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Key Innovative Industries in Taiwan

Communications Industry

Information Security	New Generation Automobiles	Communications Industry	Circular Economy	Green Energy
Biopharmacy	Smart Machinery	Semiconductors	Internet of Things	International Logistics and E-commerce

CONTENTS

Policy Initiatives

1 | Smart Taiwan |

Taiwan launched the "Digital Nation & Innovative Economic Development Program (2017-2025)" (DIGI+) at the end of 2016. DIGI+ places equal emphasis on software and hardware and builds infrastructure that will benefit digital innovation and lay a solid foundation for a digital nation. In 2021, the DIGI+ Program was renamed and upgraded to the "Smart Nation Program (2021-2025)" and included information security, Beyond 5G (B5G) satellite communications, next-generation semiconductors, cloud era industry transformation, advanced network infrastructure, and other advanced technologies to promote the overall digital transformation of the nation, society, and industries. In terms of communications infrastructure, Taiwan will accelerate 5G broadband infrastructure and verification, complete advanced network infrastructure, promote B5G satellite communications, enhance cybersecurity protection, create bandwidth policies, formulate bandwidth policies, and implement legal adjustments to respond to the arrival of the digital society.

The "Communications Industry Development Project Office, Industrial Development Bureau, Ministry of Economic Affairs" is the unit responsible for promoting development in Taiwan's communications industry. The Office acts as a government think tank responsible for comprehensively developing the network communications industry and for guiding industries to invest in the development of integrated solutions. The Office integrates resources and links startups and international platforms to develop innovation capabilities and talents, striving to enhance the competitiveness of Taiwan's communications industry.

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2 Forward-Looking Infrastructure Development Program - Digital Infrastructure

The "Forward-Looking Infrastructure Development Program - Digital Infrastructure" is created based on the "Digital Nation & Innovative Economic Development Program (DIGI+)" passed by the Executive Yuan in 2016. The government allocated a special budget of NT$87.4 billion to be invested across 3 phases from 2017 to 2022. Due to significant changes in people's lifestyles and habits in the post-pandemic era, the contactless economy has accelerated the digital transformation of industries and expanded national demand for digital infrastructure. The government, therefore, adopted the vision of "constructing a digital infrastructure to support Taiwan's development in the next 10 years" in the 4th period (2021-2025). The strategy is to "use 5G to drive Taiwan's digital transformation and global positioning," to develop "Smart Taiwan," accelerate digital transformation in Taiwan, and accumulate digital competitiveness of the country in the post-pandemic era.

3 Taiwan Mobile 5G Project

In May 2019, Taiwan launched the "Taiwan 5G Action Plan" (2019-2022), which calls for NT$20.47 billion in investments over 4 years. The Action Plan aims to "promote field-tested 5G vertical applications," "establish a development environment for innovative 5G applications," "establish comprehensive 5G core technologies and data security protection," "planned release of 5G bandwidths that meet overall interests," and "adjust regulations to foster an environment advantageous for 5G development." Taiwan also will develop various value-added and vertical application services in 5G telecommunications with deregulation, innovation, proofs of concepts, and forging of connections to establish Taiwan as an environment suitable for the development of innovative 5G applications, enhance digital competitiveness, promote industrial innovation, and realize smart living.

The government in Taiwan has released 3.5GHz and 28GHz commercial bandwidths based on the "Taiwan 5G Action Plan" for telecommunications operators to provide 5G services to consumers and businesses. The 100Mhz bandwidth from 4.8GHz to 4.9GHz is provided for exclusive 5G networks for applicants from different fields to apply for tests in the first half of 2022.

4 | Asia New Bay Area 5G AIoT Innovation Park |

Taiwan inaugurated the "Asia New Bay Area 5G AIoT Innovation Park" in Kaohsiung on December 6, 2021. Spearheaded by the Ministry of Economic Affairs, "Asia New Bay Area 5G AIoT Innovation Park Promotion Plan" is expected to invest approximately NT$11 billion between 2021 and 2025 to set up an end-to-end application and demonstration site for 5G AIoT (refer to

Note: Kaohsiung Music Center was inaugurated on October 31, 2021. Kaohsiung Port Terminal is scheduled to open in January 2023.
Source: Economic Development Bureau, Kaohsiung City Government.

Figure 1 Kaohsiung Asia New Bay Area- 5G and AIoT Innovation Park Environment

Figure 1). Domestic and foreign telecommunications operators, cloud service providers, system integrators of all industries, and startup teams will adopt a "large companies supporting small companies" approach to form industrial clusters and attract domestic and foreign accelerators, incubators, and entire startup platforms. The aim is to create a comprehensive industrial ecosystem and become the largest 5G AIoT innovation testing facility in Taiwan.

The "Asia New Bay Area 5G AIoT Innovation Park Promotion Plan" includes five measures: (a) Expand phase 2 of Kaohsiung Software Technology Park and corporate HQ area; (b) establish startup parks and attract international accelerators; (c) create an incubation hub and work with leading local companies to cultivate talent for content technologies; (d) complete the infrastructure necessary for smart city technologies, such as 5G networks and smart light poles; and (e) leverage the Kaohsiung Music Center, Exhibition Hall, Esports Arena, and Port Terminal to provide 5G and AR technology experiences. The 5G AIoT Innovation Park Promotion Plan is a cross-agency plan jointly implemented by the Ministry of Economic Affairs and the Economic Development Bureau of the Kaohsiung City Government. Inaugurated in December 2021, the "Asia New Bay Area 5G AIoT Program Office" under the Ministry of Economic Affairs is responsible for joint development, focusing on the implementation of field tests and commercial applications for Asia New Bay Area 5G AIoT. The Office will also leverage government subsidies and resources such as the A+ Industrial Innovation R&D Program to help companies accelerate technological development.

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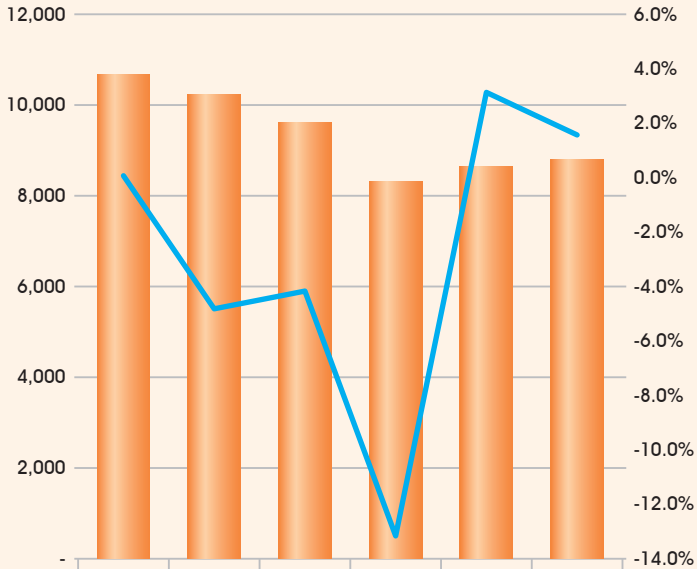
Overview of Industrial Development

1 | Output Value |

Equipped with manufacturing systems for several communications products, Taiwan is one of the key players in the global communications industry. The output value of Taiwan's communication equipment industry (including network communication equipment and personal mobile devices) was NT$873.4 billion in 2021. In 2020, The rollout of 5G networks in Western countries was delayed due to the COVID-19 pandemic, slowing the revenue growth of network operators and reducing investments in equipment. The market demand for equipment and chips also fell, and the output value of Taiwan's communication equipment industry fell by 13.2% in 2020 compared to 2019. In 2021, the industry benefited from the post-pandemic digital transformation of companies and the contactless economy as global demand for network equipment and 5G communication products increased. Despite the pandemic's impact on offshore production sites of Taiwan's network communication industry and challenges in component supplies, the industry achieved incredible results in 2021, and the overall network communication industry grew by 3.3% compared to 2020.

In 2022, Taiwan's network communication industry is expected to take over 5G development with the gradual expansion of 5G coverage, intensified development of vertical applications, and the open 5G framework ecosystem in the growth of enterprise private networks. The optimization of non-terrestrial networks (NTN) based on low-earth-orbit satellites, artificial intelligence, and mmWave communication will be critical for the development of Beyond 5G (B5G). However, the lockdown in mainland China in 2022 Q2 has affected the shipments of smartphones from Taiwan. The overall output from the communication technology industry is expected to reach NT$885.7 billion in 2022, an 1.4% increase from 2021 (refer to Figure 2).



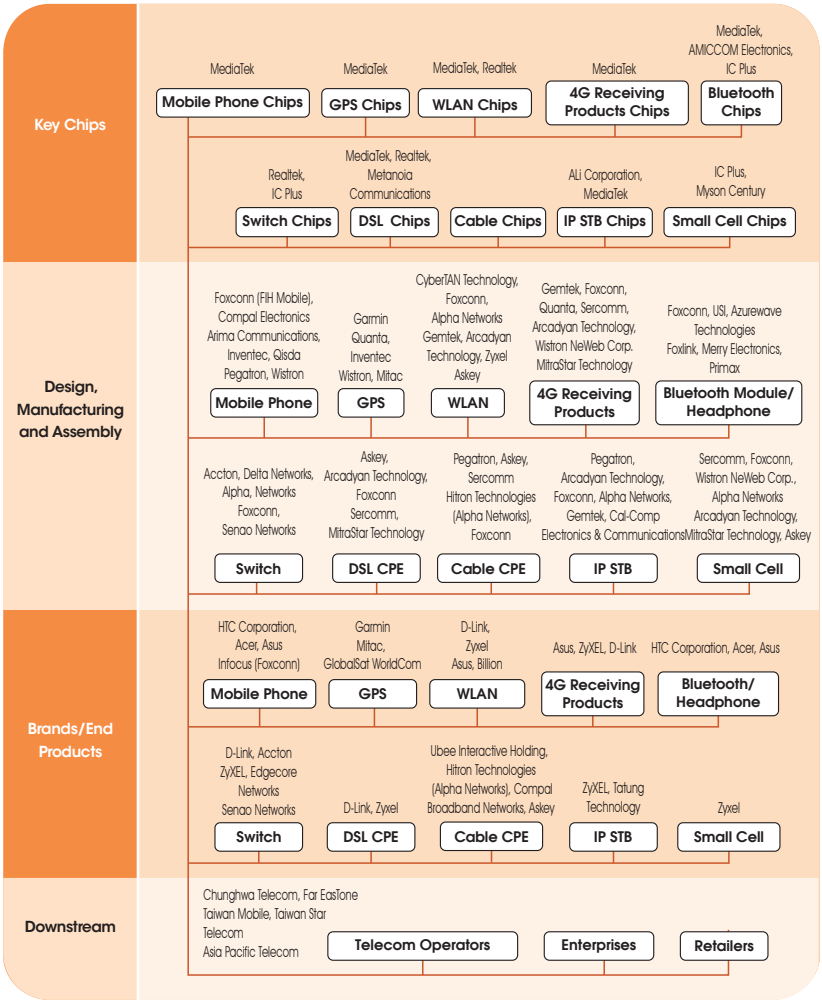
	2017	2018	2019	2020	2021	2022
Output (NT$, in 100 millions)	10,668	10,163	9,736	8,455	8,734	8,857
Growth Rate (%)	-0.6%	-4.7%	-4.2%	-13.2%	3.3%	1.4%

Source: Industry, Science and Technology International Strategy Center, ITRI.

Figure 2 Output Value of Taiwan's Communications Industry in 2017-2022

2 | Industry Value Chains |

Taiwan's communications industry is very comprehensive, and Taiwanese companies excel in system product design, production, and assembly. Figure 3 shows the main products and companies in the upstream and downstream parts of the communications technology industry. In terms of upstream manufacturing of key chips, Taiwan's communication chip manufacturers have actively invested in the market in recent years, and companies such as MediaTek, Realtek, and ALi Corporation have performed well across the world. In terms of midstream communication equipment, companies have made preparations for OEM and brand management. Companies mostly work with telecommunications operators in Western countries to provide OEM manufacturing and design services. However, many network communications operators have leveraged their strong design and production capacity and entered the white-label hardware market. In terms of brand management, many companies have continuously invested in the development of mobile phones and network communication equipment. Downstream operators consist mainly of telecommunications operators who focus on the domestic communication services market.



Source: Industry, Science and Technology International Strategy Center, ITRI.

Figure 3 Communications Industry Chain in Taiwan

3 | Industrial Clusters |

1. Clusters in Northern Taiwan

Taiwanese companies involved in the communications industry include IC manufacturers, equipment manufacturers, equipment branding companies, and telecom operators. Generally speaking, Taiwan's communications industry clusters are located in the northern parts of Taiwan, including Greater Taipei, Taoyuan, and Hsinchu, where Neihu Technology Park, Hsinchu Science Park, Tai Yuen Hi-Tech Industrial Park, and Guishan Township (Taoyuan) are located. Taiwan's leading communications companies are Accton Technology, Sercomm, and Wistron NeWeb. Leading telecom operators are Chunghwa Telecom, Far EasTone, and Taiwan Mobile.

2. Central and Southern Taiwan

Communications companies in central Taiwan are mainly automobile communications electronics and consumer electronics manufacturers such as Merry Electronics and Jabil Green Point. Even though southern Taiwan is home to Kaohsiung Software Technology Park and Southern Taiwan Science Park, occupancy by communications companies is lower than in northern Taiwan. However, after the establishment of the "Asia New Bay Area 5G AIoT Innovation Park" in Kaohsiung, more companies are expected to set up operations in Southern Taiwan. The "Asia New Bay Area 5G AIoT Innovation Park" has attracted companies such as Compal Electronics, Cisco Taiwan, Wistron, and Askey to set up operations and attracted major partners including Chunghwa Telecom, Far EasTone, and Microsoft Taiwan.

Potential Investment and Collaboration Opportunities in Taiwan

1 Leveraging Taiwan's industry clusters and advanced technology R&D capacity to invest in technology R&D collaboration or establishment of product manufacturing bases

Taiwan's communications companies have both manufacturing and global logistics capabilities and a comprehensive industrial chain, with strengths in networking chips, parts and components, touch panels, and system integration. In upstream base components, for example, Taiwan Semiconductor Manufacturing Corp. (TSMC) has partnered with leading IC vendors such as Qualcomm to develop and produce 5G chips for OEM. Taiwan's MediaTek has now launched 5G System-on-Chip (SoC) products that are compatible with both Sub-6 GHz and mmWave bands. WIN, Wha Yu Industrial, Universal Microwave Technology (UMT), Advanced Wireless Semiconductor (AWSC), and other companies are working on power amplifiers, antennae, and radio-frequency components. In the midstream segment, Taiwanese manufacturers are working on networking and hardware infrastructure (switches, routers, micro-cells, consumer premise equipment, and set-top boxes). For downstream end-user applications, Quanta, Advantech, and Gigabyte are developing virtual platform servers; Askey, Wistron NeWeb, Jorjin Technologies, and HTC are developing wearable devices.

In addition to a comprehensive communication technology industry cluster, Taiwan offers abundant technological and manufacturing capacity with advanced technology R&D capabilities. The US Department of State specified in the latest “Investment Climate Statements: Taiwan” published in July 2021[1] that Taiwan is at the center of regional high-tech supply chains due to our dominant role in the international technology supply chain with advanced R&D capability in developing products for emerging technologies such as semiconductor, 5G telecommunication, AI, and the Internet of Things (IoT).

Taiwan's complete communications industry cluster and high-end R&D capabilities can help foreign companies with technology R&D, smart application system development, and subsequent commercialization and hardware production. It can also improve the performance of R&D centers and manufacturing bases established by multinational companies in Taiwan. Since 2021, Taiwan's government has also implemented a plan for promoting Taiwan's development as Asia's "Center of Advanced Manufacturing" and "Center of Advanced Semiconductor Manufacturing." As 5G commercial applications are rolled out across the globe and as the demand for high-end production technology R&D and wafer manufacturing technology increases, foreign companies can make use of Taiwan's existing advantages in industrial clusters, division of labor, manufacturing and production, and high-end R&D capabilities for investment or partnerships in Taiwan and work together to pursue business opportunities in the communication technology industry.

1 Economic Daily News (July 23, 2021), "US Department of State: Taiwan Plays Crucial Regional Role in 5G and Semiconductor Supply Chain", https://money.udn.com/money/story/5612/5621166

2 Utilizing Taiwan's open 5G verification platform that meets international specifications to jointly develop 5G equipment and application services

Developing a 5G Open Radio Access Network (Open RAN) will create opportunities for telecommunications operators, software and hardware companies, and system integration providers to collaborate. In 2021, the "5G Open Radio Access Network" set up by the Industrial Development Bureau, Ministry of Economic Affairs of Taiwan received Telecom Infra Project (TIP) certification and became the second TIP community lab with open 5G architecture system integration and TIP certification. The "Auray Lab" established by the antenna manufacturer Auden Techno Group received Open Testing and Integration Centre (OTIC) certification for third-party labs from the O-RAN Alliance, which has 5 OTIC labs across the globe, with Auray Lab being their first in Asia, once again demonstrating Taiwan's critical role in promoting Open RAN certification.

In addition, as 5G specifications and technologies require repeated tests and corrections in different areas during development, massive amounts of data must be collected for analysis. Taiwan has such advantages as strong data security, high-speed and stable network connections, and a large pool of professional ICT talents. Many cloud data and edge computing companies such as Google and Microsoft have, as a result, set up data centers in Taiwan in recent years. 5G applications require massive data collection and analysis, and Taiwan can provide suitable sites for data storage and analysis, which is also a critical advantage for the development of 5G applications.

Taiwan network communication companies are equipped with excellent technical capabilities and have access to an open 5G verification platform and cloud data/edge computing sites that meet international standards. Foreign companies can cooperate with Taiwan's network operators to develop business opportunities for 5G equipment and application services.

3 Taiwan as a Base for the Development of 5G Business Models and Innovative Applications

Taiwan has high network coverage as well as diverse industries and consumer culture, offering an ideal test environment for smart manufacturing of industries and smart transportation, smart healthcare, and new retail for consumer applications, which makes Taiwan an incredible location as testing grounds for innovative 5G applications. Taiwan's telecom operators have actively built their own 5G testing facilities to develop a new business model for 5G. The availability of open networks and communications infrastructure will hopefully encourage vendors to experiment with different solutions. The Industrial Development Bureau also continues to promote field-tested 5G vertical applications to support the industries' development of 5G technologies and applications.

After the licensing for commercial bandwidths in the domestic market and the opening of 5G mobile broadband services, we expect to see smart healthcare, smart transportation, smart factory, and other vertical applications being gradually implemented. Foreign companies can capitalize on Taiwan's comprehensive vertical integration and commence collaborative tests and development of 5G applications and services.

4 Partnering with Taiwan to Take Advantage of Emerging Opportunities Due to COVID-19

The COVID-19 pandemic has driven changes in industries and accelerated the development of the "three zero" business model, i.e., the zero-contact economy (remote work and online meetings), zero-human production (automatic production, warehousing, and logistics), and unlimited applications (artificial intelligence and big data analysis), giving rise to new information and communication technology products and applications. The pandemic has increased the demand for remote work, video conferencing, online shopping, channel service logistics, and home entertainment. With the development of 5G communication technologies, companies now regard AR/VR/MR, digital twin, and other immersive and virtual/real integration technologies and services, and the recent rise of the metaverse as "key applications" with immense business opportunities. As a key hub of the global communications industry, Taiwan is home to a number of communications hardware manufacturing systems and is actively developing emerging sectors such as the metaverse. Foreign companies can take advantage of these business opportunities through investment or partnerships in Taiwan.

Investment Incentive Measures

1 | Tax Incentives |

The income tax rate for profit-seeking enterprises in Taiwan is 20%. To encourage foreign investments in Taiwan, support industrial innovation, and promote industry-academia collaboration, Taiwan offers the following preferential taxes to foreign companies (Table 1):

Table 1 Preferential Taxes

Item	Preferential Measures
Employee Stock Compensation	• A company employee who has obtained stock compensation worth a combined total of less than NT$5 million and continuously held the stock while remaining in the company's employ for at least two years may choose to be taxed on the market price of the stock at either the time the stock was obtained or the time the stock is sold, whichever is lower.

Item	Preferential Measures
Research, Development, or Introduction of Technologies or Machinery Equipment	• Up to 15% of the company's R&D expenditures may be deducted from its profit-seeking enterprise income tax for current year; or up to 10% of such expenditures may be credited over three years against the profit-seeking enterprise income tax payable by the company. • Royalty payments to foreign companies for imported new production technologies or products that use patents, copyrights, or other special rights owned by foreign companies are, with the approval of the Industrial Development Bureau, MOEA, exempt from the corporate income tax. • Companies are exempt from import tariffs for importing any machinery equipment that local manufacturers cannot produce.
Investment in Smart Machinery / 5G / Information Security	• Smart machinery: Use of big data, AI, and IoT in brand-new hardware, software, technology, or technical services for automatic schedules, flexible, or mixed-model production lines. • 5G: Investments in new hardware, software, technology, or technical services that are related to 5G communication systems. • Information security: Companies' investments and purchases of brand-new hardware, software, technology, or technical services for information and communication security products or services are included in the scope of investment offsetting. • For investments between NT$1 million and NT$1 billion, companies can choose from either "5% of investment spending deducted from profit-seeking enterprise income tax (current FY)" or "3% of investment spending deducted from profit-seeking enterprise income tax if the total spending is spread over three years" may be selected, but the total amount deducted may not exceed 30% of corporate income tax that year. • Applicable until December 31st, 2024.

Item	Preferential Measures
Special Foreign Professionals	• Special foreign professionals who meet certain criteria are eligible for a 50% deduction of total income tax for amounts exceeding NT$3 million.
Industrial Park Locations	• Companies that set up operations in export processing zones, science industrial parks, or free trade ports are eligible for exemptions on import duties, commodity tax, and business tax for the import of machinery and equipment, ingredients, fuel, materials, and semi-finished products for their own use.
Others	• Companies that use undistributed earnings to engage in substantive investments may exclude the invested amount when calculating their profit-seeking enterprise income tax.

2 | Subsidies |

1. Global Innovation Partnership Initiatives Program

Foreign companies that complement Taiwan's industries are encouraged to invest in Taiwan's R&D innovation and work with Taiwanese companies to jointly develop forward-looking technologies, key technologies, or integrated technologies beyond our current capacities. Such businesses could exert a key influence on Taiwanese industry by: (a) inspiring R&D work on industrial technologies as well as the establishment and development of supply chains; (b) improving R&D efficiency; (c) accelerating the timetable from R&D to production; and (d) contributing actively to the expansion of international markets. Foreign companies successful in endeavors relating to this program will be eligible, upon approval from the MOEA, for subsidies of up to 50% of total R&D expenditures.

2. Pioneers for Innovation Leadership on Technology Program

The program aims to transform Taiwan into a high-tech R&D center and encourage leading international manufacturers to establish cutting-edge R&D bases in Taiwan, empowering their work in forward-looking technologies in Taiwan and connecting with Taiwan's supply chain, thereby creating a division of labor in the areas of research, co-creation, and development, with an eye to strengthening the technological competitiveness of Taiwan's leading industries and accelerating the formation of clusters in emerging industries. Program funding of up to 50% of total expenditures may be granted for any project that has been approved by the Ministry of Economic Affairs.

3. Industrial Upgrading Innovation Platform Guidance Program

To guide industries in Taiwan to develop high-value products and encourage corporations to enter the high-end market to increase the industry's added value, the Industrial Development Bureau, Ministry of Economic Affairs, and the Ministry of Science and Technology are promoting the "Taiwan Industry Innovation Platform Program". The program provides companies that have R&D teams in Taiwan with funding of up to 40%-50% of the project budget for themed R&D projects and funding of up to 40% for projects independently conducted by corporations.

Leading Taiwanese Companies

1 | Key Chips |

Established in 1997, MediaTek Inc. became a leading global IC design company by consistently investing in advanced processes and technologies. The Company's core businesses include mobile communication, smart home, and automotive electronics, focusing on the development of core technologies for chips used by these three platforms. MediaTek also uses highly integrated and innovative chip designs to help manufacturers optimize the supply chain and reduce new product development time[2].

Established in 1987, Realtek is dedicated to developing and designing network chips and integrating key components (e.g., MCU, DSP, RISC, PLL, RFIC, and memory) to create systems on a chip (SoCs) and provide customers with total solutions[3]. Realtek is the largest supplier of high-speed Ethernet and a leading maker of audio codec chips for computers. Their most popular products include communications network chips, multimedia chips, screen control chips, and high-speed wireless broadband chips.

2 Official website of MediaTek: https://www.mediatek.com/.

3 Official website of Realtek: https://www.realtek.com/zh-tw/.

2 | Network Communication Equipment |

Established in 1988, Accton Technology is dedicated to Ethernet and wireless equipment R&D, design, and manufacturing and is a leader in the design of open hardware platforms for data centers, carrier access, and campus networks. Accton has R&D and sales centers in Taiwan, the U.S., and China, and over 5,000 employees worldwide[4].

Sercomm was established in 1992 with broadband network software and firmware R&D as its core business but has since become a leading vendor of broadband equipment. Headquartered in Taipei and with sales offices throughout North America, Europe, China, and the Asia-Pacific, Sercomm has several thousand employees worldwide. Its products span residential, commercial, telecommunications, security surveillance, and cloud applications, and main products include: Integrated Access Devices (IAD), commercial network communication equipment, FTTx fiber optic products, cable DOCSIS equipment, small cells, and smart IoT solutions.

Established in 1996, Wistron NeWeb Corporation (WNC) specializes in the design, R&D, and manufacturing of communications products and offers comprehensive technical support in RF antenna design, software design, hardware design, mechanical design, system integration, user interface development, and product testing & certification. Headquartered in Taiwan's Hsinchu Science Park, WNC has also established an overseas presence in the USA, the UK, Japan, China, and Vietnam. WNC is the global leader in built-in antennas for notebooks with a 35% market share, The company has delivered over 300 million satellite communications and digital home products to date[5].

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4 Official website of Accton: https://www.accton.com.tw/accton/.

5 Official website of Wistron NeWeb Corporation: http://www.wnc.com.tw/index.php?action=about&cid=1.

3 | Telecommunications |

Chunghwa Telecom was established in 1996, prior to which it had long operated as a business department of the Directorate General of Telecommunications, Ministry of Transportation and Communications. It is the largest general telecom operator in Taiwan, and its scope of business covers fixed network communications, mobile communications, broadband access, and Internet service. It also provides corporate customers with ICT services using its big data, information security, cloud, and network data center technologies. Chunghwa Telecom is also developing emerging technology services such as IoT and AI[6].

Established in 1997, Taiwan Mobile was the first private telecommunications company listed on the Taiwan Stock Exchange (TWSE) and has comprehensive WCDMA (3G), LTE (4G), and NR (5G) frequency licenses. In 2017, Taiwan Mobile announced its transformation into a next-generation network technology company that would focus on the four industries of "T.I.M.E" (i.e., telecoms, Internet, media & entertainment, and e-commerce) for diverse operations. In response to the 5G, IoT, and AI smart cloud developments in 2019, Taiwan Mobile implemented the "Super 5G Strategy" to actively develop IoT services and focus innovation and R&D on 5G applications[7].

6 Official website of Chunghwa Telecom: https://www.cht.com.tw/zh-tw/home/cht.

7 Official website of Taiwan Mobile: https://www.taiwanmobile.com/index.html.

Examples of Successes Achieved by Foreign Companies

1 | Production and Technology |

Qualcomm announced the establishment of its "Center for Operations, Manufacturing Engineering and Testing in Taiwan (COMET)" in June 2019 and set up 4 excellence centers/laboratories including a 5G mmWave testing center, a laboratory for the development of 5G radio frequency devices and 5G modules, a center of excellence for biometric sensing technology, a production and testing center, and an IC packaging thermal/mechanical laboratory. Qualcomm invested NT$5.5 billion in the COMET building, which spans 7,200 square meters of land, and is now collaborating with testing service providers such as KYEC and MPI.

Other collaboration projects included heat dissipation components for

5G electronic products developed by Murata Manufacturing, a major supplier of filters, and Taiwan's Cooler Master. Europe's multinational telecom operator, Vodafone, selected Accton's subsidiary Edgecore Networks, Alpha Networks, and Delta Electronics' subsidiary Delta Networks to develop the disaggregated cell site gateway (DCSG). Skyworks and Asus jointly launched the world's first ultra-fast Wi-Fi 6E extended band route and are also working with MediaTek to provide reference designs for 5G communications for automobiles and IoT. Synopsys established the "Hsinchu AI Chip Design Lab" in February 2020 to introduce core technologies necessary for AI chip design. Japanese company Nittobo Asia Glass Fiber also expanded its production capacity in Taiwan through mergers and plant construction in response to the advent of the 5G era. Nittobo's new plant in Minxiong, Chiayi opened in 2021 for the production of ultra-fine glass fiber yarn for 5G network equipment.

2 | Testing Facilities |

US-based Cisco partnered with the Taoyuan City Government in late 2019 to establish a "Cisco Innovation Center" for smart solutions in Taoyuan's Chingpu district to serve as an R&D hub for IoT in Taiwan. A number of Taiwanese companies, including Delta Electronics, MiTAC, and Syscom, had already signed on to the project. Cisco also formed a partnership with the Industrial Development Bureau, Ministry of Economic Affairs in September 2020 to establish the first "5G open architecture network platform" with domestic network communication equipment manufacturers (Pegatron, UfiSpace, Compal Electronics, Askey, Quanta Cloud, Foxconn Global Network, Wistron NeWeb Corporation, Alpha Networks, and Hwacom Systems) to provide an interface with the Taiwanese communications industry for the co-development of a dedicated 5G open architecture network and eco-system. In the future, white-label equipment and applications produced in Taiwan can be marketed internationally through Cisco's global sales network.

Qualcomm joined forces with ASE and Chunghwa Telecom to create a dedicated 5G mmWave private network smart factory, which was inaugurated in December 2020 and integrated three major applications into the production lines of ASE Group's Kaohsiung Plant: AI + autonomous guided vehicles (AGV); remote AR maintenance assistance; and the Green Technology Education Center AR Experience. The smart factory creates a development environment for 5G innovations and applications, demonstrating the scope and complexity of future smart factory and automation and accelerating the smart manufacturing process to serve as the best demonstration site for 5G applications in smart manufacturing. The project will last one year and is expected to fulfill more vertical application functions for 5G enterprise private networks after its completion.

Other collaboration projects include the partnership between Siemens and Hwacom Systems. They provide Internet of Vehicles (IoV) solutions, smart signal controllers, and smart street lights to jointly set up 5G experimental sites and provide V2X IoV solutions. The German company TUV Rheinland Taiwan is also part of the experimental site and works with the industry to provide resources and tests for meeting international standards. It helps facilitate the development of V2X applications and Taiwan's standards for intelligent transportation systems.

3 | Talent Development |

Qualcomm actively develops startup teams and talents in Taiwan. In June 2019, Qualcomm organized the first "Qualcomm Innovation in Taiwan Challenge" (QITC) in Taiwan. The Challenge became an annual event, and teams have been invited to join the Qualcomm® Advantage Network as members of Qualcomm's global business ecosystem. Qualcomm later set up the "Qualcomm Innovation Center, Taiwan" in March 2020 as the site for QITC that provides exclusive labs and technical support. In addition, Qualcomm also expanded collaboration with the industry, government, and academia and activated the "Qualcomm Taiwan University Research Collaboration Program" with top universities in Taiwan. It also signed contracts for research collaboration programs with four top universities in Taiwan to focus on three advanced technologies including wireless communication, machine learning and artificial intelligence, and multimedia.

In addition to company-founded competitions, to help industries discover local talents with creativity and design application abilities, the Industrial Development Bureau, Ministry of Economic Affairs of Taiwan established a competition mechanism with themes based on development trends and needs of the communications industry. The idea is to attract youths to R&D and design work in innovative industries. The 2022 Mobile Heroes competitions focused on the IoT Future Challenge, Next-Generation 5G^{+} User Applications and Micro Base Station Antenna System Design Competition, 5G Pioneering Innovative Application Competition, and the Connectivity International Award for international submissions aimed at connecting international innovation with local industry talent. Nearly 10,000 students and other members of society have participated in the competitions to date. Leading international communications companies such as Google, Qualcomm, Microsoft, AWS, Sigfox, and Cisco have also taken part[8] to recruit exceptional teams and talents for their companies or create new startups.

8 For example, Sigfox provided free development modules to encourage contestants to develop innovative IoT applications using Sigfox technology. It also organized Hacking House to guide excellent startup teams in Taiwan to participate in its global IoT product development project.

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