enables you to...

## DRIVE

development and evolution of Wi-Fi technology and access worldwide

## CERTIFY

devices and leverage the globally respected Wi-Fi CERTIFIED™ brand

## LEARN

from Wi-Fi experts across the globe

## NETWORK

with peers at exclusive events



## COLLABORATE

with companies worldwide to supply quality Wi-Fi devices to market

## PROMOTE

company exposure through Member Marketing Network opportunities

## ADVOCATE

for global spectrum policy that encourages Wi-Fi growth

## DELIVER

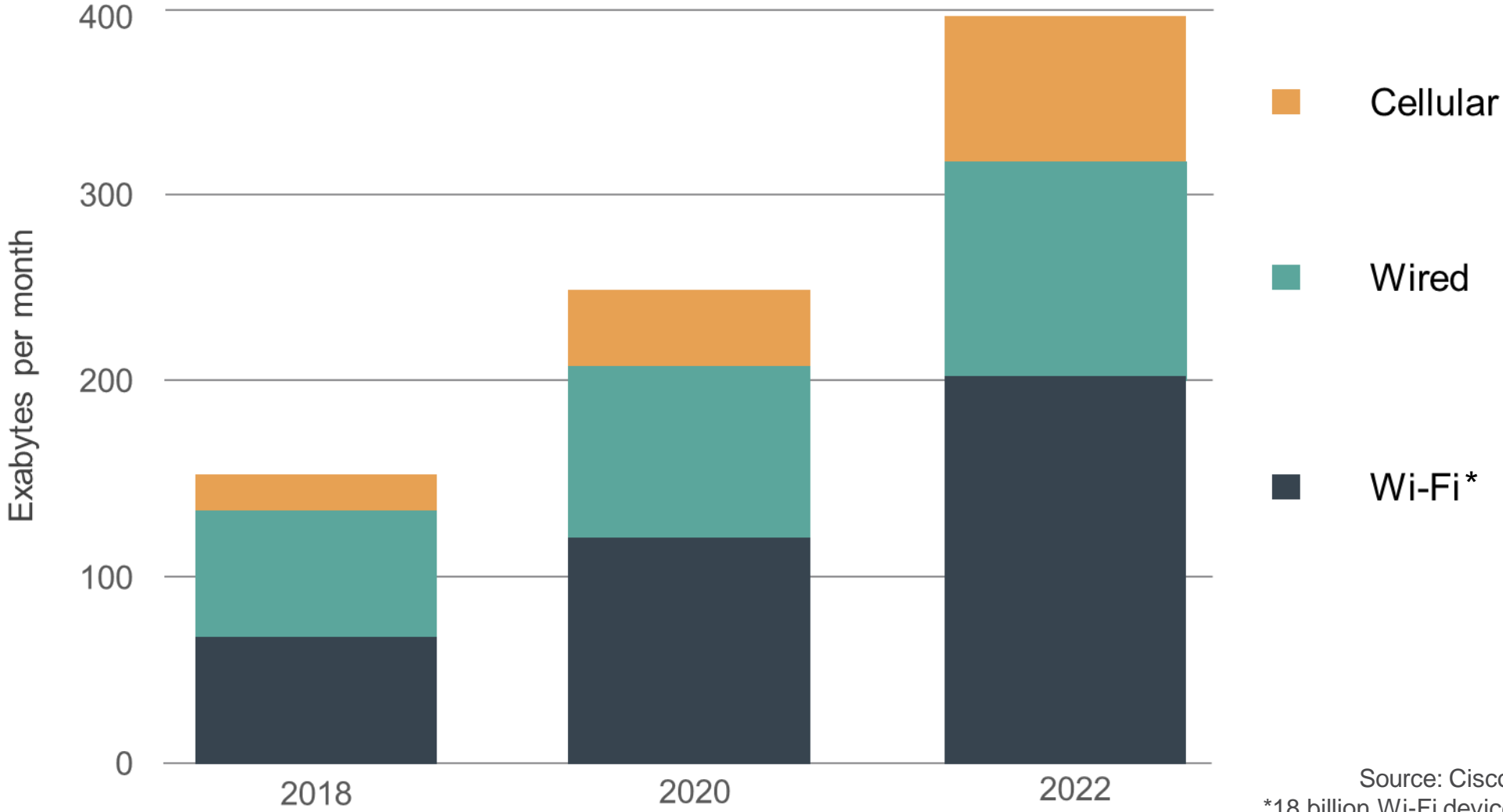
positive user experiences on secure devices



# Trends



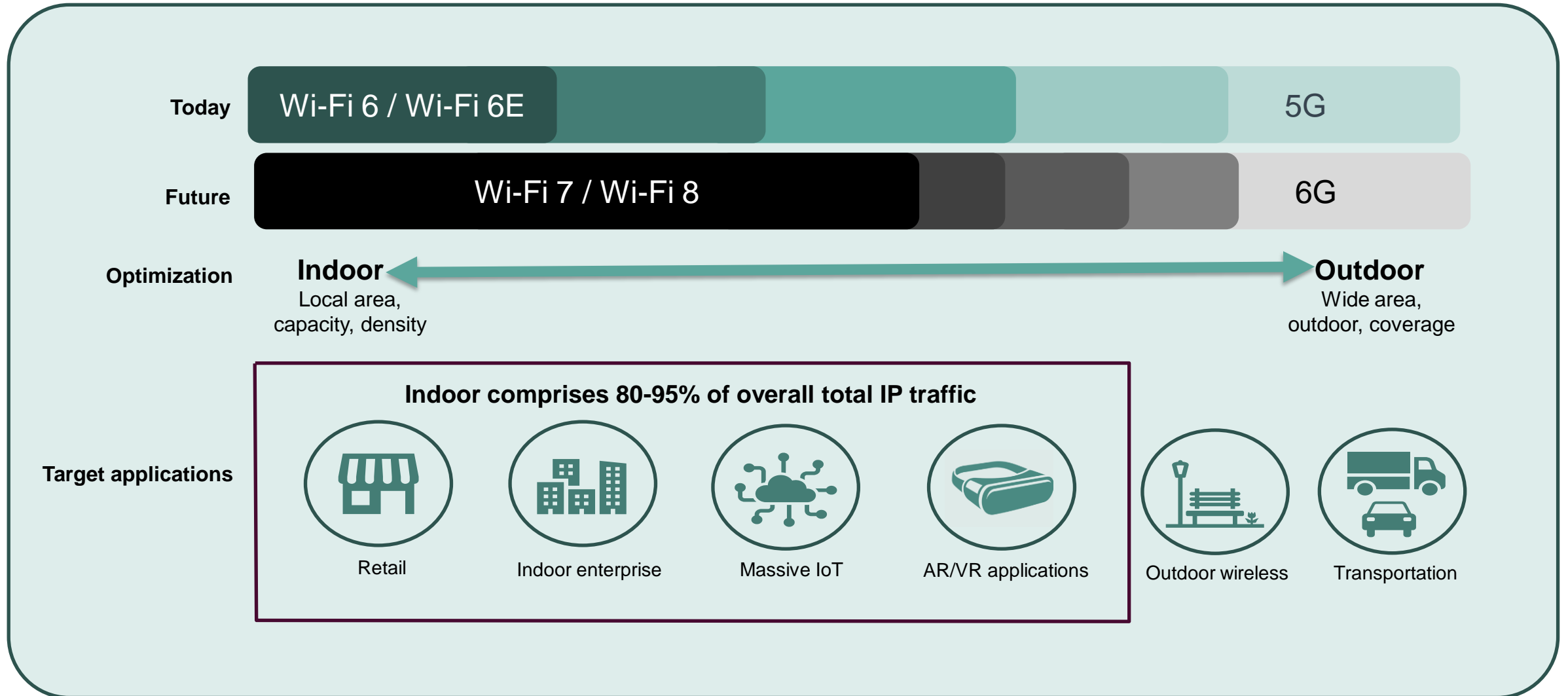
# Trend #1: Data growth



Source: Cisco VNI 2017-2022  
\*18 billion Wi-Fi devices in use in 2022



# Trend #1 corollary: Data growth now and in future predominately indoors



# Trend #2: Wi-Fi traffic share increases with each cellular generation

## MOBILE DEVICE TRAFFIC, 2022

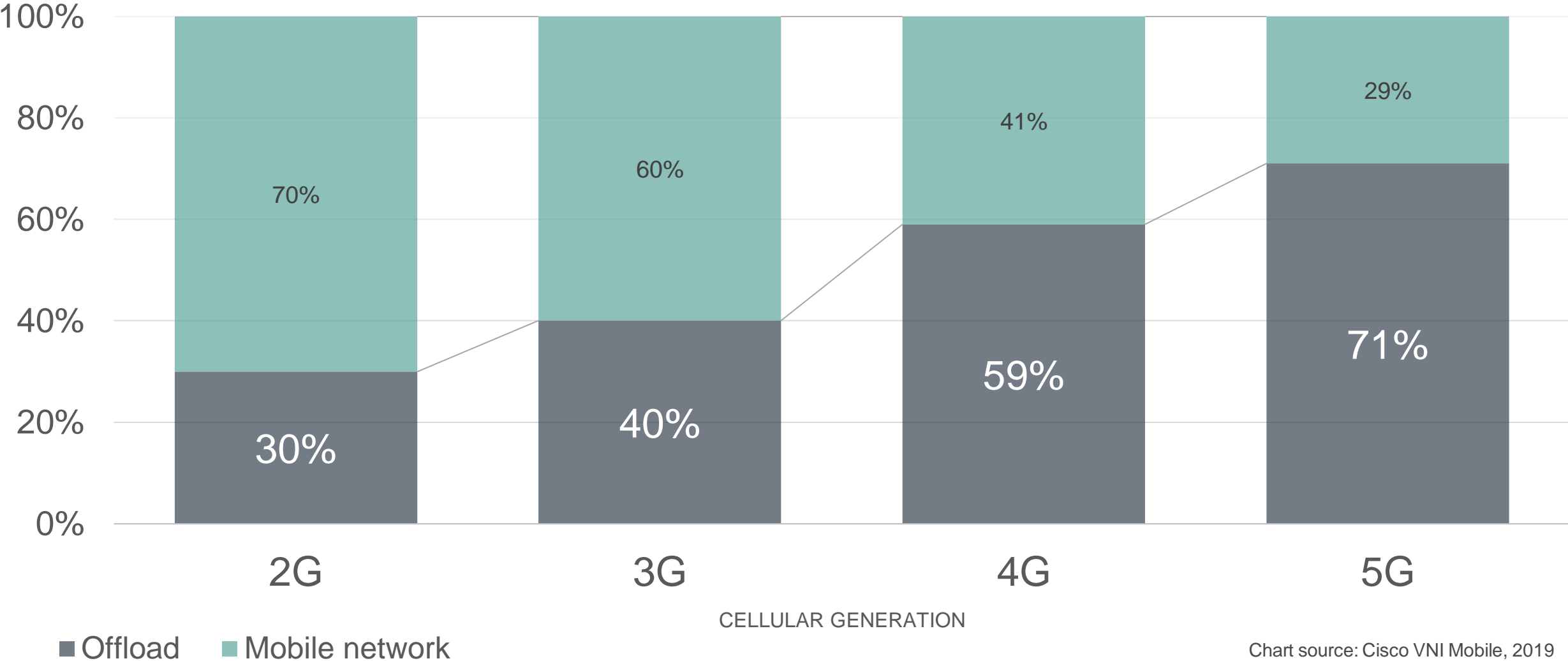


Chart source: Cisco VNI Mobile, 2019

# Trend #3:

## Distributed cloud computing next generation use cases

- Immersive experiences such as AR/VR/XR, telehealth, Industrial IoT / Automation, 3D-video
- Require expansive computational resources and connectivity hundreds, if not thousands, of times faster than 5G
  - Cannot be delivered by wide-area networks such as IMT
  - Require local-area, short-range communications such as the next generation Wi-Fi technologies designed for extremely high throughput and spectral reuse

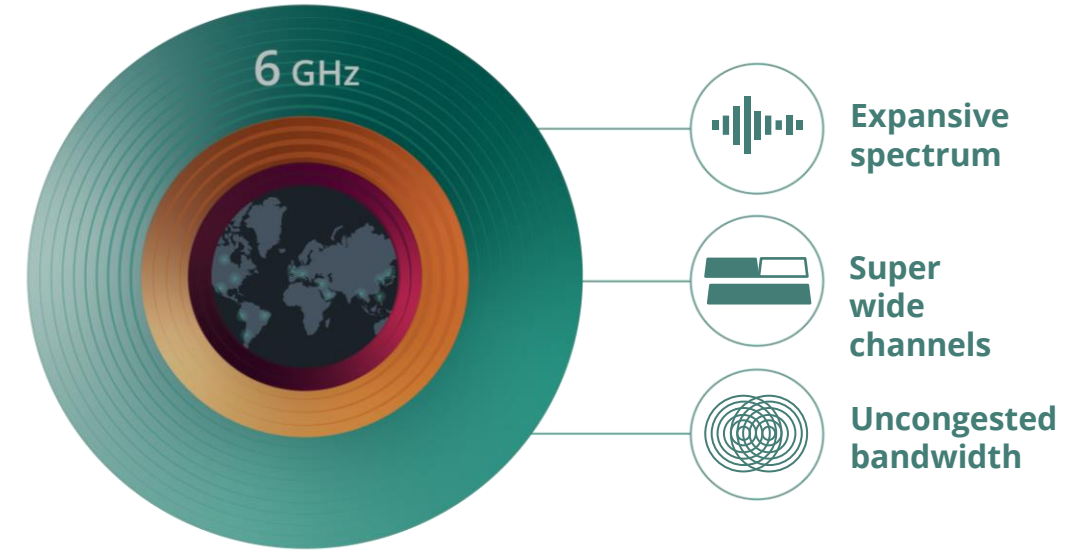




# Considerations

# Consideration #1: 6 GHz is transforming Wi-Fi technology\*\*

- [Wi-Fi 6E](#): capabilities required for advanced use cases: faster speed, lower latency, higher efficiency, higher density
  - In 2023, more than 473 million Wi-Fi 6E devices and 94.6 million Wi-Fi 6E access points will ship
  - In 2025, 32% of all Wi-Fi 6 device shipments will be Wi-Fi 6E and there will be over 1 billion Wi-Fi 6E devices
- [Wi-Fi 7](#): enhanced AR/VR/XR, industrial IoT, automotive, telepresence, immersive 3-D support with higher data rates, stringent latency, reliability, and QoS
  - Data transfers rates up to 30 Gbps
  - 84 million units expected to ship in 2024



Wi-Fi Alliance®

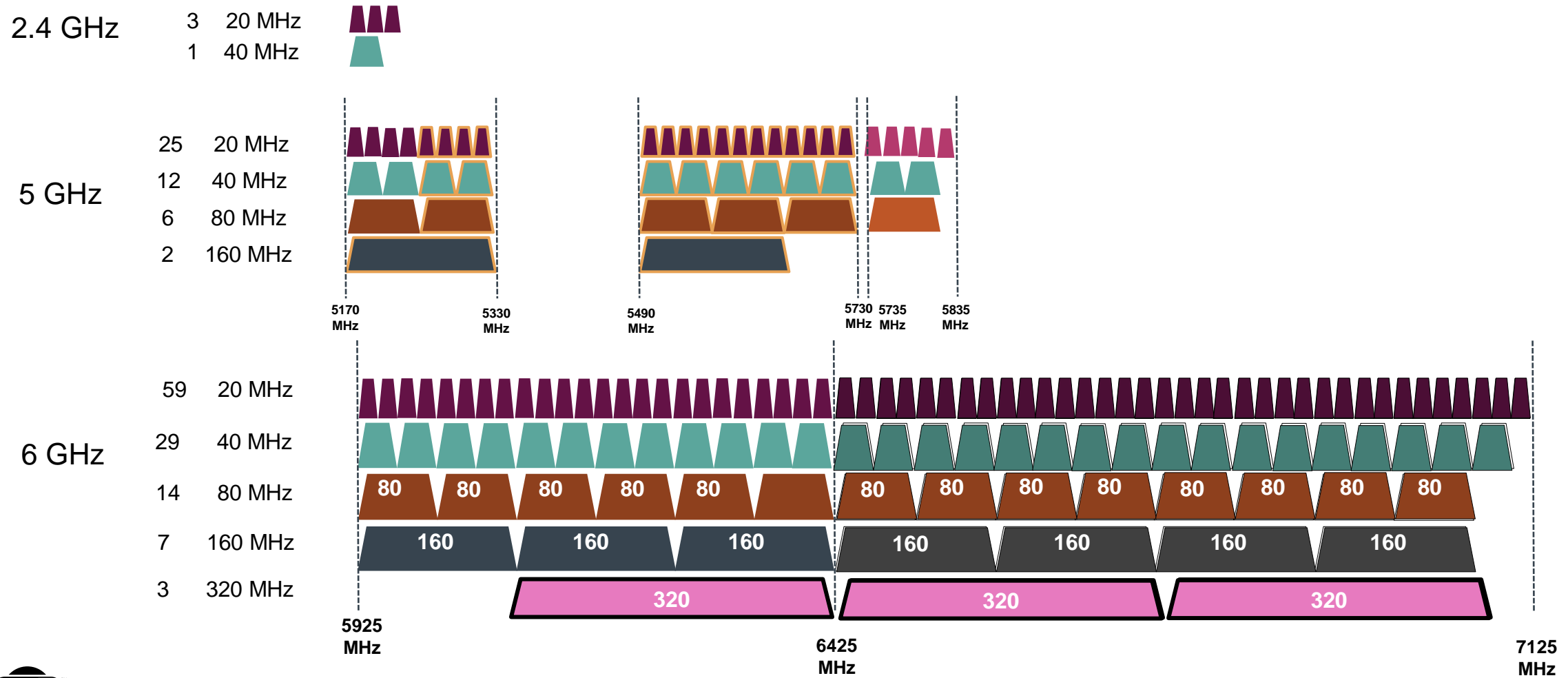
[Wi-Fi 6E video](#)

\*Source: IDC Research, Jan 2023

\*\*In a recent survey, 58% of companies said 6 GHz is critical or very important to their strategy  
Intel predicts in 2022 around 30 percent of their product mix will be Wi-Fi 6E

# Consideration #2:

6 GHz frequency band is uniquely suited to meet growing demand for Wi-Fi connectivity – no alternative spectrum now or in the future



## Consideration #3:

### IMT networks in 6.425-7.125 GHz are not feasible

- Countries in all regions are deploying Wi-Fi in 6.425 - 7.125 GHz
  - IMT frequency harmonization cannot be achieved; no interoperability
- Market fragmentation precludes economies of scale necessary for a viable IMT ecosystem in 6 GHz
  - Billions of \$ to design and produce cellular chipsets for 6.425-7.125 GHz
  - Billions of \$ to integrate chipsets into devices and bring them to market
  - Billions of \$ to deploy IMT technology network
  - Billions of \$ to operate IMT network
    - Adds up to billions of \$ that no one is going to risk without a stable regulatory framework that offers market scope and scale
- No 6 GHz IMT equipment on the market now or in the near future





# Upcoming Wi-Fi advancements

# Major opportunities in smart home Wi-Fi continue

- Smart home technology and services are one of the biggest opportunities in tech overall – and Wi-Fi is the cornerstone of the smart home
- Only a small percentage of homes around the globe are served by managed Wi-Fi and the need for smart home Wi-Fi solutions will keep rising
- Meanwhile multi-gigabit fiber to the home is driving up the need for gigabit whole-home Wi-Fi



# Enterprises transformed by Wi-Fi 6E and Wi-Fi 7

- The release of 6 GHz spectrum for Wi-Fi three years ago was a landmark decision in the history of technology. Since then, the Wi-Fi industry has been working overtime to deliver 6 GHz Wi-Fi services everywhere
- We believe we've only scratched the surface on capitalizing on 6 GHz Wi-Fi. Enterprise Wi-Fi is growing at an unprecedented rate – companies and industries are back with a vengeance following disruptions and lockdowns – and the need for device connectivity, connected vehicles, automation, sensors, control, monitoring, connected robotics, etc. is bigger than ever
- There's also a difference: New Wi-Fi standards deliver predictable and SLA-compliant performance. This expands the addressable market for Wi-Fi solutions enormously. most of the value of the band will be extracted in the coming 5-10 years

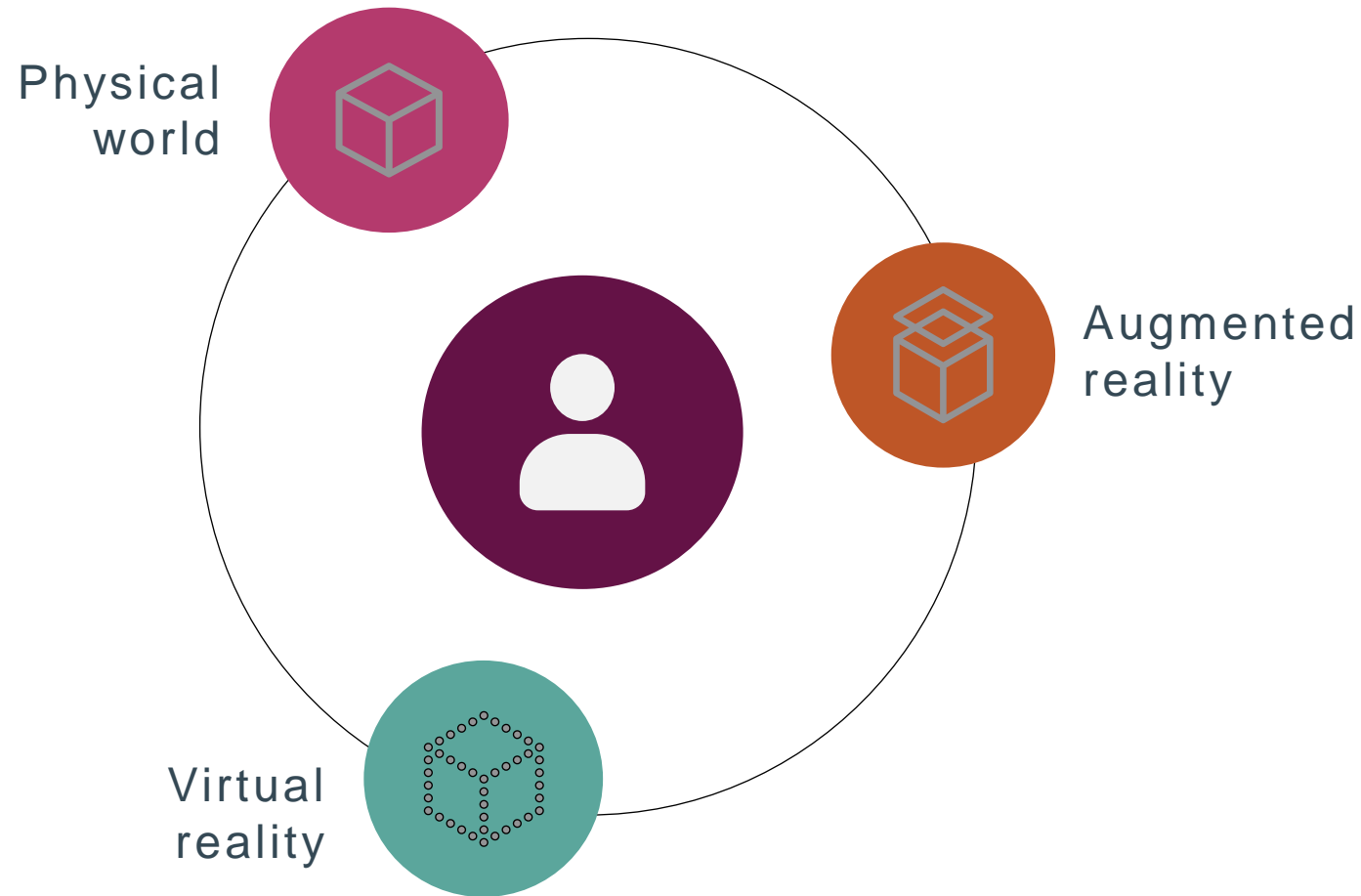
# Will there be a Wi-Fi AR/VR/XR device revolution?

- Industry says yes – and certainly the Wi-Fi standards are ready to deliver gigabit speeds and extreme low latency to make it all come alive
- And with rumored glasses and headsets from Meta, Apple, Google, and others – could AR/VR/XR become available to the mass market, or will these types of applications find their customers in industry – or both?
- Time to dive into the debate



# Extended-Reality (XR): An emerging exciting opportunity

- Promising immersive applications emerging, e.g., [How VR Is Helping Heal Soldiers With PTSD](#)
- Wi-Fi XR device development with Wi-Fi 6 and Wi-Fi 6E reported at [Apple](#), [Samsung](#), [Meta](#), [Google](#), [Amazon](#) and more...
- \$125 B market by 2026



Fantastic Power Efficiency – Multi GBPS Performance –  
Ultra Low-Latency - Extreme Reliability

# New and vastly improved: Wi-Fi Location-based services

- Wi-Fi-based location services are experiencing a rebirth – and it is ready for the mass market
- The **Wi-Fi Location** standard implemented by leading vendors allows sub-1 meter indoor location accuracy
- This is a new paradigm in LBS and will fuel myriads of use cases for consumers and industry. Watch this space carefully – opportunities abound





# Wi-Fi CERTIFIED Location™

## Accurate indoor location determination through Wi-Fi

- Enables location-based applications and services to deliver the same great experience indoors as they do outdoors
  - Uses the Fine Timing Measurement (FTM) protocol from IEEE 802.11-2016
  - Leverages existing infrastructure in Wi-Fi Location-enabled networks
  - Delivers better performance in multi-path environments than existing angle-based and RSSI methods
- Provides user control of when to share location
- Allows self-locating APs to support 6 GHz standard power requirements.



# The Wi-Fi IoT explosion – with Matter, and more

- IoT is headed towards 27 billion devices in 2025 – and we contend Wi-Fi will be the winning means of connectivity
- The Wi-Fi standards – including Wi-Fi HaLow™ – are perfectly suited to deliver the full range of IoT applications for industry and consumers



# Wi-Fi CERTIFIED™ and Matter deliver an exceptional IoT experience










- Wi-Fi CERTIFIED is an essential ingredient in Matter certification
- Wi-Fi and Matter use a common application layer and data model, allowing devices to communicate across multiple IP network technologies
- When paired together, Wi-Fi CERTIFIED and Matter allow users to choose from a wide range of brands that bring simplicity, interoperability, reliability, and security to the IoT market
- Wi-Fi CERTIFIED and Matter impart confidence in consumers because their devices are based on proven technologies
- Backward compatibility means Wi-Fi 4 or later will work with the Matter ecosystem
- Wi-Fi does not need to add any new functionality to support Matter



# Wi-Fi CERTIFIED HaLow™

## Long range, low power Wi-Fi® for IoT

- Addresses Internet of Things (IoT) use cases requiring minimal power consumption, longer range (1 km), and many devices per node
- Based on IEEE standard 802.11ah, operates in sub-1 GHz frequency band
- Leverages the latest Wi-Fi security, Wi-Fi CERTIFIED WPA3™
- Native IP support provides a scalable platform for IoT applications with no need for proprietary hubs or gateways
- Use cases: sensor networks, smart building products and systems, industrial and home automation, extended-range WLAN

Wi-Fi CERTIFIED HaLow™ for IoT	
Features	Benefits
 Sub-1 GHz spectrum operation	 Long range: approximately 1 km
 Narrow band OFDM channels	 Penetration through walls and other obstacles
 Several device power saving modes	 Supports coin cell battery devices for months or years
 Native IP support	 No need for proprietary hubs or gateways
 Latest Wi-Fi® security	

Source: Wi-Fi Alliance®

# Wi-Fi sensing comes of age

- Wi-Fi sensing is becoming a sub-industry in its own right with a handful of talented startups leading the way
- Dozens of service providers – and many more in the pipeline – have already adopted the services that are becoming more accurate and useful every day
- Sensing is a real revenue opportunity in the making

# Mobile / Wi-Fi convergence (offload) is back

- This time around the technology is vastly better and the market increasingly ready to finally bring together Wi-Fi and mobile services into a single seamless fabric
- It is a QoS improvement opportunity for ISPs – of course – and will boost the experience for subscribers



# Wi-Fi CERTIFIED Passpoint®

## Streamlined, secure access in Wi-Fi hotspots

- Improves the user experience by allowing access to networks based on user's relationships (roaming agreements) or indicates that online onboarding is possible
  - Provides automatic network discovery and selection, and seamless network access and roaming
  - Protects against security attacks and includes WPA3 security
- Passpoint is the foundation to enable:
  - Cellular data offloading
  - Wi-Fi calling
  - OpenRoaming
- Based on 802.11u, 802.1X and other technologies
- Globally deployed by major airports, stadiums, and venues
- More than 3,000 unique [Passpoint® certified devices](#), representing billions of smartphones and Wi-Fi devices



# 60 GHz reborn & going mainstream

- 60 GHz infrastructure (outdoor) radios are being deployed all over the world for fixed wireless access in unlicensed spectrum
- The time has also come to use 60 GHz for enterprise (indoor) backhaul
- We're only just scraping the surface of what this immense amount of free spectrum can do for ISPs and enterprises everywhere

# Wi-Fi 7

- Expect extremely high throughputs, low latency and jitter, and high-reliability
- Wi-Fi Alliance certification
  - Essential for interoperability, and the inflection point for mass market adoption
  - Will be based on the IEEE 802.11be standard
  - Technical development phase began mid-year 2022 and typically marks 18-24 months until the certification program is completed
- Analysts predict Wi-Fi 7 shipments will comprise about 2% of all Wi-Fi shipments in 2024\*



\* Source: IDC

# XR experiences require high performance Wi-Fi

- Advanced Power Efficiency
- Multi-Gigabit Performance
- Ultra Low-Latency
- Extreme Reliability





# Additional standards for future consideration



Target IEEE Approval*	Description		Wi-Fi Alliance TG interest
2023 December	802.11bb	Light Communications	
2023 December	802.11bc	Enhanced Broadcast Service	
2024 April	802.11bh	Randomized and Changing MAC Addresses	Security TGs
2024 May	802.11be	Extremely High Throughput	Wi-Fi 7 TGs
2024 September	802.11me	802.11 Accumulated Maintenance Changes	All
2025 May	802.11bf	WLAN Sensing	Operator MSTG
2025 September	802.11bi	Enhanced Data Privacy	Security TGs
Organization	Activity	Wi-Fi Alliance TG interest	
Broadband Forum (BBF)	Data model publication	Data Elements TG	
Connectivity Standards Alliance (CSA)	Matter specification	IoT MSTG, Wi-Fi Aware TG, Wi-Fi Easy Connect TG	
Wireless Broadband Alliance (WBA)	QoS Management Trials	Optimized Connectivity Experience TGs	
	OpenRoaming	Passpoint TGs, Operator MSTG	
	Onboarding	IoT MSTG, Wi-Fi Easy Connect TG, Wi-Fi Aware TG, Passpoint TGs	
	IoT	IoT MSTG, Wi-Fi HaLow TG	



\*Source: [http://grouper.ieee.org/groups/802/11/Reports/802.11\\_Timelines.htm](http://grouper.ieee.org/groups/802/11/Reports/802.11_Timelines.htm)



# Conclusions

# Conclusion

- Wi-Fi is optimized for high performance indoor connectivity and therefore delivers the bulk of the world's data traffic, including most data traffic on mobile devices. Demand for Wi-Fi will continue to grow with increased fiber deployments and cellular generations
- Wi-Fi 6E is a resounding success and by 2024 there will be billions of devices installed globally able to operate from 5.925 to 7.125 GHz. Only countries that allow Wi-Fi access to the entire 6 GHz spectrum range will get the most benefits
- Wi-Fi 7 and Wi-Fi 8 will depend on 6 GHz access, and 320 MHz channels will be optimized for demanding emerging use cases
- 6 GHz is perfectly suited for Wi-Fi to continue to deliver the connectivity users need, there is no alternative spectrum for Wi-Fi, and 6 GHz is unsuitable for IMT

# References

# Thank you

For follow up, please contact:

Paramjit Singh Puri  
 Director Membership  
 Wi-Fi Alliance

+91 9901255116  
[ppuri@wi-fi.org](mailto:ppuri@wi-fi.org)  
[www.wi-fi.org](http://www.wi-fi.org)

**Global economic value of Wi-Fi® to reach \$5 trillion in 2025**

Wi-Fi® worldwide economic value has grown beyond expectations

In 2021, the global economic value created by Wi-Fi will reach \$3.3 trillion USD and is expected to grow to almost \$5 trillion by 2025, according to a new study commissioned by Wi-Fi Alliance®. This growth represents a 100 percent increase from the 2018 value of \$1.96 trillion to the projected value in 2025, underscoring Wi-Fi's critical role in economies across the globe.

The study, developed for Wi-Fi Alliance by economists at Telecom Advisory Services (TAS), covers 15 economies: Australia, Brazil, Colombia, France, Germany, Japan, Mexico, New Zealand, Poland, Singapore, South Korea, Spain, the United Kingdom, and the United States, as well as an estimate for the European Union.

The economic value of Wi-Fi for each economy studied was developed by assessing several key factors, plus global developments that have impacted the Wi-Fi industry—including the growing adoption of 5G, and ground-breaking applications such as smart cities and autonomous cars. The study also considers public regulatory agency announcements to relax spectrum, assuming that countries allowing Wi-Fi use in all 1,000 MHz of the 6 GHz band will maximize the economic benefits that Wi-Fi provides.

**Wi-Fi 6 and 6 GHz band bring new opportunities, economic resilience**

Due to Wi-Fi 6's increased capacity, Wi-Fi has proven to be a critical enabler of digital economic growth momentum during the COVID-19 pandemic. The study results reveal that industry-wide support for Wi-Fi growth and development is essential to continue reaping the benefits of technology-enabled. By the end of 2021, there will be 1.4 billion Wi-Fi devices in use. Market adoption of 5G will grow to 2.3 billion devices in 2021, including nearly 500 million Wi-Fi products which are capable of operating in the 6 GHz band. High-end products in the 6 GHz band enables a suite of advanced applications—such as intelligent cities, unified communications, cloud computing, and remote telepresence—the combined effect of which could exponentially increase Wi-Fi value in years to come.

**Defining and quantifying economic value of Wi-Fi**

Economists combined qualitative and quantitative data on key factors listed below for each economy to develop the economic value, as reported in USD. Once values for each country and the European Union were determined, the economists extrapolated a global value of Wi-Fi.

2021		2025	
France	\$35	\$42	\$105
Spain	\$15	\$18	\$45
Germany	\$15	\$18	\$45
UK	\$15	\$18	\$45
USA	\$15	\$18	\$45
Japan	\$15	\$18	\$45
South Korea	\$15	\$18	\$45
China	\$15	\$18	\$45
India	\$15	\$18	\$45
EU	\$15	\$18	\$45
Other	\$15	\$18	\$45
<b>Global</b>	<b>\$3.3</b>	<b>\$4.9</b>	<b>\$11.8</b>

Wi-Fi Alliance

Highlights sheet

**Global Economic Value of Wi-Fi® 2021 - 2025**

February 2021

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Study summary

**The Economic Value of Wi-Fi®: A global view (2021 - 2025)**

Developed for Wi-Fi Alliance® by  
 TELECOM ADVISORY SERVICES

February 2021

Study details

**TELECOM ADVISORY SERVICES**  
 New York - Buenos Aires - Madrid - Bogotá

**COVID-19 AND THE ECONOMIC VALUE OF Wi-Fi**

December 2020

COVID-19 and Wi-Fi