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Transformative Technology Stats You Need to Know for 2021

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Stuart Carlaw

ABI Research Chief Research Officer



From Our Chief Research Officer

At this time, when we are faced with global instability caused by the COVID-19 pandemic, the U.S. presidential election, Brexit, and global trade wars, numbers and big stats are often trumpeted, fixated upon, and largely used as a barometer to judge which way the world is turning. Another key trend that has become evident recently is that companies and industry sectors have been forced into new ways of working and digital transformation has been accelerated.

Our analysts at ABI Research have combined these two notions to help highlight those lesser known stats that illuminate the direction in which digital transformation is heading.

We have selected, from among the many millions of data points ABI Research creates each year, to focus on some enlightening data points. Aspects like Tiny Machine Learning (TinyML), private cellular networks, Open Radio Access Network (RAN), blockchain, smart manufacturing platforms, and even connected cows point to how technology advancements are allowing our physical world to be better connected, managed, and efficient.

We are at the very beginnings of a massive technological evolution and the forecasts presented in this paper are but a series of tea leaves at the bottom of the fortune teller's cup. They are easy to dismiss, but are very important directional indicators of the technology-enabled world of the future. ABI Research looks forward to helping our clients navigate, embrace, and succeed during this period of change and transformation.



5G Core and Edge Networks



Kangrui Ling
Research Analyst



Virtual Network Functions Revenue (US\$ Billions) 2020-2025					
2020	2021	2022	2023	2024	2025
\$5.0	\$6.6	\$8.5	\$11.1	\$14.4	\$18.7

ABI Research forecasts that global telco cloud revenue will grow to US\$29.3 billion by 2025 from US\$8.7 billion in 2020, at a 5-year Compound Annual Growth Rate (CAGR) of 27%. The telco cloud growth will be driven primarily by cloud infrastructure-related investments, such as Virtual Network Functions (VNFs), Management and Network Orchestration (MANO), and Cloud Native Functions (CNFs). ABI Research believes that, by 2025, the telco cloud market will be worth US\$10 billion in North America, followed by US\$9 billion in Asia-Pacific (APAC), and, finally, US\$8.2 billion in Europe.

This introduction of cloudified environments in the telco business landscape also presents some shifts in the value chain. For example, telcos are now being presented a second option of telco cloud deployment—the multi-vendor approach, in which different network equipment vendors are responsible for different components of the telco. While this approach seems to provide some benefits, such as avoiding single-vendor lock in, it also requires substantial coordination of effort, not only through robust MANO, but also between stakeholders during certain key phases of the telco cloud deployment, such as the design and planning phase.



Don Alusha
Senior Analyst



5G Network Slicing Revenue (US\$ Millions) 2020-2026

2020	2021	2022	2023	2024	2025	2026
\$297.3	\$598.6	\$1,084.9	\$1,873.1	\$3,165.7	\$5,089.8	\$8,901.1

5G network slicing stands to create approximately US\$ 8.9 billion by 2026 at a CAGR of 76%, arguably a drop in the bucket for Communication Service Provider (CSP) service revenue. CSPs continue to possess strong network assets, namely low-latency, last-mile access and core network capabilities. But for the broader industry, capturing significant new growth opportunity will vary in line with their corresponding digitization initiatives and readiness to adopt new technologies like 5G core networks and cloud-native principles. On the other hand, hyperscalers like Microsoft and Amazon are cognizant of these dynamics and are positioning themselves accordingly with telco-specific solutions like Amazon Web Services (AWS) Wavelength and Microsoft Azure Edge Zones, particularly on edge computing deployments. Though moderate in the next 5 years, new value creation abounds, but the jury is still out who captures what parts of the bigger emerging 5G edge and network slicing ecosystem.



5G Devices, Smartphones & Wearables



David McQueen
Research Director



Smartphone Shipments (Millions) 2020-2025							
	2020	2021	2022	2023	2024	2025	CAGR 2020-25
Worldwide Smartphones	1,281.2	1,379.4	1,446.3	1,494.6	1,538.4	1,583.3	4.3%
5G Smartphones	192.1	368.1	549.3	777.2	985.3	1,150.3	43.0%
5G Smartphones % Of Total	15.0%	26.7%	38.0%	52.0%	64.1%	72.7%	

5G smartphone sales will expand exponentially, reaching 1.15 billion units by 2025 and accounting for more than 70% of total smartphone sales, becoming the most accelerated mobile technology generation ever launched.

It is expected that 5G smartphone sales will increase more aggressively compared to 4G and, in comparison to growth at launch, 5G will outperform its predecessor on nearly every metric, including the number of mobile devices, subscribers, and networks. Volume sales will outstrip 4G for a number of years, largely driven by China in the early years.



David McQueen
Research Director



Smartphone Shipments By Price Tier And Year After Network Rollout (Millions)

	Year 1	Year 2	Year 3	Year 4
4G	4.7	28.7	86.9	281.6
5G	16.4	192.1	368.1	549.3
4G Above US\$600	4.7	25.8	69.5	154.9
5G Above US\$600	14.7	134.5	202.4	219.7
4G Below US\$600	0.0	2.9	17.4	126.7
5G Below US\$600	1.7	57.6	165.7	329.6

More than 60% of all 5G smartphones shipped in 2022 will be priced below \$600.

The development and introduction of more diverse and affordable 5G smartphones will be the main driver accelerating 5G adoption after 2021, with many lead vendors expected to push deeper into the segment, quickly democratizing the 5G experience and establishing a wider ecosystem. This seismic shift to lower price tiers will be underpinned by cheaper components and the continuing availability of more affordable 5G chipset platforms, notably those from Qualcomm, MediaTek, and UNISOC. Conversely, with the expected frantic pace of plunging 5G smartphone prices, it means 5G at the high-end will be squeezed, witnessing rapid saturation, while collapsing potential increases in revenue and margins.

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David McQueen
Research Director



Although the rapid growth of 5G will provide the mobile smartphone supply chain with new opportunities until 2022, the rapid saturation of the 5G smartphone market mean that Original Equipment Manufacturers (OEMs) and chipset suppliers should reduce their reliance on the smartphone market beyond 2023 and start to think about new revenue opportunities. ABI Research believes always-on and 5G-connected Personal Computers (PCs), 5G Customer Premises Equipment (CPE), and enterprise 5G devices all have the potential to become the new cash cows of the 5G value chain in the longer term.



David McQueen
Research Director



Connected Notebook Shipments (Millions) 2020-2025							
	2020	2021	2022	2023	2024	2025	CAGR 2020-25
Notebook PCs	3.24	6.26	11.30	15.68	18.80	21.48	46.0%
Percentage of Notebook PCs with Cellular	1.82%	3.44%	6.13%	8.50%	10.17%	11.59%	
5G	1.80	4.80	10.00	14.75	18.20	20.93	63.3%
5G Share of Cellular	55.5%	76.6%	88.5%	94.1%	96.8%	97.4%	

Shipments of connected notebooks will grow to 21.5 million by 2025 at a CAGR of 46%, with a 97% share connected to 5G. Despite the cellular-connect notebook market witnessing a series of false dawns, the notebook and mobile value chains are on the edge of converging with shipments of "always-on" notebooks expected to grow significantly. This harmonisation will be brought about by positioning 5G connectivity as a central pillar in the design of notebooks and PCs, with a focus on long battery life, thin and light designs, offering always-on, always connected experiences. Such a move has been sparked by a shift to ARM-based chips that not only brings deep integration between software and hardware, harnessing innovation and connectivity that has been nurtured for years in smartphones, but also gains in efficiencies and better battery life without sacrificing performance. It also means that

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David McQueen
Research Director



implementing a common architecture will allow all mobile device types, encompassing smartphones, tablets, notebooks and wearables, to work together more seamlessly opening the door to unique value propositions and improved new User Experiences (UX), which will also be much easier for developers to create new types of mobile consumer and business applications. Companies such as Qualcomm, Intel, MediaTek, Samsung, Huawei, and Apple are all at the forefront pursuing this strategy, with many connected notebook models expected to appear starting in 2022. Crucial to success will be partnerships within the sector bringing engineering, system integration, and connectivity expertise together, as well as the notable inclusion of Apple from 2022 to the 5G always-on notebooks camp, which could be the catalyst that the industry has craved to help bolster demand and deliver on the promise of enhanced, next-generation mobile compute experiences.



Eric Abbruzzese
Research Director



Worldwide 5G Fixed Wireless CPE Shipments 2019-2025 (Millions) 2019-2025

2019	2020	2021	2022	2023	2024	2025	CAGR 2020-25
0.46	1.34	4.21	5.57	6.58	9.45	10.63	51.2%

ABI Research forecasts that 5G fixed wireless Customer Premises Equipment (CPE) shipments will grow at a 51% Compound Annual Growth Rate (CAGR) through 2025, from 0.5 million shipments in 2019 to more than 10 million units in 2025.

5G technology is set to unlock the full potential of the Fixed Wireless Access (FWA) broadband market. Although Long Term Evaluation (LTE) is the key technology used for FWA services at present, significantly higher bandwidth and lower latency offered by 5G competes with existing fixed broadband services and opens up the FWA opportunity to both urban and rural areas. 5G FWA deployments, led by Verizon since 2018, are now followed by many operators in Europe, Africa, and Asia-Pacific. Chipset and CPE makers are also gearing up to address market demand. 5G FWA CPE supporting sub-6 Gigahertz (GHz) is expected to make up the majority of shipments as operators aim to achieve better coverage. However, there is strong potential for 5G FWA CPE supporting mmWave as well. CPE vendors, including Casa System, Huawei, Samsung, and others, have announced mmWave 5G FWA devices, because mmWave enables service providers to offer a new gigabit-speed broadband alternative, which is a favorable option for targeting dense urban areas. Exponential growth in adoption of live and on-demand streaming, low-latency gaming, and Augmented Reality (AR)/Virtual Reality (VR) applications in home networks will be key drivers of 5G FWA in the next few years.



5G & Mobile Network Infrastructure



Jake Saunders

Vice President, Asia-Pacific & Advisory Services



Global Installed Macro and Small Cell Backhaul Links 2019-2027

Segment		2019	2020	2021	2022	2023	2024	2025	2026	2027	CAGR 2021-27
Total Backhaul Links	(000s)	7,683	8,661	9,661	10,812	11,976	13,274	14,606	15,727	17,194	8.6%
Millimeter Band Links	(000s)	735	936	1,169	1,438	1,735	1,959	2,448	2,798	3,346	20.0%
Fiber Links	(000s)	2,039	2,504	3,026	3,625	4,267	5,011	5,734	6,452	7,301	16.5%
Millimeter Band Links	(%)	9.6%	10.8%	12.1%	13.3%	14.5%	14.8%	16.8%	17.8%	19.5%	
Fiber Links	(%)	26.5%	28.9%	31.3%	33.5%	35.6%	37.7%	39.3%	41.0%	42.5%	

From ABI Research's own analysis, the number of backhaul links will grow from 8.6 million in 2020 to 17.2 million by 2027, across macro and small cells. Fiber-optic has been the preferred tool to manage that traffic. In 2020, 28.9% of backhaul links were fiber-optic. **By 2027, fiber-optic's share of the market grows to 42.5%.** However, the millimeter wave backhaul solutions for the E-band (71~86 Gigahertz (GHz)), the W-band (92~114 GHz), the D-band (130~175 GHz), and the V-band (57 GHz~70 GHz)

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Jake Saunders

Vice President, Asia-Pacific & Advisory Services



have a CAGR that is outstripping fiber-optic (19.4% versus 16.5%). The combined backhaul links deployed using millimeter wave are expected to grow from 10% in 2020 to 19% in 2027. With fat channel sizes ranging from 500 Megahertz (MHz) to 2 GHz, offering up to 13 Gigabits per Second (Gbps) throughput, the millimeter wave backhaul solutions will provide mobile telcos greater flexibility in terms of where they can deploy macro and small cells in urban areas, while also keeping up with 4G and 5G traffic demands.

There is a tremendous amount of fanfare revolving around 5G deployments. By the end of 2Q 2020, there were 114 5G networks up and running. A burgeoning list of 5G-capable handsets are being made available from Samsung, Apple, Huawei, etc., which will further prime the amount of traffic being generated. And yet, there is an unsung hero, the “backhaul link” that hauls the end-user traffic to and from the cell site and the core network.



Dimitris Mavrakis
Senior Research Director



Total Mobile CAPEX (US\$ Billions) 2019-2025						
2019	2020	2021	2022	2023	2024	2025
\$442.8	\$426.8	\$507.9	\$497.9	\$518.9	\$539.3	\$556.8

ABI Research’s Capital Expenditure (CAPEX) and revenue forecasts indicate that the annual CAPEX required to build out a consistent 5G network in most developed markets will require up to 40% of annual telco service revenue, also referred to as capital intensity. This indicates that although 5G is starting to accelerate in the consumer domain, service revenue will not be able to justify 5G rollouts. ABI Research expects enterprise deployments to be an absolute requirement to fund nationwide 5G rollouts, especially in countries where high-frequency spectrum is allocated to 5G.



Johanna Alvarado
Senior Analyst



Enterprise Small Cell Revenue By Protocol (US\$ Millions) 2020-2025

	World Markets		North America		Asia-Pacific		Europe		Rest of World	
	2019	2025	2019	2025	2019	2025	2019	2025	2019	2025
MulteFire	-	\$395.78	-	-	-	\$257.3	-	\$60.8	-	\$77.7
CBRS	\$1.71	\$342.40	\$1.7	\$342.4	-	-	-	-	-	-

Unlicensed and shared spectrum use will be driven by enterprise deployments where the small cell market is expected to grow more than 200X in the next 5 years.

This market trend has been triggered due to the lack of a strategic approach from Mobile Network Operators (MNOs) to address enterprise use cases, particularly in the Small and Medium Enterprise (SME) domain. Enterprises now have access to spectrum with enhanced price points to use for in-building wireless infrastructure to address multiple use cases, such as industrial digitalization and factory automation. For the unlicensed spectrum use, MulteFire will be the protocol that will be largely adopted across all regions, except for North America. On the other hand, for shared spectrum use, remarkable shared spectrum initiatives, such as OnGo/Citizens Broadband Radio Service (CBRS) will drive significant growth in the small cell market in North America.



Leo Gergs
Research Analyst



Private Network Revenues (US\$ Thousands) 2020-2030

2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
\$588,545	\$1,571,937	\$2,674,893	\$4,412,194	\$6,836,356	\$10,628,957	\$16,658,259	\$24,903,464	\$35,590,927	\$49,446,135	\$64,989,405

While the total addressable market for private networks will amount to US\$64.99 billion by 2030, enterprises with annual revenue up to US\$1 billion will account for 40% of this revenue.

This forecast underlines the importance of network operators and infrastructure vendors targeting large enterprises for a long-term sustainable private network strategy. While large enterprises (of which the world bank counts several hundred thousands) will certainly drive private cellular adoption in the short term, the long-term revenue opportunity also lies in targeting the high-end medium-tier companies. To target these companies, it is imperative for the telco community to develop appealing offerings that take into account restricted financial resources for upfront investment. Therefore, the telco community needs to develop durable monetizing strategies that incorporate service-based offerings. Importantly, the telco community needs to be prepared to sacrifice short-term gains for the tremendous long-term profit opportunity that private cellular in the enterprise verticals domain will unlock.



Jiancao Hou
Senior Analyst



Total Open RAN Revenue (US\$ Millions) 2020-2030

2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
\$439	\$7,759	\$13,484	\$20,414	\$29,436	\$37,720	\$49,202	\$65,930	\$84,287	\$103,012	\$122,900

Open RAN revenue will grow from US\$439 million in 2020 to US\$122.9 billion by 2030. Powered by network virtualization and open transport interfaces, the Open RAN opportunity will invite various stakeholders to bring their best-in-class technologies for innovations and contribute to building more flexible, secure, agile, and multi-vendor interoperable network solutions. Besides, Open RAN can also reduce time to market for implementing new network functionality and help network operators and various industrial enterprise verticals save network deployment expense and operational complexity. Apart from that, the current trade wars and the global COVID-19 pandemic have resulted in tremendous restrictions on the telco supply chain and disrupted the evolution of new technologies. These distinct effects will foster the needs of Open RAN to formulate a robust telco ecosystem with healthy supply diversity.



Dean Tan
Research Analyst



Europe Base Station Antenna Sales Revenue (US\$ Millions) 2019-2025

2019	2020	2021	2022	2023	2024	2025
\$963.2	\$1,054.5	\$1,210.1	\$1,365.4	\$1,544.1	\$1,736.8	\$1,968.4

Base station antenna sales revenue will increase from US\$963.2 million in 2019 to US\$1.97 billion in 2025. The outlook for mobile cellular antennas looks robust, not just because of the 750 million residents and high Gross Domestic Product (GDP) per capita, but also 5G deployment plans. The European Commission is also pushing for a “toolbox” that will expedite the rollout of 5G and broadband across its 27 member states, which is to be agreed upon by March 30, 2021. Other regulations and frameworks have been rolled out to boost the development for 5G and telecommunication industry, such as the European Electronic Communications Code and the 5G Action Plan. The antennas market will also see positive demand drivers from multiband and massive MIMO antennas. Multiband antennas cater to the need to accommodate existing and new frequency bands with 5G. Massive MIMO antennas will be essential to increase spectral efficiency and cell capacity, a fundamental technology to achieve gigabit performance. New antenna platforms in smaller dimensions (<400 Millimeters (mm)) are released, while some are equipped with vortex generators to tackle the challenge of wind loads.



AI & Machine Learning



Lian Jye Su
Principal Analyst



TinyML Market Shipments 2020-2030

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	CAGR 2021-2030
(Millions)	27.6	57.9	103.7	176.1	261.8	429.2	701.3	1,089.1	1,623.1	2,471.7	66%
YoY	81%	110%	79%	70%	49%	64%	63%	55%	49%	52%	

A total of 2.5 billion power-constrained Internet of Things (IoT) devices are expected to be shipped with a TinyML chipset in 2030, propelled by the increasing focus on low latency, advanced automation, and the availability of low-cost and ultra-power-efficient Artificial Intelligence (AI) chipsets.

TinyML is the intersection of Machine Learning (ML) software programming and embedded hardware expertise. Through implementing ML in ultra-low power systems, low-powered devices and sensors are able to automate singular tasks and work with other AI-powered devices and sensors to bring AI to the edge. In addition, open-source software development from Google through TensorFlow Lite for microcontroller and proprietary solutions from companies like Qeexo and SensiML offer developer-friendly software tools and libraries, allowing more AI developers to create AI models for existing IoT hardware that have computational resources to support AI computation, thereby breathing fresh air into legacy devices.

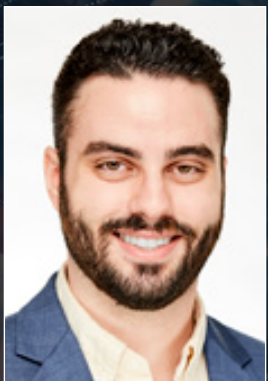


Augmented & Virtual Reality



2019	2020	2021	2022	2023	2024	2025	CAGR 2020-2025
\$292.7	\$730.9	\$1,577.8	\$4,025.9	\$7,661.5	\$12,725.8	\$18,265.5	90.3%

Augmented & Virtual Reality



Eric Abbruzzese
Research Director



Immersive (VR/AR) Enterprise Collaboration Revenue (US\$ Millions) 2019-2025

2019	2020	2021	2022	2023	2024	2025	CAGR 2019-2025
11.29	19.77	26.03	44.56	101.25	229.73	413.51	82.2%

Immersive (VR/AR) enterprise collaboration will surpass US\$410 million in revenue by 2025, growing at an 82% CAGR.

Like other markets and technologies, the COVID-19 pandemic accelerated some trends within the AR and VR space; the need for social distancing and the resulting shift to a remote workforce created new opportunities for remote collaboration at large. It also caused many companies to look beyond the traditional forms of communication for applications, including virtual meetings, training, and employee onboarding. While the immersive collaboration segment of the market is nascent, the pandemic has opened new doors and once it comes to an end, these types of technologies will continue to support a new normal that is expected to maintain a larger remote workforce. The market is ultimately limited by the penetration rate of Head-Mounted Displays (HMDs), but new hardware (including existing hardware advancements) and trends are finally drawing more parallels to the early smartphone market, rather than other tech failures like Three-Dimensional (3D) Television (TV). The pandemic also brought a new perspective to VR, in particular, which was once viewed as a technology that isolated the user. Users are now discovering the impact VR can have on bringing people together, be it family, friends, or coworkers, in ways that connect at a deeper level than traditional forms of communication. These trends will eventually flow back to the consumer market, which will further accelerate the spread to enterprise and commercial spaces, and, in time, immersive technologies will alter how we communicate, learn/educate, and experience the digital world.



Digital Security



Michela Menting
Research Director



Blockchain Information & Communication Technology Revenues (US\$ Millions) 2018-2025								
2018	2019	2020	2021	2022	2023	2024	2025	CAGR 2020-2025
\$3,644	\$2,381	\$2,252	\$2,633	\$3,397	\$4,183	\$5,641	\$7,565	27.4%

Information and Communications Technology (ICT) will reach a potential market value of US\$7.6 billion by 2025.

ICT has been the dominant revenue category in overall blockchain revenue, ranging from hardware markets for crypto-mining rigs and wallet storage to cloud-based Blockchain-as-a-Service (BaaS) offerings for enterprise applications. The crypto-winter of 2018 highlighted the volatile and risky nature of crypto-currencies, and the downturn following the COVID-19 pandemic shut out numerous potential investment opportunities.

Dampened interest and increased risk-aversion have contracted revenue-generating opportunities, with revenue down 35% Year-on-Year (YoY) between 2018 and 2019, and the trend continuing throughout 2020. As a result, the market is not expected to climb back up to 2018 levels before 2022 to 2023.

Nonetheless, these adverse events will have a positive effect on the blockchain ICT market in the longer term. First, the crypto-unicorns emerging in the last few years have had to cut out the superfluous and bootstrap operations, leading to greater efficiencies (especially in terms of mining) and stronger business models for those that survived. Further, by culling over-hyped and weak

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Michela Menting
Research Director



offerings, those blockchain applications with a genuine business use case are being quickly revealed. Certainly, the international scramble resulting from a lack of adequate medical equipment during the pandemic has exposed glaring shortcomings in the international manufacturing supply chain. Correctly leveraged, blockchain is perfectly suited to resolve these issues, and BaaS providers are poised to drive this opportunity and productize the market.

In tandem, these events will strengthen market recovery for blockchain ICT, both from a hardware and a cloud-based service perspective, leading to a potential market value of US\$7.6 billion by 2025.



Phil Sealy

Research Director



Converged eSIM/eSE Shipments (Millions) 2020-2025							
2020	2021	2022	2023	2024	2025	SUM 2020-25	CAGR 2020-25
45.24	315.99	461.59	516.15	561.01	610.49	2,510.5	68.3%

Combined Embedded Subscriber Identity Module (eSIM)/Embedded Secure Element (eSE) products are forecast to ship in excess of 610 million by 2025, thanks to future use cases that extend far beyond consumer devices within the broader IoT environment.

The year 2020 can be considered a landmark for next-generation eSIM adoption, transforming eSIMs from a standalone secure remote connectivity enabler and manager toward a solution that combines connectivity and security functionality. The first solution, the Samsung S20, launched with an integrated eSIM/eSE chipset in early 2020 and the market trajectory could not be clearer. Samsung has already extended support across its Note range, moving 2020 shipment expectations to the 45 million mark, with other OEMs rumored to follow suit. Connectivity and security convergence will play a critical role in enabling consumer OEMs to not only address remote Subscriber Identity Module (SIM) provisioning capabilities, but also security functions in order to support additional services, such as mobile payments, from a singular chipset.

IoT device OEMs continue to evaluate the best products to enable not only borderless connectivity enablement, remote provisioning, and subscription capabilities, but additionally high levels of security management and assurance across devices and fleets that can be managed over their complete life cycles, which lends itself well to the converged eSIM solution.



Dimitrios Pavlakis

Industry Analyst



Smart IoT Gateway Shipments (Millions) 2018-2025								
2018	2019	2020	2021	2022	2023	2024	2025	CAGR 2020-2025
5.8	7.0	8.5	10.3	12.9	15.7	18.0	21.4	20.2%

Smart IoT edge gateways are expected to reach 21.4 million shipments by 2025, marking an impressive 20% CAGR increase.

Instigated by the constantly evolving cyberthreat horizon, fervent expansion of IoT applications, and the ongoing pandemic, 2020 has been a significant milestone for next-generation IoT gateways. Governments, vendors, and IoT players were forced to adapt to a more intelligent edge equipped with a more automated management, connectivity, and security arsenal to counterbalance the effects of less manpower in the field (*e.g.*, industrial, manufacturing, infrastructure) or in the office (*e.g.*, enterprise, government). Near-future market demands for the IoT gateways extend far beyond interoperability and connectivity challenges and include a much higher dependence on intelligence operations, edge processing, and digital security protocols.

A symbiotic relationship between the edge and the cloud will be one of the defining factors for next-gen IoT gateways reflected at the hardware, silicon, and chipset levels, enabling native support for certain platforms, security, and device authentication options, but also at the software and cloud levels, ultimately supporting all intelligence, security, and management services. Platform-agnostic gateway services will ease implementation and increase interoperability and data-driven intelligence, thus streamlining the merger of Information Technology (IT) security tools and the Operational Technology (OT) applications across the IoT.



Sam Gazeley
 Research Analyst



Total Mobile Identifications in Circulation (Millions) 2017-2025										
2017	2018	2019	2020	2021	2022	2023	2024	2025	DIFF 2020-25	CAGR 2020-25
21.7	49.2	100.1	164.3	236.6	305.0	378.2	454.2	529.7	365.4	26.4%

Mobile national IDs will grow from an initial base of 100 million in 2019 to more than 529.7 million in 2025, thanks to significant ongoing projects, including those in Argentina, Moldova, and Turkey.

It is becoming clear that governments are looking toward mobile devices as a way to enhance and expand levels of digitization and for use as a platform to introduce new levels of transparency, flexibility, and convenience to bolt on new digital services available 24/7. The sharp market trajectory will also be positively impacted post-COVID-19, as governments seek to use mobile devices as a pandemic-proof platform to streamline Government-to-Citizen (G2C) and Citizen-to-Government (C2G) services, while creating end-to-end touchless service experiences through contactless technologies.



Freight Transportation & Logistics



Susan Beardslee
Principal Analyst



Retail Analytics & Planning Software Revenue (US\$ Billions) 2019-2025

2019	2020	2021	2022	2023	2024	2025	CAGR 2019-2025
\$5.48	\$7.43	\$9.73	\$12.21	\$15.02	\$17.88	\$21.10	30.9%

Retail supply chain technologies are growing rapidly in light of massive growth in e-commerce, with multiple retailers' digital sales up from 90% to 200+% in 2Q alone. Online sales in the United States grew over 44% YoY and nearly 32% Quarter-on-Quarter (QoQ) in 2Q 2020.

Numerous retail planning and execution gaps have been uncovered this year, including a lack of integrated solutions; both brick and mortar versus online and across Transportation Management Systems (TMSs), Warehouse Management Systems (WMSs), and Enterprise Resource Planning (ERP) systems.

Significant changes in purchase behavior patterns left many retailers with stockouts, additive costs to expedite, and challenges in scaling orders across multiple delivery mechanisms and partners. Part of the solution to address these issues is the adoption of a robust analytics and planning system. Historical-based forecasting and siloed data offer very limited benefits in the current environment.

Newer tools help build resilience. Leveraging AI and ML can anticipate problems, provide more accurate insights, and enable faster decision-making. ABI Research forecasts material growth for these retail analytics and planning software technologies, growing globally from 2019 to 2025 by over 30%.



Industrial, Collaborative & Commercial Robotics



Rian Whitton
Senior Analyst



Robotics Revenue by Type (US\$ Millions) 2019-2025							
Segment	2019	2020	2021	2022	2023	2024	2025
AGV	\$7,872	\$6,883	\$9,503	\$13,060	\$17,773	\$23,677	\$30,452
AMR	\$2,581	\$2,713	\$5,055	\$8,956	\$14,958	\$23,803	\$35,266
ROV	\$1,368	\$1,414	\$1,951	\$2,568	\$3,326	\$4,196	\$5,129
Total	\$11,821	\$11,010	\$16,509	\$24,585	\$36,057	\$51,677	\$70,846

Through improvements in sensors, algorithms, and processing, Autonomous Mobile Robots (AMRs) are becoming increasingly popular, and by 2025 will exceed Automated Guided Vehicles (AGVs) in global revenue—US\$35,266 million *versus* US\$30,452 million.

COVID-19 may have dented the ability of mobile robot vendors to deploy their solutions, but interest is way up. Companies are looking at how they can save overhead, particularly in first-mile material handling. When investments are made in the wake of the virus, onlookers can expect an acceleration in mobile robot deployments across warehouses, production facilities, and public environments for a variety of use cases. AGVs have traditionally been the most popular mobile robots. They require external infrastructure, such as magnetic tape and lasers, to navigate and are best represented by e-commerce giant Amazon.

Remotely Operated Vehicles (ROVs) require teleoperation by a human worker and offer a more niche role as robots for inspection and manipulation. As AMRs begin to mature, their improved adaptability and ability to operate without expensive infrastructure will see robots proliferate outside of logistics and manufacturing, and into real estate, malls, and field applications.



Rian Whitton
Senior Analyst



Forklift Shipments (Thousands) 2019-2025						
2019	2020	2021	2022	2023	2024	2025
2	2	3	7	16	31	54

The automated forklift market is set to grow substantially, from 2,000 units shipped in 2019 to 54,000 in 2025. Forklifts as a category include stackers, towers, tuggers, and forked vehicles designed to lift and move heavy goods throughout the supply chain. The market for autonomous forklifts is growing substantially due to the increased demand for efficiencies required for e-commerce and for increased customization demands in factories. The first mile is quickly becoming the key pain point for managers, especially from the standpoint of labor. Forklifts have previously been automated using external infrastructure like laser triangulation and magnets, but increasingly use smart sensors and machine vision to navigate autonomously. With startups like Seegrid, Gideon Brothers, Brain Corp, and Vecna partnering with established manufacturers like Yale & Hyster, Kion Group, and Toyota, the automated forklift market is one of the most promising in the entire robotics space.



Industrial and Manufacturing



Ryan Martin
Research Director



Smart Manufacturing Platform Revenue (US\$ Billions) 2019-2025

2019	2020	2021	2022	2023	2024	2025
\$16.1	\$17.9	\$20.4	\$23.2	\$26.8	\$29.9	\$32.7

Smart manufacturing platform revenue will pass US\$32.6 billion by 2025.

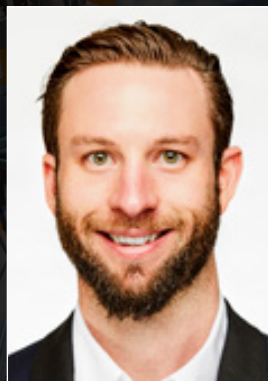
As manufacturers integrate IT and OT, they rely on Industrial IoT (IIoT) platforms dedicated to smart manufacturing to manage their devices, connectivity, infrastructure, and data. These IIoT platforms also help manufacturers implement applications, derive insights, and deliver those insights to the correct stakeholders. It seems almost every company that has built a piece of software for digital industries calls itself a “platform.” Consequently, IIoT platforms come in a variety of flavors to meet a range of needs. The most suitable definition, however, is that of an Application Enablement Platform (AEP). More than US\$32 billion will be spent on these solutions annually by 2025.

AEPs provide a solution for importing data, but they often require partners to provide gateways. Some AEPs, such as Siemens MindSphere, Emerson Plantweb, and PTC ThingWorx, provide a “one-stop shop” that can take data from devices and work like an Operating System (OS) with an app store. Some one-stop shops focus more on extracting data and getting data to the cloud, while others focus more on delivering the data to other manufacturing and enterprise systems. If app development remains open, applications can be built by the AEP provider, from partners (which may also be called platforms), end users, or independent developers, much like smartphone app stores.

Continued

There are also IIoT platforms that specialize in a specific piece of application enablement or microservice, such as adapting protocols and processing raw sensor data at the edge. Platforms that do this include Litmus Automation's Intelligent Edge Computing Platform and Foghorn's Lightning Edge AI Platform.

No single firm can meet the needs of all customers, so most IIoT suppliers have partner ecosystems. This includes everyone from industrial gateway providers like Cradlepoint, MultiTech, and Dell to major industrial powerhouses like Siemens, Rockwell Automation, ABB, and Bosch. The hyperscalers—Amazon and Microsoft—are the newer entrants in the mix.



Ryan Martin
Research Director





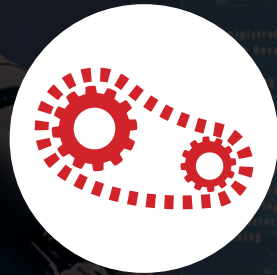
Michael Larner
Principal Analyst



Connections to Industrial Smart Glasses (Millions) 2019-2025						
2019	2020	2021	2022	2023	2024	2025
1.41	2.10	3.83	6.74	10.68	15.30	20.90

Industrial smart glasses will no longer be a novelty on the factory floor with the number of connections forecast to grow from 1.4 million in 2019 to 20.9 million in 2025 (at a CAGR of 57%).

The rapid growth in connections reveals that solutions based on AR are fast becoming a mainstream technology on the factory floor. The glasses can increasingly be part of manufacturers’ plans for onboarding staff, for providing top-up training in context, and for enabling more experienced staff to remotely support juniors. As well as maturing use cases, the growth in connections is evidence that the glasses will become comfortable enough to wear over an extended period and that investments in cellular networks means that the embedded software can support the staff in real time.



M2M, IoT, and IoE



Dan Shey
Vice President, Enabling Platforms



Cellular M2M Module Shipment Share by Air Interface 2018-2025									
Air Interface	2018	2019	2020	2021	2022	2023	2024	2025	CAGR 2020-25
2G	44%	31%	28%	21%	15%	9%	5%	2%	-24%
3G	17%	13%	13%	12%	10%	7%	4%	3%	-7%
4G	39%	55%	59%	67%	74%	82%	88%	88%	38%
5G	0%	0%	0%	0%	1%	2%	3%	7%	346%

Though 5G shipments will experience a 346% CAGR between 2020 and 2025, 4G shipments will still account for 88% of all shipments by 2025.

While all the hype is around 5G, the cellular technology that will rule IoT connections over the next decade will be 4G for several reasons. First, the Low-Power Wide-Area (LPWA) variants of Cat M and Narrowband (NB)-IoT within The 3rd Generation Partnership Project (3GPP) specifications (Release 13) have been adopted to become the Massive Machine Type Communication (mMTC) 5G specifications (Release 16). In effect, there will not be a replacement for Cat M and NB-IoT as 5G networks are rolled out. This is a major factor because of the 88% of device shipments on 4G networks, over ¾ of 4G device shipments will be Cat M and NB-IoT devices. Second, 4G will have the best coverage of any network, again supported by Cat M and NB-IoT whose link budget are the lowest of any other cellular technology enabling wide coverage in rural areas and impressive in-building penetration. Third, high

Continued

category (*i.e.*, 12, 16) 4G devices are far less expensive than 5G Enhanced Mobile Broadband (eMBB) devices; partly due to the higher volumes, but also due to fewer spectrum frequencies for 4G networks relative to 5G networks, which add Bill of Materials (BOM) costs and complexity to both the baseband chip and the antenna configuration. 4G will be the workhorse powering cellular IoT connections in the 2020s!



Dan Shey

Vice President, Enabling Platforms





Jamie Moss
Research Director



NB-IoT (NB-LTE) Shipments and Market Share 2019-2025							
	2019	2020	2021	2022	2023	2024	2025
Shipments (Millions)	43.1	54.1	76.0	113.5	168.1	263.5	378.1
Market share (%)	16%	18%	21%	26%	30%	35%	37%

NB-IoT module shipments increased by more than 180% in 2019 to 43 million units, legitimately becoming a mass-market technology. A massive 96% of all NB-IoT modules came from Chinese vendors, with half of the global total coming from just one vendor, and 65% of all shipments being destined for use within China itself. The question of how NB-IoT can break out to become a worldwide force is important, considering more than 110 networks have been rolled out by carriers. The persistence of 2G has delayed matters, but NB-IoT roaming is helping by allowing centralized manufacturing and regional activation of NB-IoT devices. Alarms, trackers, meters, and sensor manufacturing is proliferating and will propel NB-IoT module shipments to 378 million units annually in 2025, making it the single most numerous cellular technology powering the IoT, twice as substantial as the next closest technology.



Kateryna Dubrova
Research Analyst



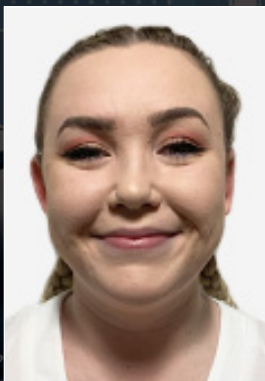
IoT Streaming Analytics Revenue (US\$ Millions) 2018-2026

2018	2019	2020	2021	2022	2023	2024	2025	2026	CAGR 2018-26
\$150.37	\$207.79	\$321.42	\$398.43	\$504.70	\$667.78	\$879.82	\$1,102.63	\$1,418.19	32%

ML on streaming IoT analytics pivots the way for Continuous Intelligence (CI) and is expected to reach US\$1.4 billion by 2026.

With the growth of data-agnostic software technologies within the IoT, combined with increases in streaming data volumes and technology advancements, more and more products are coming to market capable of analyzing data in real time. Businesses are looking for a data-driven decision-making mechanisms in real time, so vendors are accommodating the mechanism of seamless and automated data processing tasks. Alongside this, there is an emergence and greater accessibility of ML algorithms and AI technologies, which vendors are offering as-a-Service in the cloud space to consolidate data sources and enable automation of the data transformation process. Therefore, there is a clear trend for vendors to offer the application of ML and AI to the stream processing and real-time data for instant insights and instant actionable intelligence.

The growth of real-time analytics is a fundamental pillar for further development and expansion of CI. The idea behind CI is to produce actionable insights in real time from streamed data through the use of ML and AI. Hence, the expansion of streaming analytics ML and AI services pivots the way to turn CI into reality.



Harriet Sumnall
Research Analyst



Connected Cows Worldwide (Thousands) 2020-2026

2020	2021	2022	2023	2024	2025	2026	CAGR 2020-26
11,973.1	14,157.8	20,737.4	26,400.2	35,891.9	49,561.8	60,335.6	38%

By 2026, the number of connected cows will reach 60 million globally, meaning cattle ranchers will be able to have greater visibility into cattle activity and health. For context, 60 million connected cows only represent 2% to 6% of total cows, depending on the region.

Tech for agricultural purposes has been developing and is becoming more popular as agricultural businesses have been put under more pressure to produce larger amounts of crops and other agricultural byproducts. Livestock can be one of the most expensive agricultural services, with the death of a calf costing thousands, which can be prevented with the use of agricultural IoT solutions.

The year 2020 has been a turning point for several verticals, but with the year that saw most of the world in a lockdown due to the pandemic, the agricultural market has seen huge pressure to produce more food. Ag-tech enables farmers and ranchers to be able to remotely monitor their livestock, as well as other types of crops, *etc.*

A large number of forecasted connections within the agricultural sector will be enabled by LPWA technologies. The regions of Asia-Pacific and Africa offer a larger number of connections due to the value their cultures place on cattle, which is why technology vendors like Cattle Watch are specifically targeting these regions for their deployments. Although there is much emphasis on cows for remote monitoring technologies, there are also monitoring solutions for other livestock, such as sheep.



Tancred Taylor
Research Analyst



Cellular LPWAN (LTE M/ NB-IoT) Asset Tracking Device Shipments (Millions) 2018-2024								
Shipments	2018	2019	2020	2021	2022	2023	2024	CAGR 2018-24
(Millions)	0.7	2.7	5.0	9.3	20.9	53.3	145.6	143%

Asset tracking is reaching a point of exponential growth, with the CAGR expected to increase 143% between 2018 and 2024.

A key aspect of this is technology enablement on the electronic and on the network sides. The buildout of modernized cellular network infrastructure has enabled lower-cost and lower-power devices with increasing roaming capabilities, which will allow a cellular LPWA Network (LPWAN) to overtake proprietary LPWAN technologies within the next 3 years. Chipset and module vendors are escalating their production and range of hardware operating on these networks in response to the carriers’ infrastructure buildouts, and this is reflected all the way down the value chain where the majority of tracking device OEMs are building out their product range to operate on Long Term Evolution for Machines (LTE-M)/NB-IoT networks. Low-power connectivity also means smaller devices as battery requirements diminish, leading to increasingly granular tracking at the item level, thus opening broad new high-volume markets. The growth of the asset tracking market will transform supply chains and logistics, and enable a new age of global asset visibility.



Smart Cities and Smart Spaces



Dom Bonte

Vice President, Verticals/End Markets

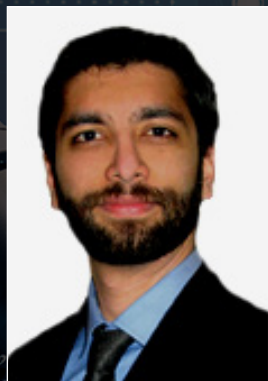


Global Smart ITS Camera Shipments (Thousands) 2019-2025

2019	2020	2021	2022	2023	2024	2025	CAGR 2020-25
34.89	33.17	48.60	70.89	95.45	126.42	155.73	36.2%

Following a slight dip in 2020 due to COVID-19, shipments of smart AI-based Intelligent Transportation Systems (ITS) cameras are expected to grow at an CAGR of more than 36% from around 33,000 in 2020 to more than 155,000 in 2025.

Smart cameras are being deployed for a wide spectrum of ITS use cases ranging from sophisticated traffic management based on prioritization and preemption, to parking access and detection, and urban and highway tolling. Applications vary from basic Number Plate Recognition (NPLR) to advanced machine vision capabilities, such as vehicle categorization, detection of different types of traffic participants, including pedestrians and cyclists, and even vehicle occupancy detection for High Occupancy Tolling (HOT) and in-vehicle driver monitoring. Advances in AI-capable processors featuring hardware acceleration, high-performance neural net software frameworks, and edge analytics are propelling smart cameras into the mainstream, offering more features and flexibility at lower price points compared with legacy traffic and Electronic Toll Collection (ETC) sensors like magnetic loops and Radio Frequency Identification (RFID). The entire ITS ecosystem is being transformed by connected smart cameras displacing often non-connected legacy traffic management solutions allowing real-time intersection management via intelligent traffic lights at lower maintenance costs. Smart ITS cameras, in conjunction with Vehicle-to-Everything (V2X) and 5G connectivity, are set to disrupt a fragmented and conservative ITS industry, via a slew of new traffic monitoring, tolling, and parking use cases enabling end-to-end optimization of multi-modal mobility in the smart cities of the future.



Adarsh Krishnan
Research Director



Smart Building Software-as-a-Service Revenue (US\$ Millions) 2018-2026

2018	2019	2020	2021	2022	2023	2024	2025	2026	CAGR 2019-26
\$5,499.3	\$6,510.0	\$5,772.6	\$5,900.7	\$6,612.6	\$7,426.6	\$8,429.4	\$9,815.8	\$11,333.0	12%

Smart building software platforms offered as a Software-as-a-Service (SaaS) will witness robust double-digit revenue growth and an 12% CAGR between 2019 and 2026, even as the overall revenue for commercial building automation contracts in the next 6 years due to the COVID-19 pandemic. Smart building technologies will play a crucial role in expanding the traditional role of Building Management Systems (BMSs) to support new applications that ensure occupants' health, wellness, and security.

The growth in software services revenue is driven by the growing demand for the new generation of smart building applications, such as space management, environmental sensing, asset management, cleaning, and hygiene management, to improve building health and safety. While these new occupant-centric, smart building applications can operate as independent sub-systems, its value to building managers will be multifold when these new sub-systems are integrated either on-premises or in the cloud to complement traditional building systems, such as Heating, Ventilation, and Air Conditioning (HVAC), Lighting, access control, and fire/life safety systems.



Smart Home



Jonathan Collins
Research Director



Smart Home Installed Base Recurring Revenue in North America (US\$ Millions) 2020-2025						
2020	2021	2022	2023	2024	2025	CAGR 2020-25
\$3,240.41	\$2,883.78	\$2,477.68	\$2,036.34	\$1,738.16	\$1,463.49	-14.7%

Recurring revenue from smart home services falls 14.7% between 2020 and 2025 in the leading North American market, despite growing smart home shipments. Over the same period, more than 20 million North American homes will start using smart home technology and more than 1.5 billion smart home devices will ship in the region.

Falling recurring revenue flows from growing consumer expectations for free services. Smart home service providers and OEMs must develop strategies and support for monetization methods beyond subscriptions, especially given the ongoing cost of cloud support for their connected services. Leveraging connected customer relationships will be key, either through internal efficiencies enabling pinpointed marketing or product development feedback or external revenue streams, such as monetizing third-party access to consumer data analysis and understanding.



Smart Mobility and Automotive



James Hodgson
Principal Analyst



Global Camera-Based DMS Revenue (US\$ Millions) 2020-2030

2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
\$10	\$103	\$318	\$481	\$605	\$943	\$1,170	\$1,489	\$1,757	\$1,972	\$2,106

A growing focus on improving in-vehicle perception to advance automotive safety will drive the adoption of camera-based driver monitoring systems, resulting in US\$2.1 billion in revenue in 2030.

Formerly a niche system on high-end models, the technology will now be featured in the European New Car Assessment Programme's (EuroNCAP) testing protocols and will be mandated in the European Union (EU) from 2022. While the European Commission (EC) mandate will also cover Autonomous Electronic Braking (AEB), this will have the effect of reinforcing an already high penetration rate, whereas the Driver Monitoring System (DMS) growth is set to outperform all other active safety Advanced Driver-Assistance Systems (ADAS) due to minimal adoption to date. Core applications will include fatigue detection and attentiveness monitoring, with premium OEMs differentiating through value-added functions, such as gesture control. In the longer term, DMS will play a key role in monitoring driver engagement in semi-autonomous functions.



Maite Bazerra
Research Analyst



Shipments of New Vehicles with Android Automotive-Based Infotainment Systems (Millions)
2019-2030

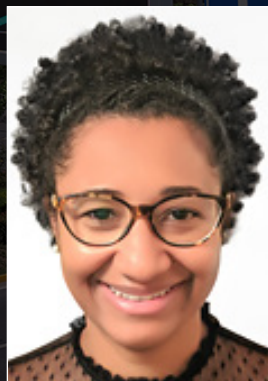
2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
0.00	0.08	1.79	2.05	2.91	4.17	6.24	9.15	13.43	19.54	28.59	35.64

Shipments of new vehicles with Android Automotive-based In-Vehicle Infotainment (IVI) systems will surpass shipments of cars with QNX-based IVI systems in 2027, and vehicles with Automotive-Grade Linux (AGL)-based IVI systems in 2029, to reach 36 million shipments in 2030.

The migration from closed systems to open-source platforms, such as AGL, provides considerable savings in development due to the enormous community of developers. As a consequence, prominent carmakers like Toyota and Audi have migrated from QNX to AGL. However, with Google entering the automotive segment and bringing the first Android Automotive into a car in 2020 in collaboration with Aptiv, both QNX and AGL are losing space. Android Automotive is ideal for mass-market vehicles because it contains the main automotive extensions (e.g., audio, navigation, and Bluetooth stacks) pre-developed, reducing time and cost of development, even in comparison to AGL. Moreover, built-in Google services provide access to other connected devices and a smartphone-like experience to the cockpit at lower costs. Reassuring the potential of Android Automotive, the PSA Group recently announced that, from 2023, its vehicles will be powered with the Android Automotive OS, joining Polestar, Volvo, GM, and the Renault-Nissan-Mitsubishi Alliance. Moreover, apart from Aptiv, other leading Tier Ones, such as Harman, Continental, and Vis-

Continued

teon, now offer Android-based infotainment platforms. While AGL was an initially preferred alternative to avoid lock-in into Google services, Google's Open Source Project provides an open-source platform in an environment that facilitates the creation of applications by third-party developers, enabling customers to design custom IVI systems. Due to increased migration to open-source platforms, QNX is positioning itself as a mission-critical OS that integrates Android and Linux in infotainment platforms safely and securely. QNX remains a leader in the ADAS industry.



Maite Bazerra
Research Analyst





Wi-Fi, Bluetooth, and Wireless Connectivity



Andrew Zignani
Principal Analyst



Smartphone Shipments (Millions) 2019-2025							
	2019	2020	2021	2022	2023	2024	2025
UWB-Enabled Smartphones	42.39	162.88	210.34	314.11	382.36	459.67	513.78
6GHz Capable Wi-Fi Chipset Shipments	0	33.16	136.71	357.52	678.57	1,070.79	1,603.36

Ultra-Wideband (UWB) is projected to become a mainstream consumer connectivity technology over the next 5 years, with **ABI Research forecasting shipments of UWB-enabled smartphones to reach well over 500 million by 2025**. UWB has experienced a large amount of growing momentum in recent months, with an increasing number of devices and chipsets supporting accurate and robust, secure, Centimeter (cm)-level, real-time ranging and positioning technology all at a very low-power budget. Smartphones, in particular, are set to lead the UWB market, with the technology offering the ability to accurately locate other UWB-enabled devices, unlock doors or vehicles hands-free, and automatically pay for products wirelessly. In addition, the Real-time Location System (RTLS) space is increasingly leveraging UWB technology for cm-level accuracy within a variety of enterprise environments. As the technology becomes increasingly adopted within smartphones, it will open up considerable new opportunities for new devices, use cases, and services to emerge within both the enterprise and consumer markets.

The increased availability of the 6 GHz band for unlicensed use across the globe will help revolutionize Wi-Fi’s performance and capacity, enabling the technology to provide more deterministic, reliable, and secure performance than ever before. **By 2025, ABI Research forecasts that more than 1.6 billion Wi-Fi chipsets will support the 6 GHz band**, leveraging technologies like Wi-Fi

Continued



Andrew Zignani
Principal Analyst

6E and, in the future, Wi-Fi 7. These continued improvements will help deliver high-throughput, low-latency services in line with 5G across a number of environments ranging from homes and enterprises to public venues and industrial deployments. High-density deployments, such as stadiums, airports, conference halls, and other venues suffering from congestion, will benefit greatly from this additional capacity, while the greater availability of 160 MHz-wide channels in the 6 GHz band will enable low-latency, multi-gigabit connectivity to better support a number of advanced use cases, such as AR/Virtual Reality (VR). Indoor enterprises will see an enormous boost in capacity and speed thanks to the use of wider 80 MHz or 160 MHz channels compared to the more common 20 MHz/40MHz channels of today, while 6 GHz mesh solutions within the home can help deliver gigabit throughput to each room. 6 GHz Wi-Fi will help enable, arguably for the first time in its history, the potential of Wi-Fi, and the new enhancements brought about by Wi-Fi 6, to be fully realized. However, potential regional variations in spectrum availability and the push for licensed use of the 6 GHz band in countries like China and Russia could restrict market opportunities within these regions in favor of 5G.





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