CFRA

Industry Surveys

Telecommunications: Asia

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Ahmad Bin Abdul Halim, CFA
Equity Analyst

Navin Kalaiselvam
Industry Analyst

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Contacts

Sales Inquires & Client Support
800.220.0502
cservices@cfraresearch.com

Media Inquiries
press@cfraresearch.com

CFRA
977 Seminole Trail, PMB 230
Charlottesville, VA 22901

Contributors

Raymond Jarvis
Senior Editor

Atifi Kuddus, Geraldine Tan
Associate Editors

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Charlottesville, VA 22901
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CHARTS & FIGURES

NEW THEMES

What's Changed: One potential future growth driver to keep in mind is the adoption of private 5G networks. See page 17.

What's Changed: We look at the role of artificial intelligence in 5G networks. Read more on page 19.

EXECUTIVE SUMMARY

CFRA has a neutral fundamental outlook on the Asia Telecommunications Services industry, for which we forecast mid-single-digit revenue growth and slight margin growth. Our key themes for 2023 are:

Subscriber Growth Returning on 5G Adoption, Driving Revenue Growth

The Asian wireless telecommunication market is in a state of transition. In markets that have launched 5G services, subscriber growth and revenue are picking up. However, in most markets without a 5G catalyst, the saturated space begets slower subscriber growth. Pricing power and data yields are falling as companies struggle to differentiate their offerings. Increased real-time connectivity and substitution into over-the-top (OTT) services raised the demand for data at lower yields, resulting in a lasting negative revenue impact.

In Search of New Growth Avenues

Most telcos in the region are looking to transition away from being solely a data pipe provider towards extracting more value by moving into adjacent, value-added digital services such as media & content, financial technology, and cybersecurity. CFRA believes this is a necessary step, but the environment may stay challenging for telco operators who still rely largely on traditional sources of revenue in this period of transition. Not only will they have to contend with slowing growth in their primary revenue base, but they will also be seeing increased competition in the new growth businesses, as a number of operators are seeking market share at the same time.

Capex Growth to Slow in 2023 as 5G Spending Becomes Selective

We expect capital expenditures (capex) to rise year-over-year in 2022, as the industry compensates for delayed 5G rollout due to Covid-19. We believe this will pressure industry cash flows but will be offset by evidence of some revenue growth from 5G adoption. Further, CFRA expects capex growth in 2022 to continue to see measured rollout in tandem with growing consumer and enterprise use cases, and as companies take a shared approach to network expansion for 5G. We foresee 5G capex peaking in 2023-2024.

Regulatory and Competitive Risks Have Receded

Regulatory action in recent years, whether on tariffs (*e.g.*, Malaysia on fixed broadband; China, Japan, and South Korea on mobile data) or on competition (*e.g.*, Australia's initial opposition to the TPG Telecom and Vodafone Hutchison merger), indicates elevated risk. Competitive risks are also high with new entrants in Singapore, Australia, and the Philippines. However, these risks have receded in the last 12 months as the issues raised by the regulators were addressed and as new competition is digested. On the 5G front, Australia, China, Hong Kong, Japan, the Philippines, South Korea, and Thailand have awarded 5G spectrum.

M&A Will Remain in Focus

In a low-growth environment, we expect companies to look for opportunities for synergy and scale via M&A. However, regional complications represent significant barriers to cross-border M&A, in CFRA's view. This is exemplified by Axiata and Telenor's initial failure in 2020 to merge their telecom assets in Asia (although this was completed in 2022 at the second attempt). Listed companies with battered valuations may go private to assist in behind-the-scenes transformations (*e.g.*, Singapore's M1).

5G May Be a Game Changer

The advent of 5G technology, with its ultra-low latency and simultaneous connectivity features, is a greater disruptive step change from simply providing faster speeds. In the long run, 5G will enable different revenue opportunities, including machine-to-machine communications (*i.e.*, the Internet of Things), self-driving cars, and business virtual/augmented reality applications. However, in the short to medium term, we forecast monetization will be more limited to consumer use cases, particularly as 5G subscriber share increases in developed markets. User subscription trends in 2021-2022 indicate strong appetite for 5G services in China, South Korea, and Japan.

TELECOMMUNICATIONS SERVICES: ASIA

Outlook: Neutral

MARKET CAP BREAKDOWN*

RANK NO.	COMPANY NAME	MARKET CAP ($ billion)
1	China Mobile Ltd	152.5
2	NTT Corp	103.2
3	KDDI Corp	68.8
4	China Telecom	62.1
5	Bharti Airtel Ltd.	54.9
6	SoftBank Corp.	54.2
7	Telstra Corp	33.3
8	Singapore Telecom	30.6
9	Chunghwa Telecom	29.2
10	PT Telekom (Persero)	25.5
	Others†	152.8

Source: CFRA, S&P Global Market Intelligence.
*Companies included in Comparative Company Analysis; as of January 24, 2023.
†Refer to the Comparative Company Analysis section of this survey for other companies in the industry.

2022 INDEX PERFORMANCE

MSCI AC Asia Pacific Index	-19.3%
FTSE Asia Pacific Telecommunications Index	-8.7%

BY THE NUMBERS

$108.5 billion
CFRA expects capex of top 10 telcos in 2023 to rise by 4.5% from 2022

$176 billion
Service revenue down in H2 2022 for top 10 largest telcos from $184 billion in H2 2021

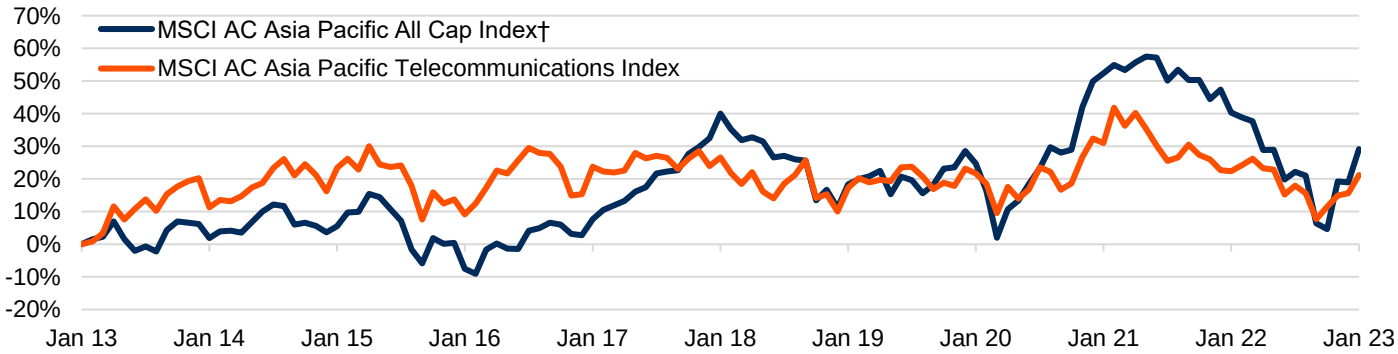
~62%
Average revenue share from conventional telecom services for top 10 telcos

4.58 billion
Expected total mobile subscribers in Asia for 2023 – 1.8% increase from 2022 by Ericsson

1.14 billion
Estimated 5G users in Asia for 2023 by Ericsson

31.0%
Average EBITDA margin for top 10 telcos increased in H2 2022 vs. 30.4% in H2 2021

10-YEAR INDEX PERFORMANCE

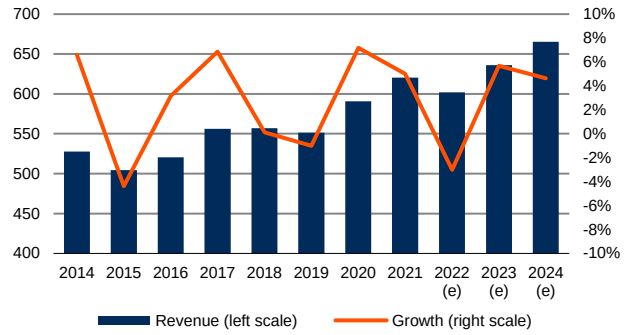


†Index was launched on Dec 1, 2010. Data prior to the launch date is back-tested data (i.e. calculations of how the index have performed over that time period had the index existed).
*Data through January 27, 2023.
Source: CFRA, S&P Global Market Intelligence.

FINANCIAL METRICS

Total Revenue

(industry aggregate, $ billions)

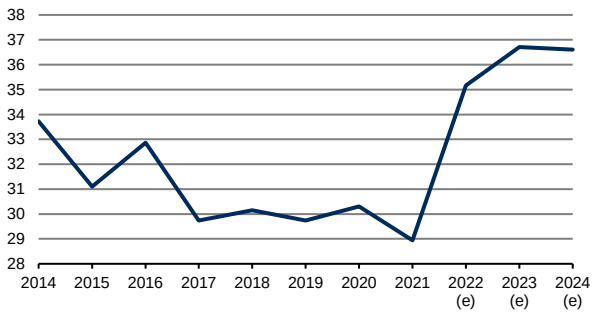


Source: CFRA, S&P Global Market Intelligence.

- CFRA projects revenue to increase 5.7% in 2023 and 4.6% in 2024 as 5G upgrade activity and increasing data traffic will dominate for the rest of 2023. CFRA expects 2023 to see USD weakness, which may boost USD revenue.
- Revenues for most Asian telecom operators are expected to move towards the development of digital services for the consumer and enterprise segments. This will drive revenue growth, particularly in markets with 5G and with strong fixed broadband growth (*e.g.,* South Korea, Japan, and China).

EBITDA Margin

(industry average, in percent)

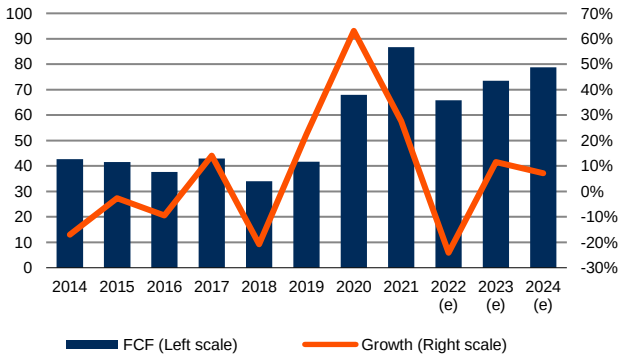


Source: CFRA, S&P Global Market Intelligence.

- Industry EBITDA margins generally trended downward between 2014 and 2021, which we mainly attribute to heightened competition and an increasingly saturated market.
- CFRA expects EBITDA margin in 2023 to increase to 36.7% from 35.2% in 2022 due to higher revenue and contained operating costs.
- CFRA expects EBITDA margin to stay flat in 2024 as a shift in revenue mix towards consumer and enterprise digitalization usually carries lower margin.

Free Cash Flow

(industry aggregate, $ billions)

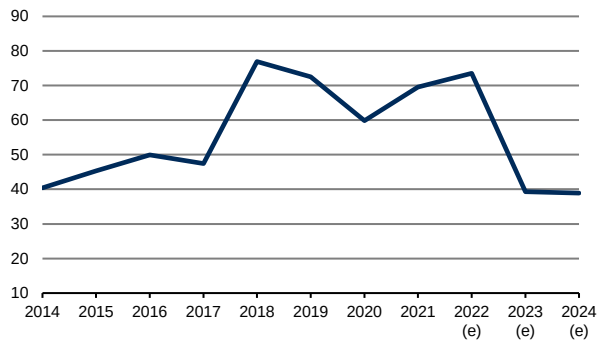


Source: CFRA, S&P Global Market Intelligence.

- As the industry grows, companies tend to realize significant free cash flow (FCF), supporting above-average dividend payouts.
- FCF may see volatility upon the rollout of new network standards and technologies, which often require large infrastructure-related capex.
- Throughout 2022, the Asian Telecommunications Services industry saw telecom operators spending on 5G network rollout and spectrum auctions. Going forward in 2023, CFRA expects 5G spending to be measured and dependent on demand.

Net Debt-to-EBITDA

(fiscal year, industry aggregate, in percent)

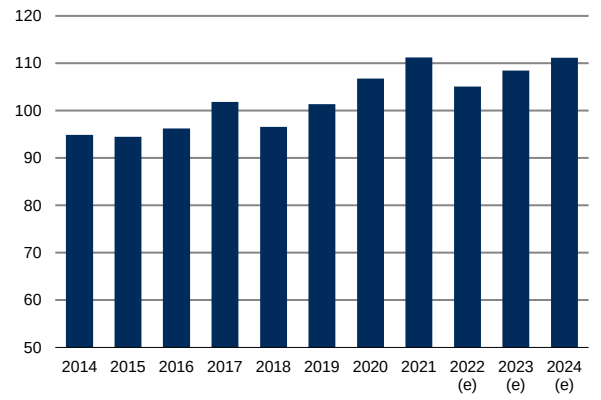


Source: CFRA, S&P Global Market Intelligence.

- Net debt-to-EBITDA has been on an uptrend since 2014, from approximately 40% to 70% in 2021. We attribute this to a 72% surge in industry net debt during the period.
- CFRA expects net debt-to-EBITDA to decrease to 39.3% in 2023 and 38.9% in 2024 as revenue growth picks up post-pandemic alongside better cash flow generation, offset by higher capital expenditure spending.

Capital Expenditure (Capex)

(industry aggregate, in $ billions)

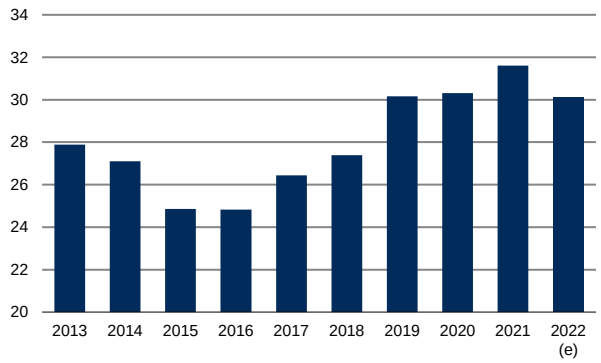


Source: CFRA, S&P Global Market Intelligence.

- For 2023, CFRA estimates industry capex to come in around $108.5 billion compared to $105.1 billion in 2022 due to the ramp-up of 5G investments across the Asia Pacific region, combined with significant ongoing spending on 4G network upgrades.
- We forecast industry capex growth to be measured in 2023 and 2024 as 5G rollout continues despite rising inflation, a higher interest rate environment, and a potential recession ahead. A number of Asia Pacific countries are expected to add more 5G spectrum bands and network enhancements. Detailed analysis on capex is available in the Operating Environment section of this survey.

Dividends Paid

(industry aggregate, in $ billions)

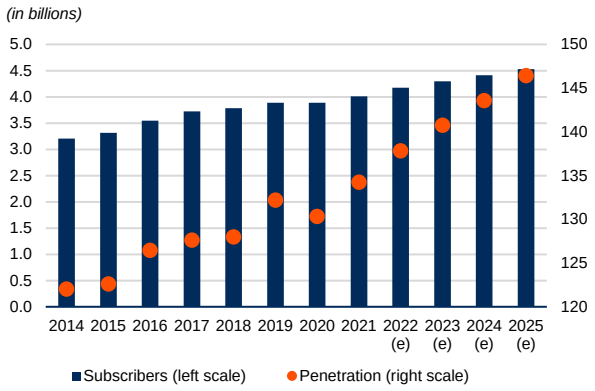


Source: CFRA, S&P Global Market Intelligence.

- In 2022, Asian telecoms (especially China Mobile, NTT Corp, KDDI, and SoftBank) continued to pay high dividends as larger telcos were able to sustain the dividend payouts and thrive due to an increase in data consumption and higher mobile subscribers.
- We expect organic growth in dividends for 2023 to preserve financial flexibility for 5G / emerging business investing capacity despite stronger U.S. dollar, high inflation, and looming spillover effects of a recession in the U.S.

KEY INDUSTRY DRIVERS

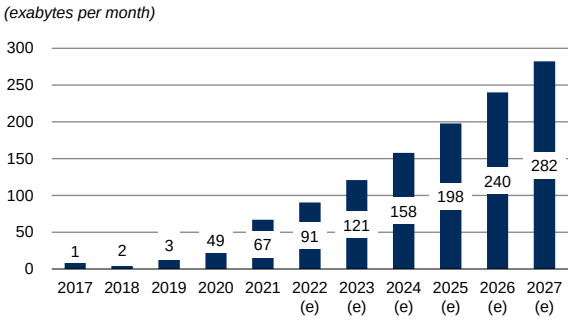
Number of Subscribers



Source: S&P Global Market Intelligence.

- There were more than 4.2 billion mobile subscribers in Asia Pacific at the end of 2022, with a penetration rate of 137.8% in Asia Pacific (including North East Asia), according to estimates from Kagan, a division of S&P Global Market Intelligence.
- Smartphone adoption and mobile internet usage continue to grow steadily in Greater China due to an increased appetite for digital content.
- By 2025, China alone will have more than 892 million 5G connections, while the rest of Asia Pacific is set to add more than 400 million 5G connections, according to GSMA Intelligence.

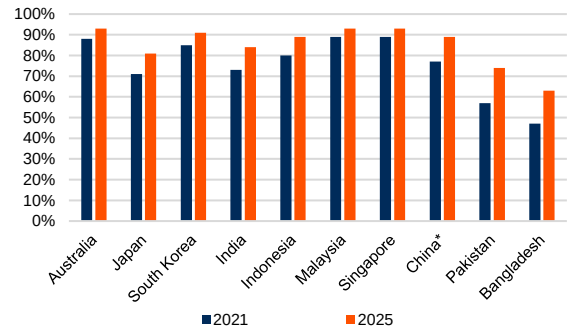
Global Mobile Data Traffic Forecast



Includes data traffic for smartphones, mobile PCs, tablets and routers.
Source: Ericsson.

- Global mobile data traffic has been increasing by leaps and bounds, and is predicted to grow by a factor of 4.2 to reach 282 exabytes per month by the end of 2027, from 67 exabytes per month in 2021. Ericsson expects that 60% of total mobile traffic data will be carried by 5G networks by the end of 2027.
- Meanwhile, North East Asia (China, Japan, and South Korea) is the world's most populous region and is expected to have the largest share of global mobile data traffic of around 30% in 2027, according to Ericsson.

Smartphone Adoption in Selected Countries



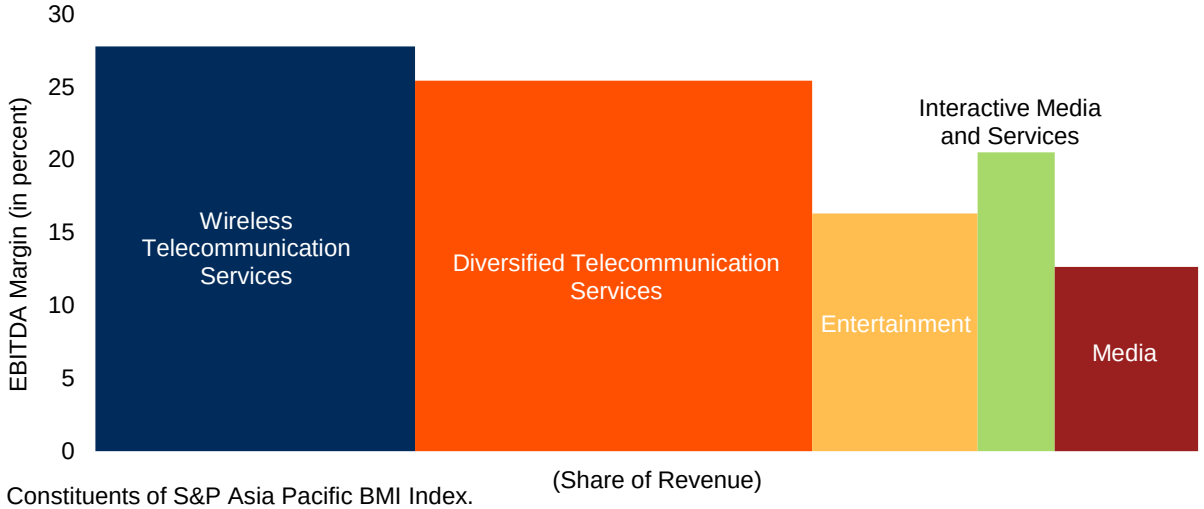
*China including Mainland China, Hong Kong, Macao, and Taiwan.
Source: GSMA Intelligence.

- The top three largest smartphone markets globally in 2025 will be in Asia Pacific (India, Indonesia, and Japan), according to a report published by GSMA Intelligence in 2022. China is already the largest smartphone market with more than 1.6 billion smartphone users, followed by India (1.1 billion) and Indonesia (370 million).
- The rapid rise of smartphone adoption, QR codes, retailer buy-in, and use of platforms such as WeChat and Alipay has led to the ubiquity of mobile payments in China.

INDUSTRY TRENDS

Competitive Environment

PROFIT SHARE MAP OF ASIA PACIFIC COMMUNICATION SERVICES SECTOR
(last twelve months through January 25, 2023)



Constituents of S&P Asia Pacific BMI Index.
Source: CFRA, S&P Global Market Intelligence.

In Asia Pacific's Communication Services sector, the Diversified Telecommunication Services industry has the largest share of revenue at 36.8% and an EBITDA margin of 25.4%, followed by the Wireless Telecommunication Services industry at 29.1% revenue share and an EBITDA margin of 27.8%.

PORTER'S FIVE FORCES

Below, we use the Porter's Five Forces framework as a tool to analyze the competitive environment of the Asian Telecommunication Services industry.

Porter's Five Forces Analysis	
Threat of New Entrants or New Entry (Low)	Unsurprisingly, the biggest barrier to new entrants in this capital-intensive industry is access to capital. Due to the high fixed costs of operating and building an extensive network infrastructure to provide fixed-line and wireless services, potential newcomers typically require a lot of cash. The threat level depends on the accommodativeness of capital markets; when markets are generous, the threat of new entrants escalates, and vice versa. The requirement to be licensed to operate represents another barrier to entry. A new company is not exempted from the requirement to obtain the approval and licensing of telecommunications regulatory bodies. There is also only a limited amount of "good" radio spectrum applicable to mobile voice and data applications. Finally, solid operating skills and management expertise are scarce, keeping the threat of new entrants low.

Bargaining Power of Suppliers (Moderate)	The bargaining power of suppliers in the telecommunications space is mixed. Some might think that telecom equipment suppliers have substantial bargaining power over telecom operators, as equipment such as high-tech broadband switching equipment and fiber-optic cables are necessary for operators to transmit voice and data from place to place. However, there is actually a sufficient number of large equipment makers to materially dilute that bargaining power. In addition, given the scarce talent pool for professionals proficient in the latest technologies, equipment makers are in a weak position in terms of hiring and salaries.
Bargaining Power of Customers (Low to Moderate)	The power of customers increases as they get more choices of telecom products and services. Basic services are becoming like a commodity (there are not many differences at all between telephone and data services provided by the companies), so customers seek the lowest prices and sign up with the telecom that provides the most reliable services. However, the power of customers differs somewhat between market segments. The switching costs for a residential customer are relatively low compared to larger business customers, especially if those enterprises depend on customized products and services.
Degree of Rivalry/Competition (High)	In the Asia Telecommunication Services industry, competition is cutthroat. The wave of deregulation in the industry, coupled with the accommodative capital markets in the late 1990s, sparked a telecommunications explosion in APAC. A raft of new substitute services is a consistent threat thanks to technological advances. The saturation of mobile devices and broadband internet forces firms to fight for market share by lowering prices and investing in infrastructure to provide more exciting services. We think the high exit barriers of the industry (*i.e.*, you can't turn off part of a network or reduce the variable costs easily) will force the major telecom companies to continue to operate, even in times of stress, keeping competitive pressure strong.
Threat of Substitutes (High)	Telecom operators face serious threats of product and service substitutes from non-traditional telecom industries. Cable TV and satellite operators compete with telecoms for customers with their own direct lines into homes, broadband internet services, and satellite links. Railway and energy utility companies are building high-capacity telecom networks alongside their tracks and pipelines. On top of that, voice substitution is well under way – telecom operators (in most developed markets) no longer charge for voice access.

Operating Environment

Innovative technology and the eager uptake of advanced services by consumers have made Asia a leader in advanced wireless services. In more mature markets, data accounts for a growing share of total revenues. The region is building on its preeminent position in wireless mobile data services by introducing new technologies like fourth-generation long-term evolution (4G LTE) in less-developed markets, and LTE-Advanced (LTE-A), fifth-generation (5G), and further innovations in more developed markets. These technologies will likely further strengthen revenue growth as the impact of Covid-19 fades.

Governments have played a major role in shaping the wireless industry in Asia. Besides the regulatory functions exercised in all countries, some Asian governments have established proprietary standards for many of the new technologies. In more developed countries, governments have sought to increase competition and reduce prices by instituting mobile number portability (MNP). In some markets, such as South Korea, Japan, and China, governments have also directly pushed operators to lower data tariffs.

Each wireless network is based on a specific technological standard or “access technology”, which determines how customers share the radio channels needed for wireless service. The first-generation (1G) cellular systems used an analog signal, where each subscriber was allocated a radio channel when making a call. The second-generation (2G) cellular network is based on digital signals, where the voice signal is translated into a series of ones and zeroes, instead of into the electromagnetic waves used in analog systems. Digital signals allow for data services and greater security. Most importantly, they allow customers to share a single radio channel. The third and fourth generation (3G and 4G) systems, also digital, are even more efficient and enable advanced data and video services.

By 2018, 4G had overtaken 2G and 3G to become the dominant technology. While 4G supported 56% of global connections in 2020, 4G has peaked and begun to decline, in some cases, in leading 5G markets such as China, South Korea, and the U.S., according to GSMA Intelligence, the market research arm of the mobile industry’s trade association. Nonetheless, GSMA Intelligence predicts 4G connection still has growth in many developing regions over the next few years, peaking under 60% of global connections by 2023. 5G is expected to grow its total number of global connections to 21% by 2025 as 5G gains traction in new markets.

Huawei: Optimistic of Longer-term Tech Demand Despite Uncertain Macro Environment
Huawei has been one of the biggest network equipment suppliers in the region, often undercutting its European rivals’ pricing by up to 30%, based on a July 20, 2020 report on the Nikkei Asian Review. However, this may change for the 5G era. While Huawei secured contracts to supply 5G equipment to Malaysia’s Maxis, Thailand’s Advanced Info Systems, and the Philippines’ Globe Telecoms, it lost out on Singtel and M1 rollouts in Singapore. Additionally, Huawei has been locked out of Australia’s, Japan’s, and India’s 5G rollouts, with New Zealand likely to follow suit. Huawei also has less than 10% market share in South Korea, supplying only to operator LG Uplus, while the rest of the market is supplied by Samsung.

On June 15, 2022, India’s Department of Telecommunications tightened telecom license conditions by mandating operators to use equipment only from vendors with “trusted sources” approval for not just network upgradation but also expansion. This amendment is seen to close a loophole in the procurement rules and completely stop Huawei and also ZTE from providing telecom gear to Indian telecoms, according to ET Telecom.

Huawei still stands at the center of the ongoing China-U.S. tech war. Even with a new U.S. president, Huawei’s designation as a high-risk vendor has remained in place. We see greater ability for European suppliers to compete in Asia Pacific given the pressure on Huawei. Sweden has become the second country in Europe to ban network operators from utilizing Huawei equipment in their 5G products. Despite

an appeal from Huawei, the Administrative Court of Appeal in Stockholm rejected the appeal. In the meantime, CFRA expects Ericsson to continue to gain market share in Europe through network sales in North America and Europe, fueled by a longer-than-expected 5G investment cycle as a key growth driver.

Huawei reported that its third quarter 2022 revenues came in at $19.95 billion, up 6.5% from the prior year. According to Huawei's rotating chairman, Eric Xu, after maneuvering out of the crisis mode in 2022, Huawei is back to business as usual. He added that U.S. restrictions are now the new normal for Huawei. Huawei is ramping up growth in different areas, particularly optical networks, cloud core networks, services, and software.

Moreover, Nokia and Ericsson may see new competition from Japanese makers, which are increasingly incentivized by the Japanese government to step into the space vacated by Huawei. Japan's Ministry of Economy, Trade, and Industry agreed to provide JPY70 billion ($670 million) to NEC, Fujitsu, and other Japanese companies to develop 5G equipment and networks. In addition, these companies also receive a 15% tax break to rebuild their economies of scale, cash flow, and ability to invest in developing new technology.

KEY ISSUES FOR ASIAN MOBILE OPERATORS

The focus of wireless operators varies greatly from country to country. For instance, markets with lower penetration (*e.g.*, China and India) still offer room for subscriber growth, albeit at a declining rate. On the other hand, operators in saturated markets (such as Hong Kong, Taiwan, Korea, Japan, and Singapore) are expanding beyond providing "dumb pipes" to exploit triple-play opportunities and/or businesses outside of core telecom operations (*e.g.*, media, enterprise, and over-the-top services).

MOBILE SERVICES, ASIA PACIFIC COUNTRIES
(*Data through third quarter of 2022)*

		MOBILE SERVICES			
Country	Population in 2022 (*in millions)*	Q3 2022 *(in millions)*	Q3 2021 *(in millions)*	Percent Change (%)	Penetration Rate (%)
China	1,453.7	1,684	1,641	3	116
India	1,412.5	1,144	1,166	(2)	81
Indonesia	280.5	380	370	3	135
Japan	125.6	199	193	3	158
Philippines	112.8	156	155	1	138
Thailand	70.2	129	118	9	184
South Korea	51.4	76	72	6	148
Malaysia	33.3	47	46	0	140
Taiwan	23.9	30	30	1	125
Hong Kong	7.6	26	24	10	342
Singapore	6.0	9	9	7	155

Source: Telecommunications regulatory authorities, Worldometers, company reports, CFRA estimates.

Subscriber growth

Signs of subscriber slowdown are already evident in the region. Most mobile markets have entered a saturated phase, with only a handful of countries still experiencing strong growth. With the recent launch of 5G services, subscriber growth has picked up in some of the developed markets, but we do not expect the pickup to sustain. In Asia Pacific, the telecom industry in Indonesia and India are expected to grow at an accelerated rate, but China will see slower growth on a larger base, even as their combined smartphone markets will account for more than 40% of global connections by 2025, according to GSMA Intelligence. CFRA thinks the large smartphone markets in these regions will translate to a higher base of

mobile subscribers. Below, we discuss the trends of mobile subscriptions and penetration in these countries.

◆ **China.** In the world's largest telecommunications market, the number of wireless subscribers crossed the one-billion mark in 2012. As of December 26, 2022, China boasted more than 1.6 billion wireless subscribers, with 592 million being 5G users. Meanwhile, CFRA expects China to soon cross the 700 million mark of official 5G subscribers by the end of 2023. Frequent Covid-19 lockdowns in 2022 saw year-over-year sales decline of smartphones in China. Growth is expected to rebound in 2023 as the lockdowns are lifted alongside a rise in 5G subscriptions.

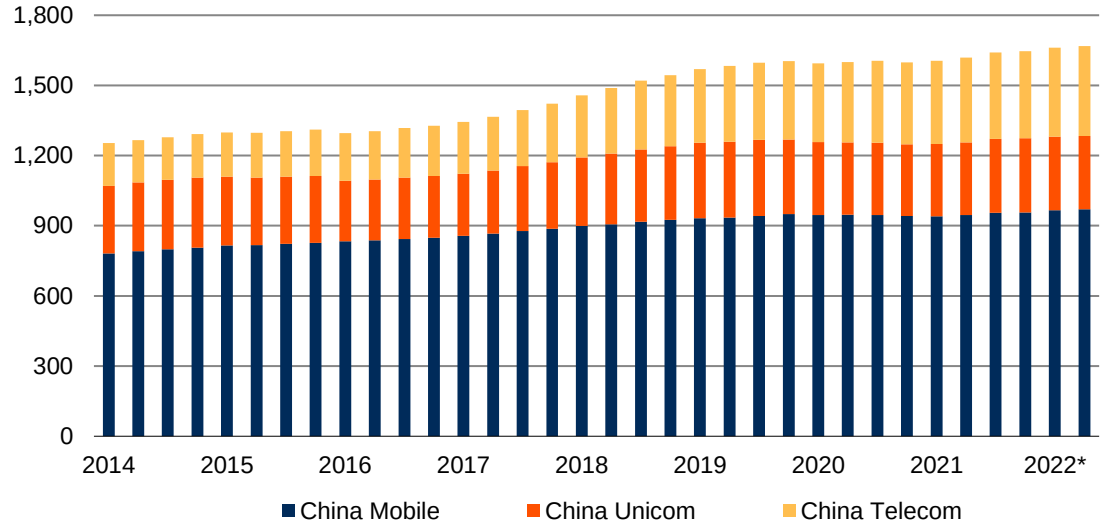
MOBILE CARRIERS IN CHINA*

SUBSCRIBERS / PENETRATION	
(in millions)	
Total mobile subscribers	1,684.3
Year-to-year growth *(in percent)*	2.6
PENETRATION RATE	
(in percent)	
Mobile	115.9
Fixed line	12.4
LEADING CARRIERS	
(subscribers, in millions)	
China Mobile	974.7
China Telecom	391.2

*Data through December 26, 2022.
Data for China Unicom is omitted as its reporting methodology for operational statistics from February 2022 is altered and as such the results are not comparable with previous periods.
Source: China's Ministry of Industry and Information Technology (MIIT), company reports.

Most of China's subscriber base is in the developed eastern region, where the booming cities of Beijing and Shanghai are located. Nevertheless, subscriber growth in recent years has come largely from rural areas, due to ongoing network coverage expansion and the launch of ultra-low-cost handsets. However, this also means that the average spending for new subscribers is lower, implying continuing pressure on average revenue per user (ARPU) for the medium term. However, the launch of 5G services, consumer upgrading, and increasing spending on online content consumption may provide an offset for ARPU.

CHINA'S WIRELESS SUBSCRIBER BASE
(in millions)



*Data through third quarter of 2022.

Source: Company websites, Ministry of Industry and Information Technology, China.

◆ **India.** India's mobile fever was initially led by major metropolitan cities. The country's mobile subscriber base has grown at an explosive rate in response to bouts of price-cutting on mobile service plans, with contributions from widening network coverage, rising incomes, and the increased affordability of handsets.

MOBILE CARRIERS IN INDIA*	
SUBSCRIBERS / PENETRATION	
(in millions)	
Total mobile subscribers	1,143.6
Year-to-year growth *(in percent)*	(1.9)
PENETRATION RATE	
(in percent)	
Mobile	81.0
Fixed line	1.9
LEADING CARRIERS	
(subscribers, in millions)	
Vodafone Idea	245.6
Reliance Jio	421.4
Bharti Airtel	365.0
Bharti Sanchar Nigam	108.7

*Data through October 31, 2022.
Source: The Telecommunications Regulatory Authority of India (TRAI), company reports.

In the world's second largest telecom industry, the focus on improving the existing telecommunication landscape has been a priority for the Indian government. According to the Department of Telecommunications (DoT) of India, Telecom Service Providers (TSP) in India have been permitted to

conduct 5G spectrum trials. India's overall mobile subscriber base reduced drastically to 1.14 billion by March 2022, compared to 1.18 billion as of March 31, 2021, according to data released by the Telecom Regulatory Authority of India (TRAI). This drop is attributable to Indian telcos' cleanup of dormant and low-value customers. In India, the rural market remains largely untapped. As of October 2022, urban subscribers command 54.7% of the country's total wireless market share, while rural subscribers make up 45.3%.

Given the government's aim to provide universal broadband connectivity to every citizen at 50 Mbps by 2022 under the 2018 National Digital Communications Policy, CFRA forecasts the mobile industry will continue to expand in the medium term (although there has yet to be any update on achieving the goal as of early 2023). Mobile remains the most viable and cost-effective form of communication and internet access for India's underdeveloped rural communities. As of October 2022, the overall teledensity (or the number of telephones per 100 population) was 84.7%, with urban areas recording 134.1%, while rural areas stood at 58.1% in general. In the 12 months through October 31, 2022, broadband subscribers rose 2.8% to 821.49 million users.

◆ **Indonesia.** Indonesia's network expansion, price competition, and wireless broadband continue to spur subscriber growth. The wireless market is dominated by three operators: PT Telekomunikasi Selular (Telkomsel), PT Indosat Ooredoo Hutchison Tbk, and PT XL Axiata, which collectively account for 83% of the Indonesian market. In the 12 months through the third quarter of 2022, the number of mobile subscribers increased by 2.6% to 380 million. The country's 135.5% penetration rate is expected to increase further with the introduction of 5G mobile services by Telkomsel, Indosat, and soon XL Axiata. Indonesian telecom operators are also expanding their coverage of 4G services in rural parts of Indonesia and have almost completed the shutdown of 3G networks.

MOBILE CARRIERS IN INDONESIA

SUBSCRIBERS / PENETRATION	
(in millions)	
Total mobile subscribers	380.0
Year-to-year growth *(in percent)*	2.6
PENETRATION RATE	
(in percent)	
Mobile	135.5
LEADING CARRIERS	
(subscribers, in millions)	
Telkomsel	159.8
Indosat Ooredoo Hutchison	98.6
XL Axiata	57.4

*Data through October 31, 2022.
Sources: Company reports.

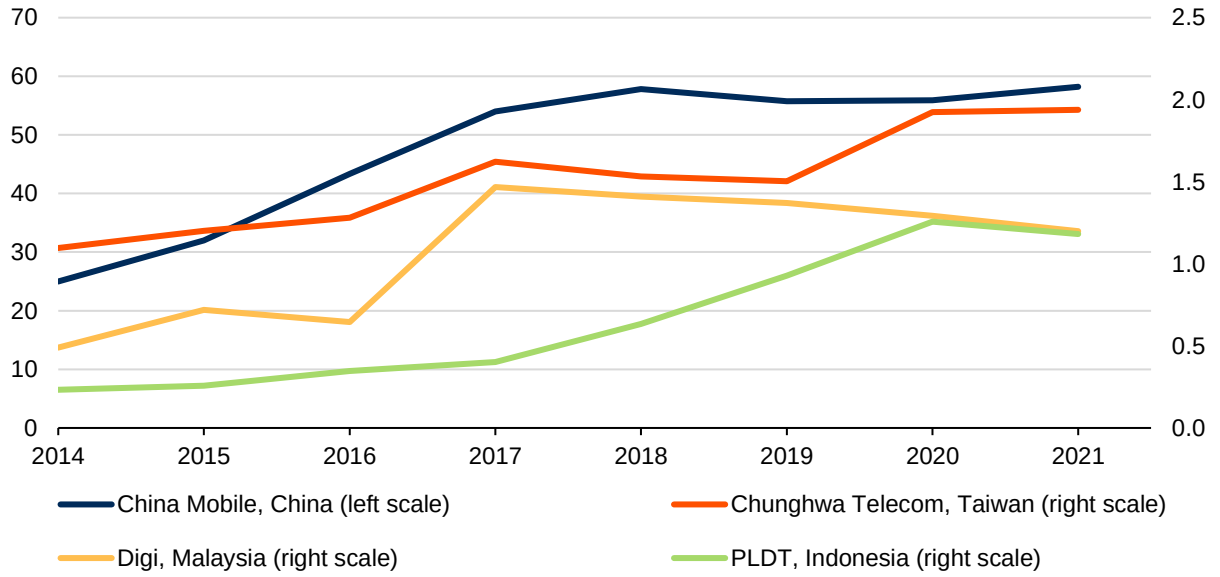
Service Commoditization

While initially (especially in the 2G and 3G era), the Asian Telecommunications Services industry sought to distinguish itself using service coverage and quality, with converging coverage and diminishing returns on network capital expenditure, telecom operators now compete mainly on price, offering significant promotional discounts in bids to attract new subscribers. This has the effect of bringing down ARPU for the industry.

With the rising adoption of smartphones and wide availability of mobile broadband data, consumers have switched to using over-the-top (OTT) applications to replace traditional voice and SMS services. These OTT applications include WhatsApp, WeChat, Telegram, and Line, most of which are free, and all of which offer messaging, voice, and video calling features that piggyback on mobile data for their service. As a result, overall revenue for voice and SMS has been falling and is now no longer a significant revenue source.

As with the transition from 3G to 4G, and now moving slowly into the 5G era, operators have competed on data network quality and coverage as well, usually focusing on data speeds. However, as data speeds continue to increase, the incremental gain for the end-user of slightly higher speeds is falling. For the end-user, the difference between one provider offering 20 Mbps on their network and one offering 18 Mbps is increasingly becoming marginal when both can offer roughly the same user experience. Hence, operators are finding that, increasingly, they are again competing on price for data services. As a result, while overall data revenue has increased tremendously in recent years due to surging data consumption in the region, data yield (revenue per unit of data consumed) has been largely falling in most markets.

TOTAL CONSUMER DATA REVENUE OF SELECT ASIAN OPERATORS
($, in billions)



*Data through full year of 2021.
Source: Company filings.

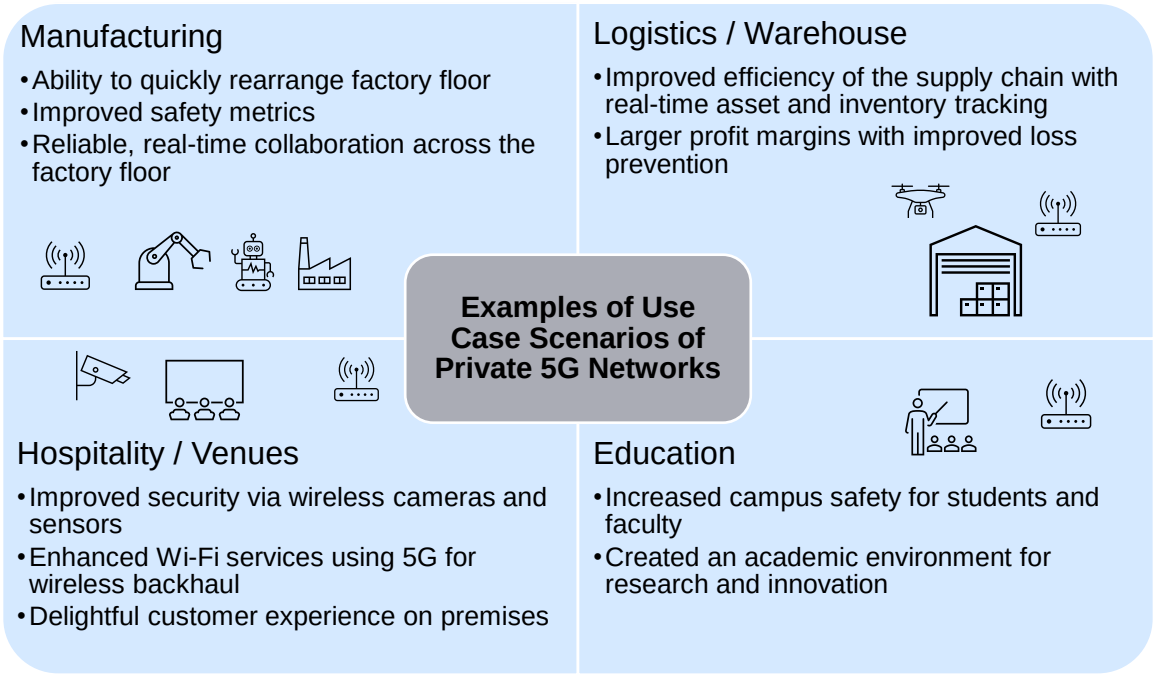
Operators in saturated markets aim to offset pricing pressure by pushing for more converged services, priced as bundled offerings. These are services tied to the core data product, such as voice, fixed fiber broadband, and on-demand video for the consumer market. Examples include MaxisONE Prime plan, Telekom Malaysia's Unifi packages, and StarHub's HomeHub. Some mobile operators package promotions on applications such as Amazon Prime, iFlix, and Netflix into their mobile plans, offering reduced prices or free periods on these subscriptions. Customers in such bundles will tend to be "stickier" given the bundled benefits, reducing overall churn rate and pressure on ARPU.

Similar competitive pressure in the enterprise space has also led to operators expanding into related businesses such as cloud services, managed services, advertising, e-payment systems, and cybersecurity. Examples include Axiata's investments into digital ventures, including digital advertising company ADA, application programming interface (API) platform Apigate, and financial technology/digital financial services unit Boost; the acquisition of cybersecurity firm D'Crypt and ICT solutions provider

Strateq by StarHub; and Singtel's acquisition of U.S.-based mobile advertising solutions provider Amobee for $321 million and cybersecurity firm Trustwave for $810 million. Overall, this reflects the operators' desire to be more than just "dumb pipes" and to participate more fully in the digital consumption value chain. Citing strategic reset, Singtel announced on July 26, 2022, that it plans to divest its U.S. digital media and advertising subsidiary Amobee to Tremor International for an enterprise valuation of $239 million with a profit of $197 million at closing.

The Rising Adoption of Private 5G Networks

Private 5G networks are nonpublic mobile networks that can utilize licensed, unlicensed, or shared spectrum. These networks are meant to augment existing capabilities, cater for specialist requirements within industries and introduce new possibilities that other systems are not able to support. IDC forecast shows worldwide revenue linking to the sales of private LTE/5G infrastructure will grow from an estimated $2.8 billion in 2022 to an estimated $8.3 billion in 2026.



Source: Cisco.

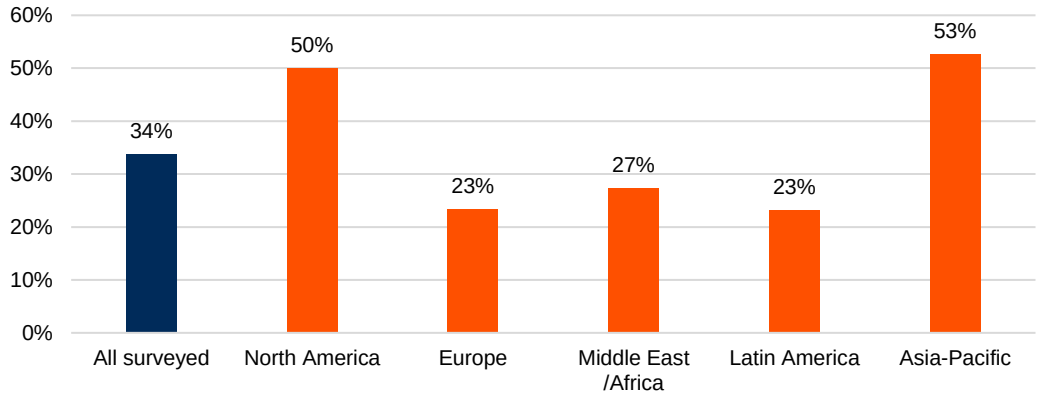
Despite the many use case scenarios coming out of private 5G networks, there are some risks that needs to be addressed. The technology-related risks arising from private 5G networks are complexity in access to spectrum and 5G technical understanding. Risks on the operational side are staying current on security patches and software upgrades, adding complexity to the existing environments, site surveying to optimize radio coverage, and new workflows to manage 5G at scale. The biggest financial risks for any enterprise looking to deploy private 5G network will be the major initial capex, recurring opex introducing additional complexity, and wait time for productivity and efficiency gains to justify costs.

At this juncture, an enterprise can choose to have a private 5G network as a service (NaaS), which is an alternative to buying, building, and maintaining a private mobile network. This in turn lowers the barrier of entry for companies and industries by cutting down on initial costs and outsourcing construction and daily management, so organizations can focus on core business initiatives.

Developing Use Case Scenarios for Retail 5G Users

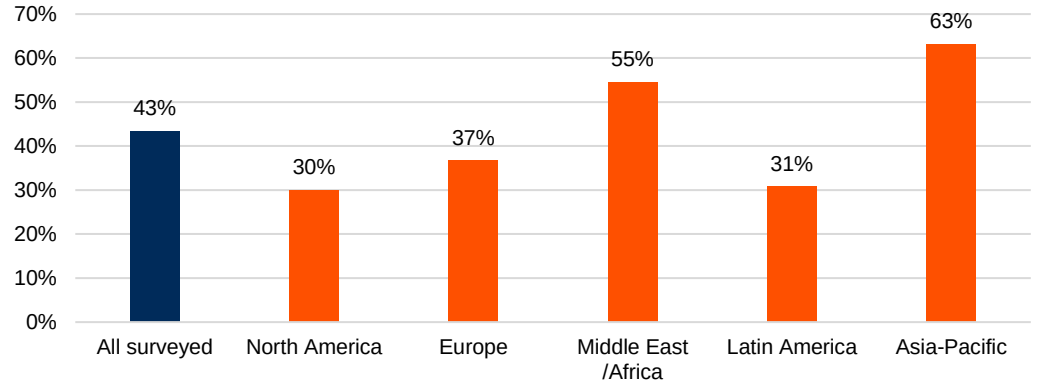
Unlike 2G, 3G, or 4G, the monetization of 5G will likely be harder. Although the benefits offered by 5G services are substantial, telecom operators' efforts to monetize the technology face some fundamental challenges. Traditionally, telecom operator revenue is mainly driven by the consumer. When 4G launched, 4G devices were already available from major players such as Samsung and Apple. At that time, many customers actively upgraded their 3G mobile services to 4G mobile services. With 5G, in contrast, consumer awareness is much lower, while enterprise use case scenarios are much higher.

CLOUD GAMING AS A 5G DRIVER BY SURVEY REGION
(percentage)



Source: Kagan's Global 5G survey (2021). Question: What consumer use cases are your company projecting to help accelerate 5G adoption? Base: All surveyed-83; North America-10; Europe-30; Middle East/Africa-11; Latin America-13; Asia-Pacific-19.

LOW-LATENCY GAMING AS A 5G DRIVER BY SURVEY REGION
(percentage)



Source: Kagan's Global 5G survey (2021). Question: What consumer use cases are your company projecting to help accelerate 5G adoption? Base: All surveyed-83; North America-10; Europe-30; Middle East/Africa-11; Latin America-13; Asia-Pacific-19.

According to a survey conducted by Kagan in December 2022, among the majority of wireless operator decision-makers (from vice-president, director, and senior network-level professionals), gaming was cited as a key 5G growth driver. Several Asia Pacific operators are increasing the speeds of their 5G networks by adding more spectrum bands and network enhancements, as well as investing in multi-access edge computing (MEC) to support low-latency applications.

Kagan's Global 5G survey found that when it comes to 5G networks, wireless operators see a clear use case for the enterprise, such as private networks, automated factories, and remote monitoring. However, use cases for the consumer market have been more ambiguous beyond faster data speeds.

IDC expects 5G growth to remain robust as many markets transition to 5G. Total market for 5G mobile phones is forecasted to climb 52.9% by the end of 2023, growing nearly 20% from 2022, according to IDC. IDC continues to expect solid consumer demand due to the increasing number of affordable 5G smartphones.

TOP DRIVERS FOR ENTERPRISE 5G ADOPTION
(percentage of total respondents)

	Total	North America	Europe	Middle East and Africa	Latin America	Asia Pacific
Autonomous Cars	55%	80%	43%	45%	62%	63%
Cloud Services	61%	100%	67%	36%	46%	58%
Autonomous Fleet Vehicles (*e.g.,* trucking)	33%	70%	27%	45%	23%	21%
Telemedicine	46%	30%	57%	36%	46%	42%
Remote surgery	65%	30%	80%	64%	46%	74%
Factory Automation	70%	100%	60%	64%	62%	79%
Smart City Applications	76%	90%	77%	73%	92%	58%

Source: Kagan's September 2021 survey B2B Global 5G survey. Question: What enterprise use cases are your company projecting to help accelerate 5G adoption? Base: All surveyed-83; North America-10;Europe-30; Middle-East/Africa-11; Latin America-13; Asia-Pacific-19.

Role of Artificial Intelligence in 5G Networks

Artificial Intelligence (AI) is the simulation of human intelligence processes by machines, usually computer systems. AI programs primarily focus on three main cognitive skills: learning (gathering data and setting rules for sorting that data), reasoning (selecting the correct data to achieve the desired goal), and self-correction (modifying the data sorting for the most accurate results). Data sorting rules are known as algorithms, which offer step-by-step instructions for how to achieve an outcome. Overall, these algorithms can help improve the network performance, operations, and ultimately the cost of running a network.

According to Ericsson, AI algorithms could analyze vast amounts of traffic data and network load in real time, without impacting the capacity of the network. Let's look into three commonly adopted AI use case clusters:

AI CLUSTERS DEEP DIVES	
Network optimization	AI use cases related to optimization and improvement of network performance. Examples include proactively identifying network bottleneck issues and maximizing capex investments using AI-powered prediction models.
Network operations	AI use cases related to improving the end-to-end operations and automation of the network, including network operations centers and fieldwork. Examples include detecting incidents affecting the network performance and notifying telcos of the possible first cut analysis.
Cloud and infrastructure operations	AI use cases related to improving the effectiveness, availability, and stability of cloud and infrastructure operations. Examples include infrastructure fault detection and prediction and capacity management.
Source: Ericsson.	

5G – More Than Just Faster Speeds

According to DeepSig, core algorithms have not evolved since the 1990s despite smartphones becoming increasingly smaller. Thus, 5G systems consume more power than desired and achieve lower data rates than expected. Replacing traditional wireless algorithms with deep learning AI will dramatically reduce power consumption and improve performance. DeepSig believes that this pathway will be fundamentally more significant than focusing AI primarily on network management and scheduling.

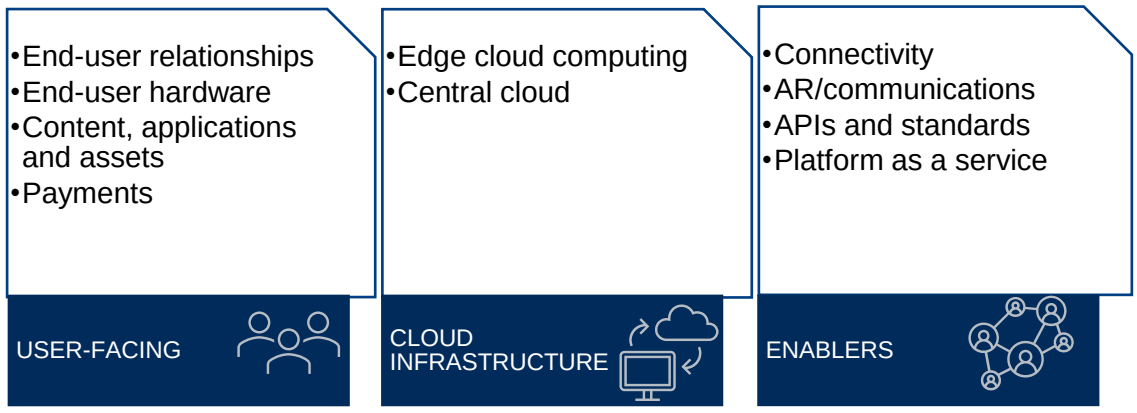
Due to its low latency, 5G speeds will allow developers to create applications that take advantage of improved response time, including near real-time video transmission for sporting events or security purposes. Besides that, 5G connectivity will allow more access to real-time data from various solutions. 5G leverages Internet of Things (IoT) sensors that could last for years, requiring less power for operation. This would allow remote monitoring of farming irrigation levels and equipment condition changes in factories.

Telcos Venture Into Metaverse

Metaverse was certainly one of the popular buzzwords of 2022, and it will be even more popular in the coming years. Metaverse is a word that was coined by author Neal Stephenson in his 1992 sci-fi novel Snow Crash. In the novel, Stephenson defined the metaverse to be an all-encompassing digital world that exists parallel to the real world. Matthew Ball, a venture capitalist and angel investor, is one of the leading experts in the metaverse universe. In his own words, the metaverse is best understood as “a quasi-successor state to the mobile internet” since the metaverse will not fundamentally replace the internet but will build upon and iteratively transform it.

The metaverse is a massively scaled and interoperable network of real-time rendered 3D virtual worlds that can be experienced synchronously and persistently by an effectively unlimited number of users, and with continuity of data, such as identity, history, entitlements, objects, communications, and payments. According to Ball, the metaverse relies on low latency and higher bandwidth for its existence. As 5G services are expected to deliver higher multi-gigabits-per-second (multi-Gpbs) peak data speeds and low latency, consumers will be able to enter the metaverse.

FRAMEWORK FOR CONSIDERING APPROACHES TO THE METAVERSE



Source: Analysys Mason, Matthew Ball.

The framework for considering approaches to the metaverse originally created by Matthew Ball has since been regrouped by Analysys Mason into 10 sub-categories and three super-categories, as shown in the chart above. A telco does not need to excel in every aspect to be successful, and operators will naturally succeed in some areas (such as connectivity) and hyperscalers in others (central cloud).

The three super-categories have been defined by Analysys Mason as follows:

- **User-facing.** This includes end users and their "digital life"; the hardware that enables them to interact with the metaverse, the content that they consume, and the applications and payment systems through which they engage in commerce.
- **Enablers.** We use this term broadly so as to incorporate all elements that enable metaverse services to operate and users to interact: connectivity, real-time communication both within different points in the metaverse and from the metaverse out to the "real world" (for example via AR), the APIs and standards, and platforms that support and enable that activity.
- **Cloud infrastructure.** The hardware and processing resources upon which the metaverse software and platform run.

CFRA expects that a full-fledged metaverse is decades away. Nonetheless, the hardware ecosystem that supports emerging technologies and trends could bring about an experience never seen before. CFRA believes that Asian telco players could monetize the metaverse by offering content and applications that complement user interests in enterprise deployment (marketing, branding, shopping) and consumer deployment (gaming, content creation). For example, SK Telecom was able to take advantage of South Korean consumers' interest in using AR/VR services more than those in other developed markets, according to Analysys Mason. As of the second quarter of 2022, SK Telecom's ifland (its metaverse ecosystem) has 1.63 million monthly active users.

Capex Growth May Slow or Turn Negative in 2023

The fundamental unit of the wireless network is the base station, which is owned by the carrier and contains radio transmitters and receivers that are usually mounted on towers. Base stations pick up and deliver transmissions within a limited geographical area, known as a "cell". They convert the radio signals sent from a mobile handset into electrical signals that are then transmitted to a mobile switching center, which converts the signal into a form that can be relayed to other base stations. The spending on these base stations and related equipment constitutes a major portion of the capital expenditures for mobile service providers. Overall, CFRA expects capex growth may slow or turn negative as 5G investment peaks, 4G investment accelerates its decline, and as economies slow amid higher rates.

As of end-November 2022, the total number of 5G base stations in China is 2.29 million, according to the country's Ministry of Industry and Information Technology (MIIT). Chinese telecom operators have made significant leads in deploying the world's largest shared network for 5G through the "co-build, co-share" rollout. In 2019, China Telecom and China Unicom agreed to collaborate to co-build and co-share, and saved around CNY80 billion, as highlighted during MWC Barcelona 2021. China Mobile and China Broadcasting Network Corp (parent of China Mobile) agreed to a "co-build, co-share" arrangement, as reported by Nikkei Asia.

In Japan, SoftBank and KDDI deployed Ericsson's network equipment for their 5G network through a joint venture, 5G JAPAN. NTT Docomo, however, chose NEC Corp to be its vendor for its 5G mobile core network rollout as a standalone instead of partnering with its peers. As of July 2022, NTT, KDDI, SoftBank, and Rakuten have deployed more than 20,000 5GmmWave gNodeBs (millimeter wave).

The 5G rollout in Malaysia is quite different from other countries. Digital Nasional Berhad (DNB), a government-owned special purpose vehicle, has contracted Ericsson to offer 5G services via a Single Wholesale Network (SWN) model, according to the Ministry of Communications and Multimedia Commission (MCMC) of Malaysia. While Ericsson will arrange financing of the 5G deployment in Malaysia, DNB will repay and maintain the wholesale network through sukuk (Islamic bonds) programs, according to DNB. While DNB stated that this method will future-proof the network and support the local telecom industry, it has received a fair share of its critics. Rollout delays, financial losses by the SWN

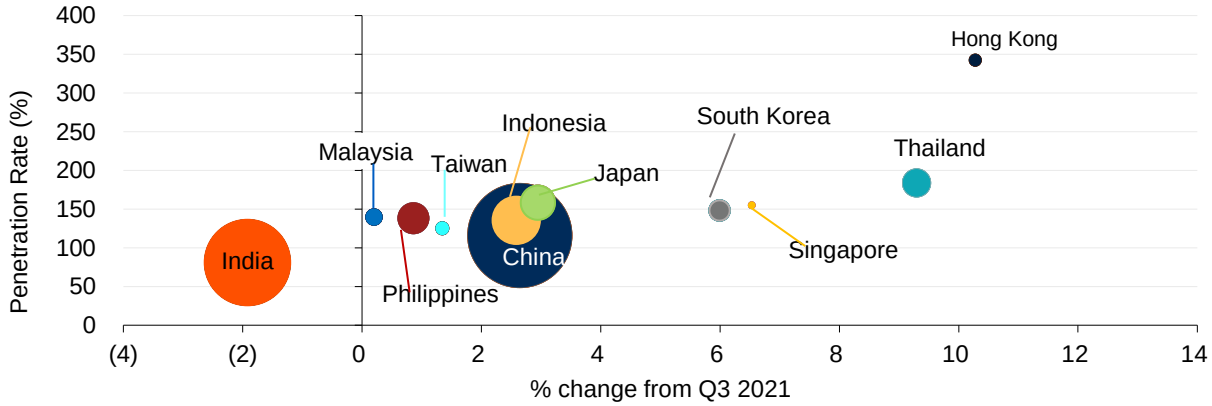
company, and low mobile broadband penetration and speeds are some of the potential downsides pointed out by GSMA Asia Pacific in its report. Network infrastructure costs, which were initially projected to be MYR11 billion, have now been revised to MYR16.5 billion, which DNB said could swell up to MYR20 billion between 2025 and 2030.

As of January 24, 2022, 5G sites had gone live in three cities in Malaysia. There was also an ongoing discussion on allowing the setup of a second 5G wholesale network to rival DNB. This recommendation came from Celcom, Digi, Maxis, and U Mobile, as all four telcos had not inked a long-term contract with DNB. However, as of October 2022, six Malaysian telcos (Celcom, Digi, Maxis, U Mobile, YTL Communications, and Telekom Malaysia) finally signed access agreements with DNB. In January 2023, DNB announced that its 5G network has achieved almost 50% coverage in Malaysia. However, Malaysia's prime minister has stated that the government will review the rollout of the national 5G network. The 5G network implementation policy is expected to be submitted to the Cabinet by the end of March 2023.

In Australia, Telstra confirmed in June 2022 that its 5G network reached 80% of the country's population. Nevertheless, Telstra continues to ramp up investments in 5G with the announcement of an additional AUD616 million to secure 2x10MHz of 850MHz spectrum, which is the maximum amount of low band spectrum Telstra was allowed to bid by the government. This low band spectrum is vital in terms of carrying mobile data (particularly 5G) over vast distances needed across regional and remote areas in Australia. CFRA expects investments in 5G networks by Australian telcos will lead to an increase in connectivity and data consumption.

REGIONAL REVIEW: RECENT DEVELOPMENTS IN SELECTED COUNTRIES

MOBILE SERVICES, ASIA PACIFIC COUNTRIES
(for the third quarter of 2022)



Note: Sizes of circles indicate relative size of subscriber base.
Sources: Telecommunications regulatory authorities, Worldometers, company reports.

China: Leading the 5G Race by Mobile Subscribers

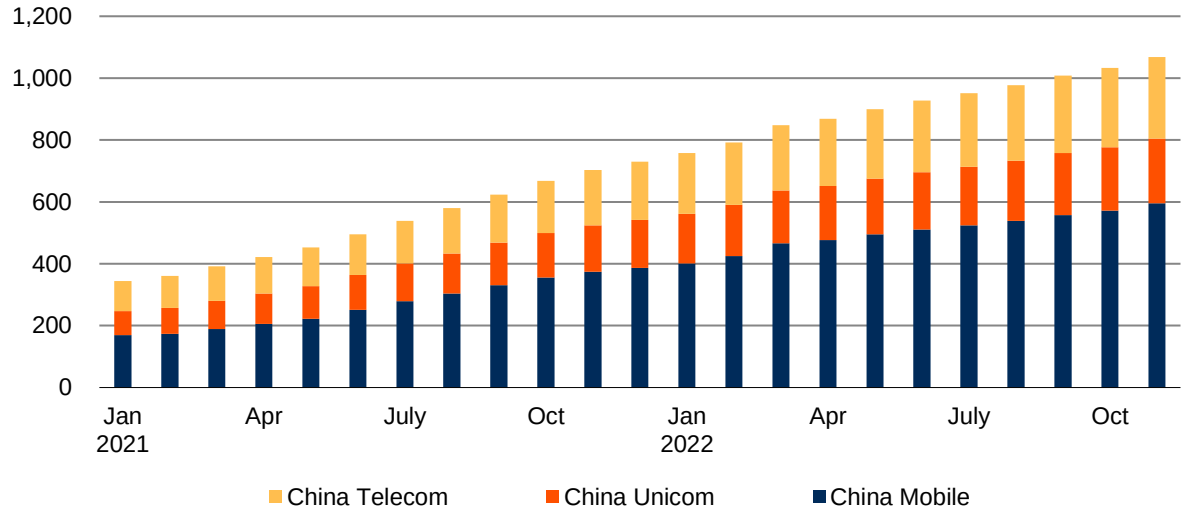
As of October 31, 2022, China remained the single largest wireless market worldwide, with more than 1.68 billion users (47.2% more than the nearly 1.14 billion users in India). Around 32.2% or 403 million of China's total mobile subscriber base came from 5G technologies in March 2022, compared with 542 million by the end of November 2022, based on data from the Ministry of Industry and Information Technology (MIIT).

China's 5G subscriber momentum will likely continue as operators leverage lower handset costs and increasing number of 5G mobile phone base stations. 3G subscribers will continue to shrink as users

move to 4G networks and start to adopt 5G technology. In October 2019, MIIT asked telecom operators to shut down their 2G and 3G mobile networks as the country races toward the era of 5G.

Based on the following chart, the big three telco players reported a total of 1.067 billion mobile 5G package subscribers, as at the end of November 2022.

CHINA'S MOBILE CARRIERS 5G PACKAGE CUSTOMERS
(in millions of subscribers)



Data through November 2022.
Source: Company websites.

In terms of 5G package subscribers, China Mobile, China Telecom, and China Unicom have reached a total of 595 million, 267 million, and 209 million as of November 2022, respectively. An important point to note here is that these figures are based on the number of subscribers that have signed up for a 5G tariff and do not mean they are all connected to a 5G network or use 5G-capable devices. In addition to that, “customers with a 5G package” could also mean the possibility to connect to a 5G network because their contract allows it. Of the three Chinese mobile operators, China Mobile is the only operator that shares the number of 5G network customers on a quarterly basis. As per CFRA’s estimate in the last iteration of this survey, China’s 5G package subscribers exceeded the 1 billion mark at the end of third quarter of 2022.

South Korea: 5G Subscribers Gain Robust, but Lagging Behind China
South Korea was the first country to launch commercial 5G network services on a nationwide basis in April 2019, according to Reuters. With one of APAC’s top mobile services penetration rates, South Korea is in a race with China, the U.S., and Japan to market 5G network services in a move to transform the country into smart cities. This follows the launch of limited-coverage, enterprises-only services on December 1, 2018 – also a world first to launch 5G network services.

Based on data from the Ministry of Science and ICT (MSIT), on average, 5G subscribers in South Korea used 2.6 times as much data as consumed by 4G subscribers. The data suggest a substantial shift in behavior and a positive response to the new capabilities and content afforded by 5G plans and devices.

By the end of July 2022, the number of 5G subscribers in South Korea increased to 25.1 million, which is around 33% of the total 76 million mobile subscriptions, as reported by MSIT. According to MSIT, the three telcos have agreed to share 5G networks for users in remote locations across South Korea, as reported by local news agency Yonhap.

Japan: KDDI's 2022 Major Network Outage Brought New Reforms
In July 2022, around 30.91 million KDDI subscribers were hit with service disruption for almost two days. Corporate logistics systems, ATM services, network-connected cars, transport charge cards, and other services were interrupted due to the network outage. The Ministry of Internal Affairs and Communications of Japan issued a guidance to KDDI, ordering it to take preventive measures of such incidents where millions were effected. KDDI has since stated that in case of occurrence of similar incidents in the future, its users will be switched to the networks of NTT DOCOMO and SoftBank Corp as a backup; however, the users will have to pay for the data used.

Network sharing agreements are becoming increasingly common. Following the launches in March 2020, SoftBank and KDDI established a joint venture that will focus on setting up 5G network in Japan's rural areas. Nokia was selected to deploy a shared radio access network (RAN) across the country while keeping core networks separate. The companies will equally own the joint venture, called 5G Japan Corp., which will oversee the management of construction for the 5G base stations. As usual, network sharing agreements help to lower the cost of building 5G networks while creating a more attractive return on investment.

In terms of handset models, Apple's iPhones have dominated the smartphone market in Japan in the last decade. The introduction of Apple iPhone 13 models has been a success in Japan, which increased the Japanese's adoption of 5G services. Samsung's 5G devices have also been a hit. CFRA believes Japan's adoption of 5G devices will be parallel with the increase of 5G base stations around the country.

India: Jio and Airtel Lead 5G Rollout Battle While Vodafone Idea and BSNL Gets Lifeline
Telecommunication Services is one of the fastest-growing industries in India, which has become the world's second-largest telecommunications market in the world after China. In terms of the number of subscribers, Reliance Jio is the clear market leader, with a total of 421 million mobile subscribers as of October 31, 2022. The company accounts for 36.8% market share, followed by Bharti Airtel (31.9%), Vodafone Idea (21.5%), and Bharat Sachar Nigam (9.5%).

On July 26, 2022, the Indian government put on sale 72 GHz of 5G airwaves across 10 bands; Reliance Jio and Bharti Airtel are expected to emerge as leading telcos for the auction. New entrant Adani Data Networks of Adani Group has surprised the industry by bidding for the 5G spectrum. However, in a later statement, Adani Group stated that it has no plans to enter the telco space and only plans to bid for a small size of spectrum for its captive network in some cities.

4G migration is still underway in India; India is one of the major telco markets that still has 2G and 3G active users in the hundreds of millions (a little over 300 million 2G users due to affordability). Broadband wireless access (BWA) technologies, such as WiMAX and LTE, are among the most recent and significant developments in the world's second most-populous nation. CFRA thinks 4G mobile subscriptions will gain momentum due to affordable 4G mobile data prices and affordable 4G-supported phones in India.

To foster the 5G rollout, the government of India introduced a few supportive measures like the alignment of states' telecom infrastructure with right-of-way rules and mandating common telecom infrastructure on highways, roads, canals, and utility infrastructure. In addition, Ericsson will start manufacturing 5G radio products in India for domestic consumption and export. Ericsson forecasts that 5G services will represent around 39% of mobile subscriptions in India by the end of 2026.

The recent Budget 2023 from India heavily favors the telecom industry. BSNL is expected to launch 4G services soon by this year and looking forward to deploy 5G services after at least a year of launching 4G services. The Indian government expects BSNL to be profitable in FY2026-2027 alongside an injection of around USD6.5 billion into BSNL in 2023. The Indian government decided to convert the interest dues of

Vodafone Idea into equity after receaving a firm commitment from Aditya Birla Group to run the company and bring necessary investment, said Telecom Minister according to a report from ET Telecom. With this conversion the government is expected to hold a 33.14% stake in the loss-making telco.

Australia: Regulator vs. Australian Telcos

The Australian mobile market is dominated by three major mobile network operators: Telstra, Optus, and TPG Telecom. All three telecom operators provide comprehensive population coverage with their 4G network services and have launched 5G network services. Telstra first announced its successful deployment of 5G standalone network. 5G standalone does not lean on existing 4G tech, which can result in more devices that can communicate simultaneously, at higher speeds, and in more complex ways than 4G can.

In July 2022, Telstra announced that 80% of the country's population has access to its 5G network service. In November 2019, Optus announced the commercial launch of 5G mobile and 5G residential fixed broadband services. Optus currently operates more than 900 live 5G sites across Australia.

On February 21, 2022, Telstra and TPG Telecom announced a 10-year regional Multi-Operator Core Network (MOCN) commercial agreement, which will provide significant value to Telstra's wholesale mobile revenues while providing TPG Telecom's subscribers with 4G and 5G services within a defined coverage zone across regional and urban fringe areas. However, Optus, ATN, and Commpete opposed this arrangement. The main reason for the opposition is that this agreement will put regional Australia at a disadvantage due to increase in prices and worse services. In December 2022, the Australian Competition & Consumer Commission (ACCC) stated it could not authorize the network arrangements between Telstra and TPG Telecom. ACCC's Commissioner noted the proposed arrangements will lead to less competition in the longer term and leave Australian mobile users worse off over time, in terms of price and regional coverage. Telstra and TPG Telecom have since lodged applications with the Australian Competition Tribunal (ACT) asking for a review of ACCC's decision not to authorize the proposed regional mobile network arrangements. ACT is expected to rule on this matter within 90 to 120 days.

There is no doubt that 5G networks can replace fixed-line broadband services in Australia. To penetrate the market, Optus has started offering 5G home connections, promising faster speeds than those currently available to consumers on the National Broadband Network (NBN), an Australian fixed-line internet network, for roughly the same price as its most popular speed tier. Telstra has also rolled out 5G home broadband, albeit with limited data, while TPG Telecom (TPG-Vodafone) has launched its 5G fixed wireless service. TPG Telecom is currently deploying its 5G network in partnership with Nokia in major Australian cities with a target of 85% population coverage. The NBN was meant to be used by everyone, but there are more rivals making moves to acquire clients from their peers. In the interim, the NBN is trying to retain its clients by offering discounts on its wholesale bandwidth.

Hong Kong: 5G Coverage is Over 90%

China Mobile Hong Kong (CMHK), Hutchison, and Hong Kong Telecom (HKT) have launched commercial 5G services in Hong Kong as of April 1, 2020. CMHK indicates that its 5G network will cover 90% of Hong Kong island. HKT said its coverage would initially reach 11 of the territory's 18 districts, including Causeway Bay and Central, with plans to extend to all districts and major subway lines in the coming months. The top three telecom operators did not reveal any specific information about the number of 5G base stations deployed in Hong Kong. On June 2, 2020, SmarTone, Hong Kong's smallest mobile operator, announced the commercial launch of 5G services with its 5G vendor, Ericsson. SmarTone reported over 90% 5G coverage to the entire city in 2021.

In October 2021, the government awarded 5G spectrum licenses to the four telecoms, raising a total of HKD1.88 billion ($241 million). 255 MHz of frequencies in the 700 MHz, 850 MHz, 2.5 GHz, and 4.9 GHz bands were sold under a 15-year license period.

HKT bought 700 MHz and 2.5 GHz; Hutchison secured frequencies at 700 MHz and 2.5 GHz; SmarTone bought 700 MHz, 850 MHz, and 4.9 GHz; and China Mobile bought 700 MHz, 2.5 GHz, and 4.9 GHz.

Taiwan: Accelerating 5G Build-Out

Taiwan completed its 5G spectrum auction on January 16, 2020, with bids totaling TWD138 billion. Chunghwa Telecom, Taiwan Mobile, and Far EasTone won spectrum in the 3.5 GHz band. NCC indicated the unit price per 10 MHz bandwidth in the 3.5 GHz band reached TWD5.075 billion, the most expensive 5G bandwidth in the world. Chunghwa Telecom won 90 MHz of spectrum in the 3.5 GHz frequency band for TWD45.675 billion, while Far EasTone won 80 MHz in the 3.5 GHz band for TWD40.6 billion. Since both players secured 80 MHz and 90 MHz spectrum in the 3.5 GHz band, CFRA expects both telecom operators to compete fiercely in a number of 5G service segments, including the Internet of Things (IoT), artificial intelligence (AI), and big data.

Chunghwa Telecom noted that it continues to excel in growing the number of 5G sign-ups and expects its private 5G network business to ramp up. Meanwhile, Far EasTone said it targets around 40% 5G subscriptions in 2023. On July 3, 2020, Far EasTone said it will spend up to TWD30 billion on 5G network deployment over the next three years as it expects half of its 7.05 million mobile subscribers to migrate to 5G services by 2023. With a mobile penetration rate of 125% as of the third quarter of 2022 in Taiwan, the competition between these players will be fierce.

On April 19, 2022, Taiwan's Asia Pacific Telecom (APT) agreed to merge with Far EasTone. The deal, valued at $845 million, was completed in January 2023, on the condition that both the telecom operators raise their 4G coverage rate to 99% and 5G coverage rate by 98% by 2027 and rural coverage rate of 5G to 95%.

ASEAN: Lagging Behind Global Players

Thailand was the first ASEAN nation to launch 5G services. Advanced Info Services (AIS), the leading Thai mobile operator by subscribers, launched the first 5G network services in Thailand in 2020. AIS stands as the strongest leader in digital network with the most spectrum of 4G and 5G services in the industry, totaling 1,420 MHz. According to True's Chief Commerical Officer at Huawei's 13th Global Mobile Broadband Forum, Thailand's 5G coverage is expected to reach 85% by the end of 2022. AIS plans to spend THB30-THB35 billion on 5G network expansions in FY 22. In Thailand's February 2020 auction, the second-largest telecom operator, True Move H Universal Communication (TUC), won nine licenses on the 2,600 MHz range, plus eight licenses on the 26 GHz range. The 2,600 MHz spectrum, known as mid-band, is suitable for providing 5G services in dense areas in downtown and suburban areas because it can transmit long-distance signals and support a large capacity of usage at the same time.

In Malaysia, 5G rollout is all but quick, with only three cities currently connected alongside limited 5G devices that can connect to the network. All six Malaysian telcos eventually gave in to the proposed equal stakes totaling 70% in government-owned DNB. Due to the recent changes in elected government, the 5G network rollout is still being discussed. As such, Maxis has decided to wait till the end of March 2023 for the submission of the findings of the 5G network rollout policy in Malaysia.

In Singapore, Singtel launched its 5G Standalone network in partnership with Ericsson while covering more than two-thirds of the island state by adding hundreds of new 5G sites. Singapore authorities awarded provisional 2.1 GHz spectrum allocations for 5G services to Singtel, the M1-StarHub Consortium (Antina), and TPG Telecom in November 2021. Both Singtel and the M1-StarHub consortium are now leading to deploy two 5G Standalone networks with a target of 50% coverage by the end of 2022 and 100% coverage by 2025. TPG Telecom is also in the middle of deploying a 5G Standalone network, albeit at a slightly later date than the previous two.

Indonesia sped up the launching of 5G commercial services in 2021. On May 27, 2021, Telkomsel launched its 5G commercial services and is on track to cover more cities. Meanwhile, Indosat launched its 5G mobile service on June 23, 2021, and targets to launch in major cities in Indonesia. XL Axiata was given the green light to operate a 5G network on August 17, 2021, by the Ministry of Communication and Information (MCI or KemKominfo), confirming that 5G services are now supported by the big three national telecom operators. The Ministry of Communication and Information has begun the process of refarming 2.3 GHz spectrum to improve service quality and prepare for 5G by using airwaves efficiently. Similar to Malaysia, Indonesia is required to improve the distribution of the country's existing internet network – 2G, 3G, and 4G – before it can move on to 5G.

M&A Environment

M&A in Core and Adjacent Businesses in Focus

In these tough market conditions, the overcrowded mobile market is ripe for consolidation. We expect increasing M&A activity, particularly as valuations have come down significantly in recent years. There is a recurring theme developing in this space: the race to switch from relying on legacy mobile services to consumer and enterprise digital services, including cloud computing, data centers, payment services, and AI. CFRA expects telecom operators to operate like Silicon Valley venture capitalists by acquiring smaller tech companies that develop AI-based applications and software that can be monetized by the telecom operators using its data and network reach.

On February 18, 2022, the proposed merger of True Corporation and Total Access Communication (DTAC) was approved by their respective boards. This merger will create Thailand's largest telco player by subscriber number, overtaking AIS. Importantly, this merger would create a duopoly, which is usually viewed as a retrograde step by antitrust authorities. There are still concerns being raised by consumers about this merger. At the same time, two of the four panels set up by Thailand's National Broadcasting and Telecommunications Commission have voted against approving the proposed merger, according to The Bangkok Post. In October 2022, Thailand's telecom regulator approved the proposed merger. The new entity will be known as True Corporation and the merger will be completed within the first quarter of 2023. However, True Corporation and DTAC will continue to serve their subscribers in the current arrangement for the next three years, according to one of the conditions set by the regulator. True Corporation and DTAC will each hold a 30% stake in the new company.

On January 31, 2022, Bharti Airtel announced its plans to acquire an approximately 25% equity stake in Lavelle Networks, specializing in Software-defined Wide Area Network (SD-WAN). Airtel will offer software defined connectivity solutions for enterprises by offering cutting-edge technology and cost efficiencies.

On January 27, 2022, Axiata Group and PT XL Axiata made an offer to acquire a 33.9% stake in PT Link Net for around $312 million. Link Net distributes cable TV and high-speed broadband, and is considered among the leading operators in Indonesia. Axiata Group and PT XL Axiata expect to benefit from Link Net's strong cash flow and consistent dividend payouts alongside exposure to high average revenue per user and growing fixed broadband market.

On January 6, 2022, Indosat Ooeredoo and Hutchison 3 Indonesia (Tri) completed a $6 billion merger. The combined entity will be known as Indosat Ooredoo Hutchison. This merger has now become the new second-largest telecom operator in Indonesia with an estimated annual revenue of $3 billion. CFRA expects this merger will roll out its network and increase coverage area in rural parts of the archipelago alongside 5G deployments in urban areas.

On June 21, 2021, Axiata and Telenor Asia announced the merger of Celcom and Digi (MergeCo). On June 29, 2022, the Malaysian Communications and Multimedia Commission approved the merger. The

combined entities were renamed Celcom Digi Berhad, with Axiata and Telenor having equal share of 33.1% in the MergeCo. Cost and capex synergies are expected to be around MYR8 billion as both Celcom and Digi brands will continue as is post-merger. As Malaysia has deployed 5G through a single wholesale network, CFRA expects Malaysian telcos to focus on delivering service innovations while strengthening existing connectivity as per their commitment to the government's plan to expand service coverage to the whole country.

Artificial Intelligence (AI) is the new theme set by SoftBank's new CEO, Junichi Miyakawa, on April 27, 2021. In order to sustain growth over the medium to long term, SoftBank is in pursuant of its "Beyond Carrier" strategy, which is to leverage its customer base from its telecom business to extend its business into the service and content fields and related areas. On May 11, 2021, SoftBank announced its investment of $60 million in Axiata Digital Advertising (ADA), the digital marketing subsidiary of Axiata Group. ADA is the largest independent analytics, data, and AI digital marketing business across nine markets in South and Southeast Asia. SoftBank's intention for this partnership is to make ADA a core to its digital and data marketing arm and simultaneously seek to leverage its network of portfolio companies to create huge synergy globally. Approximately 23.07% of ADA will be owned by SoftBank post-investment, with ADA's valuation at $260 million. With the hunger for digital content ever-rising in a post-pandemic world, in CFRA's view, SoftBank's investment in ADA is a strategic monetization of their data services and will be used as a reference by other telcos in the region for their digital marketing solutions.

HOW THE INDUSTRY OPERATES

Several important aspects of the Asia Telecommunication Services industry affect its structure and influence company profitability. Some of the most relevant include the underlying technologies, the role of government, the importance of handset manufacturers, and the growing use of roaming agreements. While these issues are important worldwide, they play out differently in Asia due to conditions in local markets.

WIRELESS TECHNOLOGY

Each wireless carrier operates a network of radio towers that are connected to each other and to the larger, wireline network usually referred to as the public switched telephone network (PSTN). Each carrier earns revenues by charging customers various fees to use its network.

The fundamental unit of the network is the base station, which is owned by the carrier and contains radio transmitters and receivers, usually mounted on a tower. Base stations pick up and deliver transmissions within a limited geographical area, known as a “cell”. They convert the radio signals sent from a mobile handset into electrical signals that are then transmitted to a mobile switching center, which converts the signals into a form that can be relayed to other base stations or to the PSTN. As a customer travels from one cell to the next, the mobile switching center coordinates a “hand-off”, which maintains the continuity of the call.

The amount of radio spectrum that each country can allocate to carry the radio signals from wireless handsets is very small relative to the number of people who would like to use wireless services. Before frequency-sharing techniques were developed, the limited number of radio channels put a tight cap on the number of subscribers.

Each cellular network is based on a specific technological standard or “access technology” that determines how customers share the radio channels needed for wireless service. The first-generation (1G) cellular systems used an analog signal, in which each subscriber was allocated a radio channel when making a call. Few of these networks exist anymore, and those that do are mainly in isolated areas or developing countries.

The second generation (2G) of cellular networks is based on digital signals, in which the voice signal is translated into a series of ones and zeroes, instead of into the electromagnetic waves used in analog systems. Digital signals allow for data services and greater security. Most importantly, they allow multiple customers to share a single radio channel. Third-generation (3G) and fourth-generation (4G) systems, also digital, are even more efficient and speedy, and enable advanced data and video services. 4G systems also provide mobile ultra-broadband internet access. The cellular network of the fifth generation (5G) will be 10 times faster than the 4G network. Where 4G often struggled during peak hours, 5G will allow for a higher number of users to connect simultaneously.

2G: Waning in Most Parts of Asia

Two major competing digital technology standards or access technologies comprise 2G wireless networks: CDMA and GSM. GSM is an open, non-proprietary standard that allows manufacturers to make equipment compatible with other GSM products without paying a royalty fee; it is based on a technology known as time division multiple access (TDMA). CDMA, developed by Qualcomm Inc. using military technology, represented an alternative to GSM, but was only used in South Korea.

As technology and economies have progressed, 2G users have largely migrated over to the 3G and 4G technologies, with spectrum previously used for 2G systems being re-farmed for 3G and 4G use as well.

Still, 2G does have a role to play, particularly in underdeveloped rural areas with little telecommunication infrastructure (e.g., certain provinces in India and China).

In various countries in APAC such as in Japan, Taiwan, Singapore, Australia, Taiwan, and South Korea, 2G networks have already been shut down and their spectrum refarmed.

3G: WCDMA Widely Accepted but Overall Approaching Sunset

Although mobile operators in other Asian countries initially lagged their counterparts in Japan and South Korea, 3G network infrastructure is now largely ubiquitous in the region. Commercial 3G services have been available in certain countries in the region since 2006, while 3G services went live in China in October 2009.

GSM networks, the prevalent 2G standard in Asia, can be upgraded to full 3G capabilities using either wideband code division multiple access (WCDMA) or time division-synchronous code division multiple access (TD-SCDMA), China's proprietary 3G standard. In almost all Asian operators, WCDMA was the preferred path, with the notable exception of China Mobile (TD-SCDMA) and China Telecom (CDMA2000 – the upgrade path from 2G CDMA).

Other than 2G networks, the conditions for the exit of 3G networks have become mature as well. Mobile carriers in China, Australia, Malaysia, and India have started phasing out parts of their 3G networks. For instance, Malaysia fully switched off its 3G networks since the end of March 2022, while in Australia, Telstra will fully switch off its 3G networks by June 2024.

WIRELESS TECHNOLOGY STANDARDS				
GENERATION		**ACCESS TECHNOLOGY**	**TRANSMISSION SPEED**	**ADVANTAGES / DISADVANTAGES**
2G		GSM	14.4 kbps	Widely deployed, allows international roaming
		cdmaOne (IS-95A)	14.4 kbps	Stronger security features, longer handset battery life, more efficient use of bandwidth than GSM. Disadvantages include lack of global roaming capabilities, narrow deployment, fewer equipment suppliers, proprietary technology.
2.5G	For GSMA	GPRS	64 kbps	"Always on" allows easier Internet browsing. Bandwidth shared with other users a disadvantage.
		EDGE	384 kbps peak, 140-160 kbps more likely.	Allows greater data rates per timeslot than GSM/GPRS.
	For CDMA	cdmaOne (IS-95B)	64 kbps peak, 14.4 kbps typical.	4 to 5 times capacity of GSM systems.
3G		WCDMA	2 Mbps peak, 400 kbps typical.	Faster data speeds and greater capacity than CDMA2000 1X. More expensive to deploy than CDMA2000 1X. Not compatible with earlier GSM networks.
		TD-SCDMA	2 Mbps peak, 1.2 Mbps typical.	Excellent for transmitting Internet data. Wide coverage area, more efficient use of spectrum for one-way transfer. Disadvantages include no commercial deployments, few equipment vendors.
		CDMA2000 1X(Release 0)	307 kbps peak, 144 kbps typical.	Greater voice and data transmission capacity than cdmaOne using same bandwidth.
		CDMA 1X EV-DO (Evolution-Data/Optimized)	2.4 Mbps peak, 750 kbps typical.	Faster data speeds, handsets compatible with earlier CDMA networks.
		CDMA 1X EV-DV (Evolution-Data/Voice)	3.1 Mbps peak	Able to deliver real-time video streaming.
3.5G	For GSMA/ WCDMA	HSDPA (High-Speed Downlink Packet Access)	14 Mbps future potential, currently 3.6 Mbps	Delivers streaming video, interactive gaming, and multimedia music WCDMA tracks at speeds almost 3 times faster than WCDMA. Compatible with GSM/WCDMA.
	For GSMA/W-CDMA	HSPA+ R8 (High-Speed Packet Access Plus)	Enhances rates up to 42 Mbps; future potential to 84 Mbps and beyond	Doubles data capacity over HSPA, more than doubles voice capacity over WCMDA. Enhances end-user experience, improved "always-on" experience.
	For CDMA	CDMA 1X EV-DO Revision A (Evolution-Data Optimized)	3.1 Mbps peak download speed, 1.8 Mbps upload	Revision A is an upgrade for CDMA 1X EV-DO. Compatible with CDMA networks.
4G	For GSMA/ WCDMA	LTE (Long Term Evolution)	100 Mbps peak download, 50 Mbps upload	Widely supported by equipment suppliers and wireless operators. Compatible with GSM/WCDMA.
		LTE-Advanced	1 Gbps peak download, 500Mbps upload	Compatible with GSM/WCDMA/LTE.
	For CDMA	UMB (Ultra Mobile Broadband)	288 Mbps peak download, 75 Mbps upload	Compatible with CDMA networks. Disadvantages on fewer equipment suppliers. Discontinued.
		WiMAX	128 Mbps peak download, 100 Mbps upload	High power consumption a disadvantage.
5G	For GSMA	New Radio (NR)	Low-Band Specttrum (<1 GHz): 250 Mbps peak download	Provide widest coverage among the spectrums. Lower data speeds as compared to mid-band and high-band spectrum.
			Mid-Band Spectrum (1-6 GHz): 900 Mbps peak download	Provide wide coverage with high data speeds.
			High-Band Spectrum (>24 GHz): 2 Gbps peak download	Able to transmit very high volume of data at ultra-high speeds. Short range of coverage and cannot penetrate buildings.
Sources: CFRA, CDMA Development Group; GSMA Intelligence; S&P Global.				

4G: LTE the Preferred Path

There are three major standards for 4G technology: long-term evolution (LTE), ultra-mobile broadband (UMB), and mobile WiMAX. Among the three, network providers offer LTE, WiMAX, or both, depending on how these technologies benefit their business. By far, LTE is the preferred 4G standard, as it is compatible with existing WCDMA and HSPA networks. LTE supports channel bandwidths from 1.25 MHz to 20 MHz, and both Frequency Division Duplex (FDD) and Time Division Duplex (TDD) operations.

LTE technically does not meet the criteria of a 4G wireless service, as specified in the 3rd Generation Partnership Project (3GPP) documents. However, due to marketing pressures and the significant advancements that WiMAX and LTE bring to the original 3G technologies, the International Telecommunication Union (ITU) decided that LTE and these technologies can be called 4G.

In 2011, the LTE-Advanced (LTE-A) standard was formalized. It is a major enhancement to the LTE standard, offering peak data rates of up to 1 GB per second. One of the major features of LTE-A technology is the availability of carrier aggregation. This allows service providers to combine up to five separate LTE carrier bands and increase the peak user data rate, raise the overall capacity of their networks, and exploit fragmented spectrum allocations.

Despite the hype and potential of 5G in offering faster and low-latency connectivity for all users, 4G will still account for 68% of global mobile users by 2025 in Asia Pacific, according to the forecast by the GSMA. CFRA expects 4G LTE network technology to continue to support the bulk of services throughout APAC for the foreseeable future, despite the advent of 5G technology.

5G: Looking to the Future

While the deployment of 5G networks started in late 2018, commercial deployment of 5G networks is aimed at meeting the requirements for mobile communications beyond 2020. Rising mobile data consumption requires more support, a key objective of the 5G network.

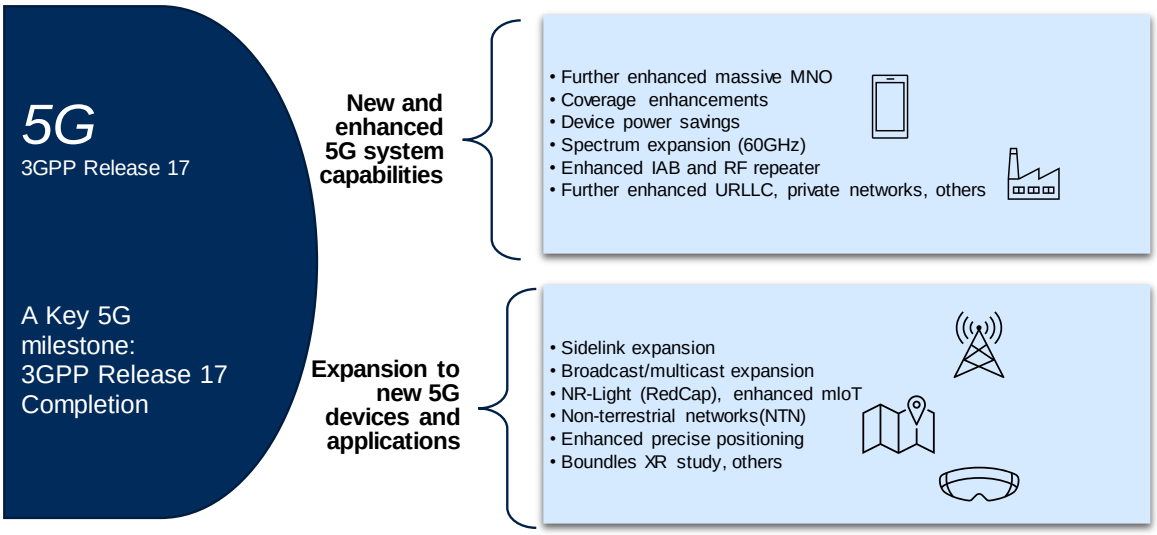
4G wireless technology provides the foundation for 5G. Unlike 4G, which requires large, high-power cell towers to radiate signals over long distances, 5G wireless signals will be transmitted via large numbers of small cell stations located in places like light poles or building roofs. 5G uses a 5G New Radio interface, along with other new digital technology called massive multiple-input multiple-output (MIMO), to transfer more data over the air for faster speed, reduced congestion, and lower latency. 5G download speeds can reach 1,000 Mbps. Low-band 5G is more likely to be available for more rural locations with speeds up to 250 Mbps, while mid-band 5G is available in major urban areas with download speeds up to 900 Mbps.

Telecommunication companies will have to contend with new challenges in setting up the next generation of data and telecommunication standards. Key issues are the highly efficient use of the scarce radio spectrum and the minimization of energy consumption. In addition, the proliferation of device types and usage environments means that a robust security system across a wide variety of operating environments and technologies is required. 5G technologies also need to address the rising complexity of transactions, significant multi-device simultaneous connections, and lower latency requirements, all of which are essential for the development of machine-to-machine communications and IoT.

Initially, 5G standards were associated with the International Telecommunication Union's International Mobile Telecommunications-2020 (IMT-2020) standard, which required a theoretical peak download capacity of 20 gigabits per second, along with other requirements. However, 3GPP, the industry standards group, proposed the 5G New Radio (NR) standard together with LTE as its submission to the IMT-2020 standard.

After initially delivering "Non-Stand-Alone" (NSA) NR specifications for 5G in late 2017, 3GPP worked on completing Release 15, which is the first full set of 5G standards. While initial specifications enabled NSA 5G radio systems to be supported by existing 4G infrastructure, Release 15 extends to cover "standalone" 5G, with a new radio system complemented by a next-generation core network. On July 2, 2020, 3GPP finalized Release 16, the second set of specifications for 5G New Radio technology. Release 16 is set to target enhancements for new capabilities and expansion into different verticals, including support for unlicensed spectrum, industrial IoT, and automotive applications. Looking ahead, 3GPP highlighted that Release 17 Stage 2 is expected to be completed in June 2021.

In March 2022, the completion of Release 17 marked the conclusion of the first phase of the 5G technology evolution and also proved to be a testament to the mobile ecosystem's resiliency and commitment to drive 5G forward. Release 17 brings further enhancements to the following foundational aspects of the 5G systems:



Source: Qualcomm

Following the successful rollouts of 5G networks and infrastructure in several APAC countries in 2019 – South Korea with 85 cities, China with 50 cities, Australia with over 200 cities and towns – 2020 and 2021 saw Japan, Taiwan, Thailand, Singapore, Indonesia, and Malaysia introduce commercial and trial 5G services. China and South Korea have a greater potential benefit from 5G, in CFRA's view, as consumers in these countries are willing to pay extra for faster service.

6G: Initial Research Kicked Off

NTT Group announced its intention to collaborate with Fujitsu, Nokia, and NEC to develop new technologies for the targeted commercial launch of sixth-generation (6G) services by around 2030. NTT DOCOMO and NTT Corp will begin indoor trials within the fiscal year ending in March 2023 and outdoor trials to start in the following fiscal year.

On May 30, 2022, Japan's Network Research Institute at the National Institute of Information and Communications Technology (NICT) announced the "World's First Successful Transmission of 1 Petabit per second in a Standard Cladding Diameter Multi-core Fiber". One petabit equals one quadrillion bits of data(1 million gigabits). 5G has an ideal maximum data transmission speed of 10 gigabits per second (Gbps). NICT's announcement was therefore 100,000 times faster.

WIRELESS MARKETS GROW THROUGH HANDSET PARTNERSHIPS AND SUBSIDIES

Handsets are an important part of the wireless services industry, and one over which many carriers have little control. For this reason, handset manufacturers are important business partners for the wireless services industry. In many Asian countries, governments have allowed handset subsidies to help fuel the growth of wireless markets by making handsets more affordable.

Partnerships with Manufacturers

The availability of good quality handsets at reasonable prices is a prerequisite for providing wireless service. If handsets are unreliable, customers will drop their service. High prices can discourage customers from signing up. The vendors must also be able to provide phones that work on the various spectrum bands that each carrier uses.

Mobile phones have increasingly become a fashion accessory and must-have gadget for tech-savvy users. To attract these subscribers, service providers work with manufacturers to incorporate cameras, video capabilities, and other desirable features into their handsets. These handsets, which are generally linked to mobile broadband and feature significant processing power, are branded as smartphones, as distinguished from regular voice and SMS feature phones. Mobile carriers form close relationships with handset vendors, though the carrier's feature phone bargaining power is being significantly eroded with the consolidation of phone brands and the rise of the smartphone dichotomy. Currently, the choice for smartphone buyers lies either in the iOS path, for which they would buy iPhones, or the Android path, in which the choice would be mainly between Samsung or Xiaomi handsets. Other Android-based players such as Huawei, Lenovo, and HTC then compete for a smaller piece of the pie. These smaller players have been taking market share from both Samsung and Apple due to attractive price points and comparable features.

Subsidies Support Growth

Wireless service providers in Asia and elsewhere often subsidize the purchase of handsets to reduce the customer's upfront cost of buying wireless service. The practice originates from the industry’s early days, when few people had mobile phones and handsets cost thousands of dollars. In that environment, handset subsidies were considered necessary so that new customers would try the service and its popularity would spread. The cost of the subsidies could be recouped over time through subscription fees.

The strategy was clearly successful in luring a wide range of customers to wireless service, particularly in countries such as China. It has endured as a means of attracting subscribers to new services that require more advanced, and therefore more expensive, handsets. While carriers have often tried to curtail subsidies once a new service is well established, many continue to rely on them as a tool for winning market share.

Many regulators have sought to discourage the use of subsidies, though they are wary of allowing new services to falter due to the cost of handsets. In particular, subsidy regulation is often very strict in highly developed, mature markets such as South Korea, Hong Kong, and Japan. Unregulated subsidies can prove harmful to market development, as was the case in South Korea in 2013, when irrational competition based on handset subsidies led to significant losses for operators.

INTERNATIONAL ROAMING AGREEMENTS

As wireless telecom service grows more popular, the desire to use a mobile phone outside one’s home country increases as well. Carriers that operate wireless networks with similar access technology standards are technically able to allow customers from other countries to use their network while traveling.

For roaming to work, a customer’s home network must be able to communicate with the network being visited to register and validate the presence of the customer on the visited network. The various transmitters and receivers, signaling systems, and mobile switching centers must be compatible and able to interact. In addition, the customer’s home and visited network must have an agreement describing procedures for exchange of payment and billing information so their customers can use each other’s network.

Roaming agreements are competitive issues that carriers weigh in terms of their ability to attract new customers and revenue. Customers who rely heavily on their mobile phones would like to be able to use them when traveling internationally. The service is more attractive to high-end customers who use their mobile phones for business purposes than it is for those seeking basic telecommunications services.

Regulatory Environment

Regulatory and Competitive Risks Remain Elevated

Government regulators in Asian countries help shape the wireless industry through their role in allocating radio spectrum and issuing licenses. Regulators are also involved in developing standards for technologies and platforms such as 5G. In certain countries, such as China, South Korea, and Japan, regulators can affect carrier revenues by suggesting tariff cuts and interconnection fees to promote usage. Finally, regulators can control foreign investment in the wireless segment, while mergers and acquisitions may also be regulated to promote fair competition. Some examples of recent government action in this space include:

China: In the 2020 Government Work Report delivered by Premier Li on May 22, 2020, he pointed to the need to strengthen new infrastructure development, such as 5G telecommunication networks, while no further fee-cutting policy was mentioned. The lack of any further fee-cutting initiatives may come as a relief to telecom operators, as stabilization of prices will likely boost such closely-watched metrics as ARPU. The Chinese government has invested more than $3.45 billion in the development of communications networks in rural and remote regions since 2015. Policy and financial support from the Beijing government to improve rural internet infrastructure and the promotion of digital development continues strong. China Broadcasting Network Corp Ltd (China Broadnet) is now China's fourth largest telecom operator launching its 5G services on June 27, 2022. Competition in the 5G market in China is expected to intensify because of China Broadnet's entry. However, the expansion of China Broadnet will prove to be quite challenging as the existing three telcos have a huge base of 5G consumers and winning them over would prove to be quite difficult.

From CFRA's view, China Broadband has to rely on keeping its prices for 5G packages lower compared to the other three telcos for the next few years as well as use its national broadcaster background to its advantage to promote its 5G packages to win over customers.

South Korea: In July 2022, South Korea's Ministry of Science and ICT (MSIT) revealed the commercialization of the first phase of shared access to 5G networks belonging to the country's mobile network operators (MNOs) in rural areas. The reason behind this agreement is to have 5G networks available in remote coastal and farm towns, to accelerate the rollout of mobile broadband technology. South Korea's MSIT revealed the reallocation of frequencies for 3G and 4G services last year. However, spectrum pricing depends largely on the number of 5G base stations that the telcos could roll out. SK Telecom is also reviewing the possibility of sharing its 3G network with KT Corp to reduce maintenance costs for base stations nationwide.

Malaysia: On July 5, 2021, the Malaysian Communications and Multimedia Commission (MCMC) unveiled its Mandatory Standard for Quality of Service (MSQoS), which prioritizes customer protection, customer complaints, and experience of satisfactory services for both line and wireless broadband. As per the new standards, operators will be required to provide a download speed of 2.5 Mbps 90% of the time for connections made via both FDD and TDD technology. For Fixed Wireless Access (FWA) broadband services, operators are to ensure 25 Mbps downlink speed 90% of the time. The Malaysian government introduced National Digital Network (JENDELA) in August 2020 to facilitate a digital infrastructure plan to meet the needs of digital connectivity and prepare the nation for a gradual transition to 5G technology. JENDELA's first phase would target increasing 4G coverage from 91.8% to 96.9% and increasing mobile broadband speed from 25 Mbps to 35 Mbps.

Licenses and Standards

Radio spectrum suitable for mobile telecommunications is a scarce commodity. Governments can exercise a large degree of control over the wireless industry in the way they distribute the spectrum to

various parties. Regulatory authorities often use their control over spectrum to advance policy objectives related to competition and industry growth.

Governments determine how many wireless carriers will exist within their jurisdiction when they set the number of licenses available for spectrum allocated to mobile telecommunications services. Several governments established a relatively large number of licenses to promote diffusion of the technology at low cost to the end-user. In some cases, too many licenses are granted, making the business unprofitable and consolidation necessary. In Malaysia, for example, the telecommunications market consolidated as companies sought the size necessary for the considerable investments then needed for 3G and 4G. In Taiwan, a government decision to limit the number of 3G licenses spurred consolidation. Companies that did not obtain a license faced limited growth opportunities.

The licensing process gives governments a large degree of influence over which carriers operate in their markets. Governments distribute spectrum to carriers in two main ways. They can auction licenses to the highest bidder, or conduct a “beauty contest”, in which the license is awarded to the company whose proposal most closely matches a set of criteria. A hybrid approach combining elements of the two has also emerged.

Licenses often come with obligations and conditions for service. Governments can impose requirements regarding when service will begin, what areas of the country will be covered, and what portion of the population will be included. Governments can sometimes delay the development of wireless communications by putting off decisions on licensing; this was evident in 3G segments in India and Thailand. Political considerations often drive these decisions, though within technically feasible parameters. Operators may face other obligations as well, such as pricing constraints, universal service obligations, and provision of emergency services.

The ability to license spectrum use also gives governmental regulators significant power over the technology standards a wireless carrier will use, and how the technology will develop. China’s government, for instance, took one of the most active roles in this process when it promoted its domestically developed standard, TD-SCDMA, and its successor, TD-LTE. While officially, the government has said it will not require any carrier to adopt a specific technology standard, it reserved a large amount of spectrum for future growth in TD-SCDMA but relatively little for WCDMA or CDMA2000. Later on, the government issued TD-LTE licenses about two years ahead of the granting of full FDD-LTE licenses, to allow the build-out and maturing of its home-grown standard.

Tariffs and Interconnection Rates

Regulators control fees that operators charge consumers for roaming, and interconnection rates charged to other carriers. These decisions have a direct impact on carrier revenues and sustainability. For instance, in April 2015, the Telecom Regulatory Authority of India (TRAI) issued an order to reduce maximum charges for national roaming calls and SMS, effective in May 2015, cutting fees by as much as 20%–23%. On July 23, 2022, India’s Department of Telecommunications (DoT) sought views on the need for overhauling laws governing the telecom sector to keep pace with the change in technology like 5G, simplify laws and promote investments, according to a consultation paper released by DoT.

Keeping Track of Foreign Investment

Government regulators also closely monitor foreign investment in the wireless segment. Governments want to attract foreign investment to help develop their wireless industries and spur economic growth; on the other hand, they also want to limit foreign control of domestic carriers and services.

HOW TO ANALYZE A COMPANY IN THIS INDUSTRY

At CFRA, we recommend a top-down approach to valuation. An examination of the industry drivers outlined on page 8 – number of subscribers, global mobile data traffic, and smartphone penetration – and below is a good starting point.

Industry Drivers

◆ **Subscribers.** The number of subscribers and, particularly, the monthly change in subscribers are the most watched indicators of a wireless market and of a company's performance. If the market is growing, monthly subscriber additions are scrutinized for signs of how fast it is growing, whether growth is accelerating or decelerating, and which carrier is winning a greater or lesser share of the new signups. Subscriber growth rates are also important in judging the success of new technology standards, the popularity of various types of services, and a company's skill at marketing them.

Subscriber numbers must be viewed in the context of a company's marketing efforts. If subscriber growth is weak despite strong promotional activity and price discounting, the market may be approaching saturation.

Most of the major Asian carriers are publicly owned, so subscriber numbers can be found in their financial reports. Wireless operators own stakes in other carriers and often report wholly owned and partially owned subscribers separately. Differences in methodologies for measuring these mean that company-provided data may be inconsistent with numbers published by government agencies and data aggregators.

◆ **Market share.** Market share figures are readily available for wireless carriers, since there are usually relatively few operators – and subscriber numbers are publicly available. The total number of cellular users in a given country can be obtained by consulting the website of the International Telecommunication Union (ITU). Companies publish their subscriber numbers in financial statements or other materials.

Market share is an important indicator of the strength of a specific carrier in its market. A single carrier, often related to a government-owned or government-backed wireline carrier, dominates many wireless markets. How successful that operator is in defending its market share and how far others can gain share for themselves are crucial indicators of the competitiveness of a market.

In Asia, the high level of government influence over the wireless segment makes market share a key policy issue. New regulations are sometimes designed specifically to alter (or preserve) market structure.

◆ **Average revenue per user.** Together with subscriber numbers and market share, the average revenue per user (ARPU) for a company and a national or regional market is a highly telling indicator of the outlook for growth. ARPU is usually calculated monthly. The overall level of ARPU indicates how much customers are willing to spend on wireless service relative to other companies in national or regional markets.

Trends in ARPU are also important. Given the high cost of acquiring new customers through price discounts, handset subsidies, or marketing campaigns, most wireless companies are intensely focused on increasing the ARPU of customers they already have, rather than spending heavily to acquire new ones. As wireless voice pricing declines due to competitive pressures and commoditization, value-added data services such as music, gaming, and TV may contribute to overall ARPU and help boost operator

revenues. Still, ARPU may or may not rise when new, advanced services are introduced. ARPU data are usually included in each carrier's financial reports.

◆ **MOU and DOU.** Minutes of use and average data use per month (MOU and DOU) are important indicators of how much each customer uses a carrier's network, and thus of the carrier's ability to handle current traffic and future growth. MOU was initially important when voice service was the dominant revenue generator for a carrier. However, as carriers transition to greater data-driven services, DOU becomes the more relevant measure. When the average MOU/DOU is high, networks must have greater capacity to serve the same subscriber base than in cases where the average MOU/DOU is lower. MOU/DOU data is usually included in each carrier's financial reports.

◆ **Churn.** Customer churn, or the amount of turnover within a customer group in a given period, is an important yardstick of how well a company is able to retain customers and thus of its pricing power and popularity. Wireless carriers are constantly striving to reduce churn rates, because it is expensive to replace lost customers. Like ARPU and MOU/DOU, churn rates are usually included in each carrier's financial reports.

◆ **Handset sales.** Sales of mobile handsets are an important indicator of wireless demand, and of interest in new services. Sales figures can be obtained from the financial reports of major handset manufacturers such as Apple and Samsung, as well as from market researchers such as International Data Corp. (IDC) and Gartner/Dataquest.

KEY MARKET VARIABLES

The markets served by a company's wireless network help define the company's strategic direction and the focus employed to expand its market presence. Thorough analysis requires a study of a company's market penetration, geographic footprint, service offerings, and the level of competition in its markets.

Penetration and Share

Market penetration is defined as the subscriber base as a percentage of a population (POPs, which are customers or potential customers within a licensed area) – the actual versus the potential customer base. Penetration varies from region to region, with some countries approaching or even surpassing saturation. For an individual company, market penetration is comparable to market share. This percentage should be compared with those of a company's peers and with the industry average.

Market Maturity

In the last few years, wireless operators adjusted their growth strategies. Rather than seek market penetration at any cost, they now favor higher quality, profitable growth with higher customer retention, lower customer churn, and more focus on market segmentation. National and regional wireless operators have moved in this direction, while certain carriers address the underserved prepaid market, which has low market penetration.

Companies just beginning to operate in a market new to them typically are not profitable in the short term, but investors must gauge longer-term revenue potential from reasonable estimates of market penetration and ARPU. Investors must be mindful of companies that seek to increase penetration rates too aggressively by offering overly generous terms to new subscribers: doing so may stimulate higher subscriber growth, but the higher marketing costs may narrow operating margins and drain available funds.

Profitability with strong top-line growth is key for companies operating as nationwide or regional operators. In any given region, the first people to subscribe to wireless service tend to be business customers, whose accounts are highly profitable for providers. As market penetration increases, new subscribers tend to consist of customers who want cheaper services. Nonetheless, companies can grow

service revenues and expand ARPU by offering new services and tailoring their offerings to the different customer segments.

Depth of Coverage
When assessing the depth of coverage that a company offers, investors need to consider the company's footprint, size, and competitors; and whether it is part of a larger alliance.

◆ **Geographic footprint.** In assessing a company's footprint (or licensed and developed geographic territory), primary consideration should be given to the market type: major metropolitan, suburban, or rural. Factors in a market's desirability include the capital costs of putting up cell sites, the economies of scale that can be realized in providing service, and the income levels and spending patterns of inhabitants. The value of any given POP varies from one geographic region to the next. For example, potential customers in a wealthy, densely inhabited city will be more lucrative for a wireless company than will POPs with low per capita income and scattered across a broad rural region.

Ever-widening footprints create the potential for larger customer bases and greater network efficiency. Larger carriers have negotiating power with vendors and can leverage information technology (IT) facilities such as billing and network management systems. They can more easily retain customers by eliminating roaming fees over a broader area.

◆ **Scale and scope.** In terms of overall market strategy, competitive approaches vary widely regarding company scale (size of territory) and scope (extent of coverage within that territory). National and regional wireless operators have strong brands and economies of scale that enable them to offer more comprehensive services to varied customer segments. Smaller, rural operators must economize on network expansion and marketing to potential customers who often are widely dispersed in large geographic areas.

In the past, the drive for scale and scope stimulated merger and acquisition (M&A) activity between carriers of a similar size; more recently, it has fostered acquisitions of roaming partners by the large carriers. The investor should verify that acquisitions and partnerships are consistent with an overall strategy and that they will provide firm synergies and improve operating performance. Do the merging companies use compatible technologies? Do they operate on the same spectrum? Do they have overlapping networks with redundant cell sites, or does the merger fill geographic gaps in coverage? The pros and cons of marketing alliances should be similarly assessed.

Competition
Wireless markets are highly competitive. When analyzing a company's competitive position, questions to ask include: What are the major competitors in its markets? What are their competitive advantages and disadvantages? Which company can bundle other services, such as local and long-distance wireline services or internet connectivity? What service offerings and pricing packages do competitors offer? Are these companies able to support a price advantage in wireless services and handset subsidies, funded by the cash flows generated from other businesses?

CORE TELCO OPERATIONS VERSUS GROWTH ADJACENT TO THE CORE

As the digital market grows, telecoms face a couple of challenges from tech firms and over-the-top (OTT) providers. OTT players offer core telco services such as voice or messaging, and the media space is becoming their domain. As such, the telecoms' revenue is in steep decline as revenues from mobile data and fixed broadband start to slow. Meanwhile, demand for capex is increasing because telecoms have to invest in existing infrastructure not only to meet rapid growth in data traffic, but also to find new ways to build their future businesses by strengthening their core businesses and finding growth in other areas.

These digital players are systematically attacking telco profit pools by tying customers to their own ecosystems. To compete with these digital players, some of the telecoms have started to make investments in future network technology, such as cybersecurity, cloud services, media, and IoT.

MARKETING IS CRUCIAL

In the wireless segment's mad dash to market, companies that establish a strong, loyal customer base will be the most likely winners. In this environment, marketing strategy is of primary importance. Its success may be deduced from the number of customer additions.

Company analysis should include an understanding of the firm's specific marketing strategy and programs, including branding, pricing, distribution channels, partnerships, and related areas. How well is a company able to package multiple service plans to different customer segments such as businesses, government, professionals, upper-income households, and consumers with high credit risks? An advertising program is a key component of a company's marketing plan, particularly in the mass market. The effectiveness of marketing can be gauged in terms of gains in penetration and net subscriber additions relative to expenditures.

Historically, many wireless companies have subsidized handset sales as a means of attracting new subscribers to their services. As markets mature and approach saturation, companies are trying to balance customer acquisition and retention more carefully. Some companies have set up wholesale channels to drive resale traffic onto their networks. The replacement cycle for new handsets with more enriched features has helped wireless operators retain their best customers. However, operators must still aggressively subsidize these advanced handsets.

With the widespread adoption of fourth-generation (4G) and fifth-generation (5G) technology, wireless companies are beginning to offer more real-time data and video services. They have been surprised and rewarded by the broad demand for smartphone features available through network downloads. Their focus has clearly shifted toward receiving more revenue from existing subscribers and selectively and profitably acquiring new subscribers.

KEEPING THE CUSTOMER HAPPY

Quality is a key ingredient in telecommunications services. As markets have become more competitive in recent years, customer satisfaction and retention are primary drivers of companies' long-term revenue growth.

Staying connected

Companies target call-completion rates of 95% and higher: nearly every time a subscriber dials, the connection is made. Values less than 3% are targeted for dropped calls (calls disconnected before either party hangs up). For data services, which are becoming increasingly more important, carriers often compete on the coverage levels for their 4G data networks, as well as on delivering higher average speeds for their customers. These qualities provide basic standards for assessing service quality, which are compared with the industry average. They also translate into customer churn and retention, as discussed below.

Minimizing churn

Just as important as securing customers is retaining them. Churn is the number of subscribers that terminate wireless service with a carrier monthly, and it is an indicator of customer satisfaction. A company's churn rate can influence profitability, and it should be measured against the industry average to gauge its relative performance.

What steps has a company taken to promote customer satisfaction? Price, quality, and service reliability are basics in keeping customers happy. In addition, functions that are inherent to the wireless carrier's

operations, such as efficient and accurate billing systems and fraud control, also influence customer relations. Operators with dynamic, creative approaches to these areas will generally tend to be market overachievers.

Product and service innovation is also crucial to minimize churn. Data services are no longer considered luxuries; they are now basic services in the transition to next-generation wireless. As companies move toward 4G and 5G services, they must provide customers with the means to interconnect with existing networks at a reasonable cost. In addition, offering more dynamic handsets with new features is an important way to delight customers.

TOP-LINE EXPANSION, ARPU KEY

A key financial metric is forecasting service revenues. Top-line growth is especially important for the wireless services industry because large upfront costs (for equipment deployment, spectrum rights, and branding) create significant operating leverage.

Service revenue forecasts reflect expectations for market penetration rates, net customer additions, and the average monthly bill (as measured by average revenue per user). For established operators, the growth curve will flatten as the customer and revenue bases become larger and more mature.

An investor must address the following questions when evaluating a company's outlook: At what customer level will the company likely reach the break-even point, based on current ARPU trends and cost structure? Given reasonable expectations regarding net customer additions, when might that occur? Sharply declining ARPU is typically a negative sign: it may indicate that a carrier is adding too many low-margin customers, cutting its prices too much, or losing its best customers.

Prepaid wireless customers generally have much lower ARPUs than postpaid customers. Historically, prepaid customers have been either low-usage subscribers (focused on emergency use) or applicants with poor credit. These groups have tended to offer carriers minimal profitability along with significant churn. However, carriers have also shifted their focus on prepaid accounts for young subscribers who have no credit history. If costs can be kept appropriately low, the prepaid youth market could offer new opportunities for profitability, while these users can later on be incentivized to convert to postpaid once their credit record is more stable. Conversely, the youth market tends to be even more volatile in terms of churn, as wireless accounts are viewed as merely dumb pipes to access more highly valued OTT content.

Every customer market segment generates a different ARPU. Decisions regarding the pursuit of business and government versus residential customers, and of prepaid versus postpaid will clearly have an impact on revenue per subscriber. Of course, each of these decisions affects a firm's cost structure as well, and the investor should evaluate each firm's ARPU considering its strategy and cost structure. One should continuously monitor ARPU rates (released quarterly with earnings results) for indications of short-term competitive pressures and longer-term profitability trends.

VALUATION: FROM POP TO P/E

When a new wireless service provider is issued a license, the license's valuation may be expressed in terms of the potential size of the market based on its population, which is compared with wireless subscriber penetration rates over time. At this point in a company's development, there frequently is no other available valuation measure.

Start-up wireless carriers take on heavy debt loads to purchase licenses and build networks. It usually takes several years, and significant marketing outlays, to cultivate a customer base yielding substantial revenues. As a result, the cost per potential customer that the company paid in obtaining its license, also known as price per POP, reflects prospects for cash flows far in the future. At this early stage of a

company’s development, stock market prices tend to fluctuate sharply with changes in expectations and investor sentiment.

As operating income increases, investors turn from per-POP comparisons to valuation measures based on sales or earnings before interest, taxes, depreciation, and amortization (EBITDA). Typically, for the first several years of operation in new markets, wireless companies experience net losses – even with EBITDA margins in the 30%-45% range – and have significant debt obligations on their balance sheets.

Most operators have enterprise values-to-EBITDA multiples (stock price plus long-term liabilities minus cash, divided by EBITDA) in the mid- to upper-single-digit range. Standard valuations based on price divided by net earnings (P/E) ratios can be used for more developed, publicly held wireless companies.

FREE CASH FLOW

In the end, valuation of wireless phone companies is like any other business – it is an exercise in forecasting and discounting cash flows. The investor’s objective is to obtain a free cash flow (FCF) estimate for the total enterprise, including equity and debt holders. FCF can be calculated by subtracting capital expenditures (capex) from an after-tax estimate of EBITDA.

Historically, capex can exceed EBITDA for a period of time for most firms because the industry required large upfront investments before revenue can be realized. However, as the industry has grown, and capital spending has leveled off, significant FCF can be generated, particularly in the years between new network generations. Projections must assume reasonable anticipated growth rates based on market penetration, total covered POPs, churn trends, net customer additions, and ARPU trends.

GLOSSARY

2G—A circuit-switched, digital wireless network that is voice-centric, although it may include some data capabilities such as text messaging.

2.5G—More feature-rich than 2G networks, but still not capable of full 3G services. Often an evolutionary step designed to help carriers raise new revenue from data services without full investment in, and deployment of, a 3G network.

3G—A platform that uses packets, as opposed to circuit switching, resulting in higher capacity and faster data transfer rates that can provide real-time video, high-speed multimedia, and mobile internet access.

3.5G—An evolutionary step toward 4G, with faster transmission speeds and higher capacity; supports features such as streaming video.

3rd Generation Partnership Project (3GPP)—An umbrella term for a number of standards organizations that develop protocols for mobile telecommunications.

4G—A faster data rate than 3G services, up to 20 megabits per second (Mbps), compared with 2.4 Mbps for most 3G services; 4G transfers data at 100 Mbps while the user is moving and at 1 gigabit per second (Gbps) when stationary.

5G—The next-level network standard, which focuses on high-speed data connections over multiple devices, low latencies, machine-to-machine communications, and lower power usage. The first half of the 5G standard was finished by the 3GPP in December 2017, while the second half was finalized in June 2018, completing the overall standardization process.

5G NR (New Radio)—A set of standards that replace the LTE network 4G wireless communications standard.

Analog—Analog wireless telephone systems convert voice signals into electromagnetic waves, rather than the 1s and 0s of digital networks.

Average revenue per user (ARPU)—A measure of a carrier's average monthly revenue generated by each customer account, including cell phones and pagers.

Bandwidth—The amount of data that can be transmitted in a fixed period of time. For digital devices, bandwidth is usually expressed in bits per second (bps) or bytes per second. For analog devices, bandwidth is expressed in cycles per second, or hertz (Hz). The bandwidth needed to send a given signal depends on the amount of information the signal contains. Frequency modulated (FM) radio takes 10 times as much bandwidth per station as amplitude modulation (AM) radio, a differential that explains FM's higher fidelity; a television (TV) channel requires 33 times the bandwidth of an FM station. In telecommunications, bandwidth measures two characteristics of an electronic transmission: range and capacity. It describes the range of electrical frequencies (from short to long waves) that a device can handle without distortion: the higher the bandwidth, the better the quality of the voice or data transmission. Bandwidth also describes the capacity of a channel, which determines what kinds of communications can be carried on it. A voice-grade bandwidth is 4 kilohertz.

Broadband—A transmission facility with a bandwidth greater than 4 kilohertz (the amount needed to transmit voice communications); it can carry numerous voice, video, and data channels simultaneously.

Cell site—The location of the wireless antenna and network communications equipment.

Code division multiple access (CDMA)—One of several technology standards used to let many subscribers share the same radio channel. CDMA2000 and wideband code division multiplex (WCDMA) are used for 3G networks.

Data Center—A building, dedicated space within a building, or a group of buildings used to house servers and associated components, such as telecommunications and storage systems.

Evolution-Data Optimized (EV-DO)—EV-DO is a broadband data protocol that is part of the CDMA2000 standard. The protocol supports download speeds of up to 2.4 Mbps.

Frequency Division Duplex (FDD)—A method for establishing a full-duplex communications link that uses two different radio frequencies for transmitter and receiver operations.

Global system for mobile communications (GSM)—Europe's digital cellular standard, based on TDMA technology.

Handset—The equipment purchased and carried by a subscriber to send and receive calls; also referred to as a terminal.

Hertz (Hz)—Cycles per second, a measure of radio frequency. Kilohertz (kHz) = thousands; megahertz (MHz) = millions; gigahertz (GHz) = thousand millions; terahertz (THz) = million millions. The spectrum allocated to wireless services is measured in Hz, as are the size of radio channels used to provide service.

High-speed downlink packet access (HSDPA)—A wireless protocol built on top of WCDMA-based systems to increase data transmission speeds, theoretically up to 14 Mbps. Also known as 3.5G, HSDPA will allow for faster and better-quality video and audio, and greater network capacity.

Interconnection rates—Also known as termination rates, interconnection rates are the fees that wireless and wireline network operators must pay to complete a call originating on their own network but terminating on another network. They can be fixed/mobile, mobile/fixed, or mobile/mobile, depending on the originating and terminating networks. In Asia, these rates are largely set by domestic regulators.

International Mobile Telecommunications- 2020 (IMT-2020)—The requirements issued by the ITU Radiocommunication Sector (ITU-R) of the International Telecommunication Union in 2015 for 5G networks, devices, and services.

Massive Multiple-input, Multiple-output (MIMO)—An extension of MIMO – expands beyond the legacy systems by adding a much higher number of antennas on the base station. The industry sometimes also uses the term massive MIMO for analog beam-forming with many antenna elements at millimeter-wave frequencies.

Metaverse—A virtual reality space where people or users can communicate with a computer-generated environment and other users.

Minutes of use (MOU)—Usually expressed as an average per customer.

Mobile number portability (MNP)—The ability of wireless subscribers to keep their wireless phone number when switching carriers.

Multimedia messaging services (MMS)—A wireless service that allows the transmission and receipt of images, audio, and video clips, in addition to voice and text.

Non-standalone (NSA) 5G New Radio (NR)—An early version of Standalone 5G NR, which uses an LTE RAN and core with the addition of a 5G component carrier.

Over-the-top (OTT) media services—A streaming media service offered directly to viewers via the internet. OTT bypasses cable, broadcast, and satellite television platforms, the companies that traditionally act as a controller or distributor of such content.

Penetration—The number of customers for a particular service as a percentage of population.

Re-farming—Refers to previously awarded spectrum that is re-assigned for a different use at the end of an initial contract term. For example, in Hong Kong, spectrum that was previously held by companies operating in the 3G space was taken back by the government and re-auctioned to incumbents and new entrants for use in the 4G space.

Roaming—Traveling outside a carrier's local network. Wireless service providers arrange to allow their customers to use other networks, usually for a fee.

Roaming agreements—Agreements between phone companies in different countries that allow the subscribers of each company to use the other's network. These agreements are becoming more important in Asia. The region's increasingly mobile population relies more heavily on the widespread availability of wireless service, even overseas. The ability to offer roaming agreements for key countries can be an important factor in a wireless operator's efforts to gain business customers.

Short messaging service (SMS)—Allows customers to send text messages up to 160 characters long to mobile phones either from their own handset or from the internet. Messages sent to handsets that are turned off are stored until the unit is switched on again.

Subscriber information module (SIM) card—SIM cards are used in wireless handsets to record a subscriber's personal information and settings, such as the phone number, network authorization, and billing codes, as well as address books. SIM cards can be transferred from handset to handset, letting the new handset receive calls previously directed to the old handset.

Tele-density—The number of telephone connections for every hundred individuals living within an area. It varies widely across the nations and also between urban and rural areas within a country.

Time division Duplexing (TDD)—Refers to duplex communication where uplink is separated from downlink by the allocation of different time slots in the same frequency band.

Time division multiple access (TDMA)—An access technology that has been replaced with 2.5G networks that are technological variants of CDMA.

Time division-synchronous code division multiple access (TD-SCDMA)—A 3G access technology developed by Siemens AG and the Chinese Academy of Telecommunications Technology (now known as Datang Technology). TD-SCDMA was one of the five 3G technology standards approved by the International Telecommunication Union (ITU).

Universal mobile telecommunications system (UMTS)—UMTS is the Western European term for WCDMA, the 3G platform that GSM network operators can migrate to with greatest ease. However, while GSM was based on TDMA standards, UMTS/WCDMA is not. Instead, it uses technology based on CDMA, as does the other leading 3G standard, CDMA2000.

Wideband code division multiple access (WCDMA)—A 3G technology that increases data transmission rates in GSM systems by using the CDMA air interface instead of TDMA.

Wireless broadband (WiBro)—WiBro is a mobile broadband access technology developed in South Korea. It is based on the same IEEE 802.16 standard as worldwide interoperability for microwave access (WiMAX), but is able to provide connectivity on the go, tracking a receiver at speeds up to 37 miles per hour (60 km/h). While the South Korean standard was initially incompatible with the global standard for WiMAX, WiBro has been modified to work with WiMAX equipment following pressure from the U.S.

Wireless fidelity (Wi-Fi)—Popular name for an international standard, 802.11b, established by the Institute of Electrical and Electronics Engineers Inc. for wireless networking. The standard operates in the 2.4 GHz frequency range and provides signaling rates of up to 11M bit/sec. Many airports, hotels, and fast-food facilities offer public access to Wi-Fi networks. These locations are known as “hot spots”. Many charge a daily or hourly rate for access, but some are free.

Worldwide interoperability for microwave access (WiMAX)—Wireless technology based on the 802.16 technology standard for 2 GHz to 11 GHz within a wireless metropolitan area network. WiMAX provides broadband wireless connectivity to fixed and mobile users. It has a service range of up to 50 kilometers and provides data transfer rates of up to 70 Mbps. (Unlike WiBro, WiMAX is not designed to be used while the receiver is in motion.)

INDUSTRY REFERENCES

PERIODICALS

Asia Times
asiatimes.com
A Hong Kong-based English language news media publishing group, covering politics, economics, and business.

Bangkok Post
bangkokpost.com
Oldest publisher of English news in Thailand, including business news and lifestyle features.

ET Telecom
telecom.economictimes.indiatimes.com
Offers in-depth news, views, analysis, and global trends in the telecom industry. Biggest news publisher on the telecom industry in India with coverage encompassing the entire events and segment of business.

Financial Times
ft.com
An international daily newspaper that focuses on business and economic current affairs.

Nikkei Asia
asia.nikkei.com
Provides comprehensive coverage of politics, economy, markets, and trends across APAC.

Reuters
reuters.com
Covers news in markets, business, and politics from around the world.

The Economic Times
economictimes.indiatimes.com
Covers extensively on markets, business, and politics from India and around the world.

The Wall Street Journal
wsj.com
Covers breaking news and current headlines from around the world.

Yonhap News Agency
en.yna.co.kr
South Korean news agency that delivers news to customers, newspapers, broadcaster government agencies, businesses, and online portals.

RESEARCH AND ADVISORY FIRMS

Analysys Mason
analysysmason.com
World's leading management consultancy focused on telecoms, media, and technology.

Ball Metaverse
ballmetaverse.co
Matthew Ball is a venture capitalist and corporate advisor to many large firms in the gaming and technology industries.

Gartner Inc.
gartner.com
IT research and advisory firm.

IHS Markit
ihs.com
Provides economic, financial, and political coverage of countries, regions, and industries.

International Data Corp.
idc.com
Market intelligence and advisory firm in the IT and telecommunications industries.

Kantar Worldpanel
kantarworldpanel.com
Global research, monitoring, and advanced analytics on diverse markets such as telecommunications.

MoMagic Technologies Pvt. Ltd.
momagic.com
Advisory firm focusing on mobile platform operation and internet service for India and other emerging markets.

TeleGeography
telegeography.com
Telecommunications market research and consulting firm, focusing on areas including retail mobile, broadband, and fixed-line services and providers.

TRADE ASSOCIATIONS

3rd Generation Partnership Project
3gpp.org
An organization formed by seven telecommunications standard development organizations to produce reports that define 3GPP technologies.

Cellular Operators Association of India
coai.com
An industry association of mobile service providers, telecom equipment, internet services providers, and other digital technology companies and businesses in India.

Global Mobile Suppliers Association
gsacom.com
A non-profit organization representing companies across the worldwide mobile ecosystem engaged in the supply of infrastructure, semiconductors, test equipment, and mobile support services.

GSMA
gsma.com
Dedicated to the development, deployment, and evolution of the Global System for Mobile Communications standard.

International Telecommunication Union
itu.int
The ITU brings together governments and private entities to develop communications standards, spur technology development, and standardize spectrum allocation globally; provides statistics on the global communications industry.

OpenSignal
opensignal.com
A leading source of crowdsourced insight into the data coverage and performance of mobile operators worldwide.

REGULATORY AND GOVERNMENT AGENCIES

Jendela
myjendela.my
Comprehensive digital infrastructure plan aimed at addressing the needs and demand for better quality for fixed and mobile broadband coverage in Malaysia.

Korea Communications Commission
kcc.go.kr
Administers laws and regulations for the information and communications industries in South Korea.

Malaysian Communications and Multimedia Commission
mcmc.gov.my
Oversees the communications and multimedia industry in Malaysia.

Ministry of Industry and Information Technology
miit.gov.cn
A state agency of the People's Republic of China (PBOC) responsible for regulation and development of the postal service, internet, wireless, and communications.

Ministry of Internal Affairs and Communications
soumu.go.jp
Japan's ministry that regulates information and communications, along with many other tasks (running the election system, local taxation, disaster prevention, and overseeing the civil service).

National Communication Commission
ncc.gov.tw
Responsible in regulating telecommunications and broadcasting services in Taiwan.

Telecom Regulatory Authority of India
trai.gov.in
Issues quarterly performance numbers and recommendations on India's telecommunications and internet industries.

OTHER SOURCES

Cisco
cisco.com
Designs and sells a broad range of technologies across networking, security, collaboration, applications, and the cloud.

Consumers Union of Korea
consumersinternational.org
A consumer organization in Korea and responsible in handling consumer complaints.

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COMPARATIVE COMPANY ANALYSIS

				Operating Revenues																
				Million $							CAGR(%)			Index Basis (2012=100)						
Company	Country		Yr. End	2022	2021	2020	2019	2018	2017	2016	10-Yr.	5-Yr.	1-Yr.	2022	2021	2020	2019	2018	2017
WIRELESS TELECOMMUNICATION SERVICES																				
ADVANCED INFO SERVICE PUBLIC COMPANY LIMITED	Thailand		DEC	5,365.6	5,461.2	5,759.4	6,078.2	5,254.6	4,839.6	4,251.2	2.7	3.3	2.3	126	128	135	143	124	114
AXIATA GROUP BERHAD	Malaysia		DEC	4,960.2	6,216.4	6,022.5	6,003.3	5,775.8	6,000.8	4,808.9	2.1	(2.3)	(16.1)	103	129	125	125	120	125
BHARTI AIRTEL LIMITED	India	#	MAR	0.0	15,427.8	13,840.7	11,449.2	11,706.6	12,737.2	14,752.5	5.1	4.1	15.6	0	105	94	78	79	86
CHINA MOBILE LIMITED	Hong Kong	#	JAN	0.0	133,529.3	117,647.0	107,127.3	107,131.6	113,807.9	102,028.0	NA	NA	NA	0	131	115	105	105	112
DIGI.COM BERHAD	Malaysia		DEC	1,553.1	1,526.8	1,535.7	1,541.8	1,583.0	1,564.3	1,475.2	0.6	1.3	6.9	105	103	104	105	107	106
FAR EASTONE TELECOMMUNICATIONS CO., LTD.	Taiwan		DEC	2,902.0	3,078.7	2,829.9	2,803.5	2,830.3	3,103.5	2,911.3	0.3	(0.6)	4.5	100	106	97	96	97	107
GLOBE TELECOM, INC.	Philippines	#	JAN	0.0	3,261.1	3,342.5	3,286.9	2,883.2	2,707.0	2,559.2	NA	NA	NA	0	127	131	128	113	106
HUTCHISON TELECOMMUNICATIONS HONG KONG HOLDINGS LIMITED	Hong Kong	#	JAN	0.0	690.6	586.2	716.6	1,010.3	864.2	1,074.5	NA	NA	NA	0	64	55	67	94	80
INTOUCH HOLDINGS PUBLIC COMPANY LIMITED	Thailand		DEC	0.3	0.6	122.2	163.9	197.7	295.4	325.4	(48.2)	(73.8)	(42.1)	0	0	38	50	61	91
KDDI CORPORATION	Japan	#	MAR	0.0	44,853.2	48,034.8	48,672.2	45,847.4	47,474.0	42,585.3	4.3	2.8	2.5	0	105	113	114	108	111
MAXIS BERHAD	Malaysia		DEC	2,234.9	2,208.8	2,231.0	2,274.2	2,222.7	2,316.3	1,920.3	0.9	0.8	6.4	116	115	116	118	116	121
PLDT INC.	Philippines	#	JAN	0.0	3,753.3	3,767.8	3,335.7	3,106.1	3,179.9	3,335.9	NA	NA	NA	0	113	113	100	93	95
PT INDOSAT OOREDOO HUTCHISON TBK	Indonesia		DEC	3,010.7	2,203.1	2,005.0	1,887.4	1,604.4	2,207.6	2,166.0	7.6	9.3	48.9	139	102	93	87	74	102
PT XL AXIATA TBK	Indonesia		DEC	1,876.6	1,877.9	1,867.4	1,816.2	1,590.4	1,687.5	1,583.9	3.3	5.0	8.9	118	119	118	115	100	107
SK TELECOM CO.,LTD	South Korea		DEC	13,760.2	14,060.7	14,782.9	15,366.7	15,157.4	16,400.5	14,197.2	0.7	(0.2)	3.3	97	99	104	108	107	116
SOFTBANK CORP.	Japan	#	MAR	0.0	46,861.7	47,066.8	45,178.0	33,808.4	33,398.0	31,238.2	NA	10.3	9.3	0	150	151	145	108	107
STARHUB LTD	Singapore		DEC	1,735.7	1,515.1	1,534.9	1,732.8	1,733.8	1,803.8	1,658.3	(0.4)	(0.7)	13.9	105	91	93	104	105	109
TAIWAN MOBILE CO., LTD.	Taiwan		DEC	5,605.5	5,633.1	4,729.3	4,159.1	3,878.9	3,949.7	3,599.6	5.6	8.0	10.3	156	156	131	116	108	110
VODAFONE IDEA LIMITED	India	#	MAR	0.0	5,072.9	5,732.4	5,965.0	5,341.1	4,340.7	5,486.9	7.0	1.6	(8.2)	0	92	104	109	97	79
INTEGRATED TELECOMMUNICATION SERVICES																				
CHINA TELECOM CORPORATION LIMITED	China	#	JAN	0.0	69,192.5	60,282.6	53,962.3	54,832.9	56,284.9	50,772.5	NA	NA	NA	0	136	119	106	108	111
CHINA UNICOM (HONG KONG) LIMITED	Hong Kong	#	JAN	0.0	51,609.4	46,539.5	41,723.3	42,292.8	42,237.8	39,490.3	NA	NA	NA	0	131	118	106	107	107
CHUNGHWA TELECOM CO., LTD.	Taiwan		DEC	7,055.1	7,594.9	7,390.1	6,937.0	7,039.6	7,669.2	7,097.2	(0.2)	(1.0)	3.0	99	107	104	98	99	108
HKT TRUST AND HKT LIMITED	Hong Kong		DEC	4,376.5	4,355.2	4,177.4	4,249.9	4,493.1	4,232.1	4,365.0									
KT CORPORATION	South Korea		DEC	20,395.8	20,902.3	21,976.8	21,084.7	21,051.9	22,042.3	22,042.3	0.5	1.7	3.0	93	95	100	96	96	100
LG UPLUS CORP.	South Korea	#	JAN	0.0	11,628.3	12,329.3	10,725.1	10,532.8	11,494.8	9,511.7	NA	NA	NA	0	122	130	113	111	121
NIPPON TELEGRAPH AND TELEPHONE CORPORATION	Pakistan	#	MAR	0.0	100,107.4	107,993.4	110,587.3	107,209.1	110,937.8	102,161.6	1.5	1.3	1.8	0	98	106	108	105	109
PAKISTAN TELECOMMUNICATION COMPANY LIMITED	Pakistan		DEC	669.9	780.1	808.4	836.1	911.9	1,060.5	1,122.6	2.0	5.3	10.2	60	69	72	74	81	94
PERUSAHAAN PERSEROAN (PERSERO) PT TELEKOMUNIKASI INDONESIA TBK	Singapore	#	JAN	0.0	10,051.9	9,797.7	9,796.7	9,067.8	9,461.2	8,633.9	NA	NA	NA	0	116	113	113	105	110
SINGAPORE TELECOMMUNICATIONS LIMITED	Malaysia	#	MAR	0.0	11,329.4	11,632.3	11,634.3	12,823.9	13,178.7	11,963.9	(2.0)	(1.7)	(1.9)	0	95	97	97	107	110
TELEKOM MALAYSIA BERHAD	Malaysia	#	JAN	0.0	2,767.1	2,697.4	2,792.2	2,858.0	2,971.9	2,689.5	NA	NA	NA	0	103	100	104	106	111
TELSTRA GROUP LIMITED	Australia		JUN	14,659.6	16,162.8	16,369.8	17,710.7	19,118.3	19,962.4	19,302.7	(1.7)	(3.9)	(1.3)	76	84	85	92	99	103

Note: Data as originally reported. CAGR-Compound annual growth rate. #Of the following calendar year.
Souce: S&P Capital IQ.

				Net Income															
				Million $							CAGR(%)			Index Basis (2012=100)					
Company	Country		Yr. End	2022	2021	2020	2019	2018	2017	2016	10-Yr.	5-Yr.	1-Yr.	2022	2021	2020	2019	2018	2017
WIRELESS TELECOMMUNICATION SERVICES																			
ADVANCED INFO SERVICE PUBLIC COMPANY LIMITED	Thailand		DEC	752.4	810.8	913.9	1,048.0	918.2	922.9	856.8	(2.9)	(2.9)	(3.4)	88	95	107	122	107	108
AXIATA GROUP BERHAD	Malaysia		DEC	2,229.6	196.5	90.9	355.9	(1,151.5)	223.7	112.4	14.5	60.8	1092.5	1,983	175	81	317	NM	199
BHARTI AIRTEL LIMITED	India	#	MAR	0.0	560.7	(2,061.7)	(4,274.0)	59.1	168.9	586.4	(0.0)	2.3	NM	0	96	-352	-729	10	29
CHINA MOBILE LIMITED	Hong Kong	#	JAN	0.0	18,283.5	16,518.5	15,315.6	17,125.1	17,563.3	15,661.1	NA	NA	NA	0	117	105	98	109	112
DIGI.COM BERHAD	Malaysia		DEC	174.3	278.9	303.8	349.9	372.6	363.1	364.1	(4.5)	(12.4)	(34.3)	48	77	83	96	102	100
FAR EASTONE TELECOMMUNICATIONS CO., LTD.	Taiwan		DEC	312.7	329.2	297.4	292.0	306.5	366.0	351.5	(1.0)	(2.4)	5.3	89	94	85	83	87	104
GLOBE TELECOM, INC.	Philippines	#	JAN	0.0	459.4	386.7	439.1	355.4	301.4	320.5	NA	NA	NA	0	143	121	137	111	94
HUTCHISON TELECOMMUNICATIONS HONG KONG HOLDINGS LIMITED	Hong Kong	#	JAN	0.0	0.5	46.6	55.1	51.6	610.0	88.0	NA	NA	NA	0	1	53	63	59	694
INTOUCH HOLDINGS PUBLIC COMPANY LIMITED	Thailand		DEC	304.7	323.7	368.0	372.4	355.5	327.5	458.2	(2.7)	(0.3)	(2.0)	67	71	80	81	78	71
KDDI CORPORATION	Japan	#	MAR	0.0	5,537.9	5,890.6	5,945.7	5,574.1	5,390.8	4,902.8	10.9	4.2	3.2	0	113	120	121	114	110
MAXIS BERHAD	Malaysia		DEC	269.9	313.9	343.9	369.2	430.4	536.1	448.9	(4.4)	(11.5)	(9.6)	60	70	77	82	96	119
PLDT INC.	Philippines	#	JAN	0.0	512.1	505.5	444.0	360.6	267.5	403.8	NA	NA	NA	0	127	125	110	89	66
PT INDOSAT OOREDOO HUTCHISON TBK	Indonesia		DEC	304.2	473.8	(51.5)	113.4	(166.7)	83.8	82.0	28.8	33.0	(30.0)	371	578	-63	138	-203	102
PT XL AXIATA TBK	Indonesia		DEC	71.4	90.4	26.7	51.5	(228.6)	27.7	27.9	(8.7)	24.2	(13.9)	256	324	96	185	-820	99
SK TELECOM CO.,LTD	South Korea		DEC	725.5	2,021.2	1,382.3	769.8	2,809.7	2,433.7	1,392.1	(2.3)	(18.9)	(62.1)	52	145	99	55	202	175
SOFTBANK CORP.	Japan	#	MAR	0.0	4,261.7	4,442.1	4,397.1	3,887.5	3,885.9	3,956.9	NA	3.2	5.3	0	108	112	111	98	98
STARHUB LTD	Singapore		DEC	46.4	110.7	119.5	138.5	148.1	204.2	236.2	(16.1)	(25.6)	(58.3)	20	47	51	59	63	86
TAIWAN MOBILE CO., LTD.	Taiwan		DEC	358.9	396.5	401.8	417.2	445.7	478.4	472.8	(3.8)	(4.9)	0.3	76	84	85	88	94	101
VODAFONE IDEA LIMITED	India	#	MAR	0.0	(3,721.9)	(6,046.1)	(9,811.2)	(2,107.8)	(640.5)	(61.7)	NA	134.3	(36.1)	0	6,034	9,801	15,905	3,417	1,038
INTEGRATED TELECOMMUNICATION SERVICES																			
CHINA TELECOM CORPORATION LIMITED	China	#	JAN	0.0	4,084.6	3,193.6	2,946.6	3,083.9	2,861.2	2,595.0	NA	NA	NA	0	157	123	114	119	110
CHINA UNICOM (HONG KONG) LIMITED	Hong Kong	#	JAN	0.0	2,261.8	1,913.6	1,627.2	1,482.6	280.9	90.0	NA	NA	NA	0	2,513	2,126	1,808	1,647	312
CHUNGHWA TELECOM CO., LTD.	Taiwan		DEC	1,187.4	1,290.1	1,189.1	1,101.4	1,227.0	1,314.2	1,249.3	(1.3)	(1.3)	2.0	95	103	95	88	98	105
HKT TRUST AND HKT LIMITED	Hong Kong		DEC	628.6	616.6	684.0	669.8	616.1	607.3	630.5	11.8	0.6	1.9	100	98	108	106	98	96
KT CORPORATION	South Korea		DEC	1,003.9	1,139.1	604.7	533.4	579.9	432.1	432.1	1.9	22.3	(7.0)	232	264	140	123	134	100
LG UPLUS CORP.	South Korea	#	JAN	0.0	598.0	428.9	380.1	432.6	512.3	409.3	NA	NA	NA	0	146	105	93	106	125
NIPPON TELEGRAPH AND TELEPHONE CORPORATION	Pakistan	#	MAR	0.0	9,726.1	8,283.8	7,948.8	7,711.9	8,454.3	7,176.0	9.7	8.1	28.9	0	136	115	111	107	118
PAKISTAN TELECOMMUNICATION COMPANY LIMITED	Pakistan		DEC	(34.4)	14.6	20.4	15.3	41.0	39.1	15.5	NA	NM	NM	-221	94	132	99	264	252
PERUSAHAAN PERSEROAN (PERSERO) PT TELEKOMUNIKASI INDONESIA TBK	Malaysia	#	JAN	0.0	1,737.9	1,493.7	1,348.7	1,250.2	1,633.6	1,436.2	NA	NA	NA	0	121	104	94	87	114
SINGAPORE TELECOMMUNICATIONS LIMITED	Malaysia	#	MAR	0.0	1,439.2	411.7	755.8	2,284.4	4,176.9	2,758.2	(6.9)	(12.7)	251.9	0	52	15	27	83	151
TELEKOM MALAYSIA BERHAD	Australia	#	JAN	0.0	214.9	252.8	154.5	37.0	228.6	173.0	NA	NA	NA	0	124	146	89	21	132
TELSTRA GROUP LIMITED	Australia		JUN	1,163.0	1,392.3	1,255.9	1,510.3	2,656.1	2,986.0	4,305.9	(6.8)	(15.4)	(9.1)	27	32	29	35	62	69

Note: Data as originally reported. CAGR-Compound annual growth rate. #Of the following calendar year.
Souce: S&P Capital IQ.

Company	Country		Yr. End	Return on Revenues (%)						Return on Assets (%)						Return on Equity (%)					
				2022	2021	2020	2019	2018	2017	2022	2021	2020	2019	2018	2017	2022	2021	2020	2019	2018	2017
WIRELESS TELECOMMUNICATION SERVICES																					
ADVANCED INFO SERVICE PUBLIC COMPANY LIMITED	Thailand		DEC	14.0	14.8	15.9	17.2	17.5	19.1	7.7	7.6	7.8	10.8	10.2	10.6	31.0	34.2	37.8	49.1	55.0	64.6
AXIATA GROUP BERHAD	Malaysia		DEC	44.9	3.2	1.5	5.9	NM	3.7	12.0	1.1	0.5	2.2	NM	1.3	NM	5.2	2.7	8.0	NM	3.9
BHARTI AIRTEL LIMITED	India	#	MAR	0.0	3.6	NM	NM	0.5	1.3	NA	1.2	NM	NM	0.1	0.4	0.0	9.5	NM	NM	2.1	2.9
CHINA MOBILE LIMITED	Hong Kong	#	JAN	0.0	0.0	13.7	14.0	14.3	16.0	NA	NA	6.3	6.2	6.5	7.7	0.0	0.0	9.8	9.6	9.9	11.5
DIGI.COM BERHAD	Malaysia		DEC	11.2	18.3	19.8	22.7	23.5	23.2	2.0	14.8	14.9	17.6	24.8	25.3	9.0	187.6	192.9	215.0	258.5	284.5
FAR EASTONE TELECOMMUNICATIONS CO., LTD.	Taiwan		DEC	10.8	10.7	10.5	10.4	10.8	11.8	5.6	5.2	4.8	6.5	7.4	8.2	14.9	13.7	12.2	12.2	13.0	15.3
GLOBE TELECOM, INC.	Philippines	#	JAN	0.0	0.0	14.1	11.6	13.4	12.3	NA	NA	5.2	5.5	7.3	6.2	0.0	0.0	24.1	22.7	28.9	26.7
HUTCHISON TELECOMMUNICATIONS HONG KONG HOLDINGS LIMITED	Hong Kong	#	JAN	0.0	0.0	0.1	7.9	7.7	5.1	NA	NA	0.0	2.4	3.0	2.2	0.0	0.0	0.0	3.0	3.1	2.7
INTOUCH HOLDINGS PUBLIC COMPANY LIMITED	Thailand		DEC	0.0	323.4	301.2	227.2	179.8	110.9	0.0	19.9	21.0	22.4	23.0	20.9	0.0	23.5	26.8	24.9	31.0	24.8
KDDI CORPORATION	Japan	#	MAR	0.0	12.3	12.3	12.2	12.2	11.4	NA	6.1	6.2	6.7	8.4	8.7	0.0	13.6	14.0	14.7	16.0	16.6
MAXIS BERHAD	Malaysia		DEC	12.1	14.2	15.4	16.2	19.4	23.1	5.1	5.8	6.3	6.8	9.0	11.4	18.0	19.5	20.2	21.4	25.3	37.4
PLDT INC.	Philippines	#	JAN	0.0	0.0	13.6	13.4	13.3	11.6	NA	NA	4.2	4.2	4.3	3.9	0.0	0.0	20.3	19.5	18.3	15.6
PT INDOSAT OOREDOO HUTCHISON TBK	Indonesia		DEC	10.1	21.5	NM	6.0	NM	3.8	4.1	10.6	NM	2.5	NM	2.2	25.6	59.1	NM	12.6	NM	9.0
PT XL AXIATA TBK	Indonesia		DEC	3.8	4.8	1.4	2.8	NM	1.6	1.3	1.8	0.5	1.1	NM	0.7	4.9	6.6	1.9	3.8	NM	1.8
SK TELECOM CO.,LTD	South Korea		DEC	5.3	14.4	9.4	5.0	18.5	14.8	2.9	7.8	3.1	2.0	7.4	7.8	7.7	6.9	2.9	3.8	15.5	15.6
SOFTBANK CORP.	Japan	#	MAR	0.0	9.1	9.4	9.7	11.5	11.6	NA	4.1	4.0	4.8	7.5	8.0	0.0	20.7	24.6	0.0	42.8	36.3
STARHUB LTD	Singapore		DEC	2.7	7.3	7.8	8.0	8.5	11.3	2.0	4.6	5.4	6.8	7.6	10.4	10.1	22.7	26.5	30.6	33.6	68.3
TAIWAN MOBILE CO., LTD.	Taiwan		DEC	6.4	7.0	8.5	10.0	11.5	12.1	5.7	5.8	6.1	8.1	9.2	9.2	17.8	17.7	17.0	18.7	21.7	22.7
VODAFONE IDEA LIMITED	India	#	MAR	0.0	NM	NM	NM	NM	NM	NA	NM	NM	NM	NM	NM	0.0	NM	NM	NM	NM	NM
INTEGRATED TELECOMMUNICATION SERVICES																					
CHINA TELECOM CORPORATION LIMITED	China		JAN	0.0	0.0	5.9	5.3	5.5	5.6	NA	NA	3.4	2.9	2.9	3.2	0.0	0.0	6.6	5.8	5.9	6.4
CHINA UNICOM (HONG KONG) LIMITED	Hong Kong		JAN	0.0	0.0	4.4	4.1	3.9	3.5	NA	NA	2.4	2.2	2.0	1.9	0.0	0.0	4.4	3.9	3.6	3.3
CHUNGHWA TELECOM CO., LTD.	Taiwan		DEC	16.8	17.0	16.1	15.9	17.4	17.1	7.0	7.0	6.6	6.9	8.0	8.6	9.7	9.5	9.0	8.8	10.2	10.9
HKT TRUST AND HKT LIMITED	Hong Kong		DEC	14.4	14.2	16.4	15.8	13.7	14.3	4.4	4.4	5.1	5.2	4.9	5.0	13.4	12.8	14.0	13.9	12.8	12.3
KT CORPORATION	South Korea		DEC	4.9	5.4	2.8	2.5	2.8	2.0	3.1	3.7	2.0	1.8	2.0	1.5	7.9	9.1	4.6	4.5	5.2	4.2
LG UPLUS CORP.	South Korea	#	JAN	0.0	0.0	5.1	3.5	3.5	4.1	NA	NA	3.7	2.5	2.4	3.5	0.0	0.0	9.3	3.4	6.2	8.1
NIPPON TELEGRAPH AND TELEPHONE CORPORATION	Pakistan	#	MAR	0.0	9.7	7.7	7.2	7.2	7.6	NA	4.9	4.0	3.7	3.8	4.2	0.0	14.6	11.5	9.6	9.7	10.4
PAKISTAN TELECOMMUNICATION COMPANY LIMITED	Pakistan		DEC	NM	1.9	2.5	1.8	4.5	3.7	NA	0.5	0.8	0.7	1.8	1.5	NM	2.9	3.8	2.9	6.7	4.9
PERUSAHAAN PERSEROAN (PERSERO) PT TELEKOMUNIKASI INDONE	Malaysia	#	JAN	0.0	0.0	17.3	15.2	13.8	13.8	NA	NA	8.9	8.4	8.4	8.7	0.0	0.0	25.5	24.8	23.5	23.5
SINGAPORE TELECOMMUNICATIONS LIMITED	Malaysia	#	MAR	0.0	12.7	3.5	6.5	17.8	31.7	NA	4.0	1.2	2.2	6.3	11.3	0.0	7.2	2.1	3.7	10.3	18.8
TELEKOM MALAYSIA BERHAD	Malaysia	#	JAN	0.0	0.0	7.8	9.4	5.5	1.3	NA	NA	3.9	4.2	2.5	0.6	0.0	0.0	12.3	14.7	8.2	NM
TELSTRA GROUP LIMITED	Malaysia		JUN	7.9	8.6	7.7	8.5	13.9	15.0	4.1	4.4	4.1	5.1	8.4	9.2	11.3	12.5	12.4	14.7	24.4	25.4

Note: Data as originally reported. CAGR-Compound annual growth rate. #Of the following calendar year.
Souce: S&P Capital IQ.

Company	Country		Yr. End	Current Ratio						Debt/Capital Ratio (%)						Debt as a % of Net Working Capital					
				2022	2021	2020	2019	2018	2017	2022	2021	2020	2019	2018	2017	2022	2021	2020	2019	2018	2017
WIRELESS TELECOMMUNICATION SERVICES																					
ADVANCED INFO SERVICE PUBLIC COMPANY LIMITED	Thailand		DEC	0.4	0.4	0.4	0.4	0.5	0.5	46.1	47.6	54.7	49.9	65.4	70.8	NM	NM	NM	NM	NM	NM
AXIATA GROUP BERHAD	Malaysia		DEC	0.7	0.6	0.7	0.4	0.7	0.6	37.7	37.8	38.7	29.9	39.2	33.1	NM	NM	NM	(63.7)	NM	NM
BHARTI AIRTEL LIMITED	India	#	MAR	0.0	0.5	0.5	0.6	0.4	0.4	NA	63.1	61.6	55.8	67.8	58.8	NA	NM	NM	NM	NM	NM
CHINA MOBILE LIMITED	Hong Kong	#	JAN	0.0	0.0	1.0	1.1	1.1	1.1	NA	NA	0.0	0.0	0.0	0.0	NA	NA	0.0	0.0	0.0	0.0
DIGI.COM BERHAD	Malaysia		DEC	0.5	0.5	0.6	0.7	0.8	0.8	40.2	74.3	80.5	80.5	78.9	83.8	NM	NM	NM	NM	NM	NM
FAR EASTONE TELECOMMUNICATIONS CO., LTD.	Taiwan		DEC	0.9	0.8	1.1	1.2	0.9	0.9	47.0	45.1	52.4	32.1	27.1	29.6	NM	NM	2417.0	644.2	NM	NM
GLOBE TELECOM, INC.	Philippines	#	JAN	0.0	0.0	0.6	0.8	0.7	0.9	NA	NA	62.9	65.4	60.2	64.3	NA	NA	NM	NM	NM	NM
HUTCHISON TELECOMMUNICATIONS HONG KONG HOLDINGS LIMITED	Hong Kong	#	JAN	0.0	0.0	2.3	3.2	3.2	5.5	NA	NA	0.0	0.0	0.0	0.0	NA	NA	0.0	0.0	0.0	0.0
INTOUCH HOLDINGS PUBLIC COMPANY LIMITED	Thailand		DEC	0.9	2.6	2.0	2.6	1.8	2.1	0.0	1.8	2.5	8.5	10.2	15.6	0.0	11.7	17.3	50.9	72.1	103.8
KDDI CORPORATION	Japan	#	MAR	0.0	0.9	1.0	1.0	1.8	1.5	NA	16.5	19.8	19.1	19.0	15.2	NA	NM	2979.1	12217.1	101.7	102.8
MAXIS BERHAD	Malaysia		DEC	0.6	0.5	0.6	0.5	0.6	0.6	55.1	48.3	53.9	52.7	52.4	53.1	NM	NM	NM	NM	NM	NM
PLDT INC.	Philippines	#	JAN	0.0	0.0	0.3	0.4	0.4	0.5	NA	NA	64.1	61.7	58.2	55.6	NA	NA	NM	NM	NM	NM
PT INDOSAT OOREDOO HUTCHISON TBK	Indonesia		DEC	0.5	0.4	0.4	0.6	0.4	0.6	35.0	48.2	51.3	53.8	57.4	50.1	(99.0)	(53.8)	NM	NM	NM	NM
PT XL AXIATA TBK	Indonesia		DEC	0.4	0.4	0.4	0.3	0.4	0.5	20.1	29.8	28.9	27.8	38.0	33.7	(40.7)	(64.5)	(68.9)	(51.9)	NM	NM
SK TELECOM CO.,LTD	South Korea		DEC	0.9	0.9	1.1	1.0	1.2	0.9	37.9	37.5	28.7	28.9	28.0	24.9	NM	NM	1637.8	3904.3	780.0	NM
SOFTBANK CORP.	Japan	#	MAR	0.0	0.8	0.8	0.7	0.9	0.5	NA	66.9	66.8	76.1	56.9	190.9	NA	NM	NM	NM	NM	NM
STARHUB LTD	Singapore		DEC	1.2	1.5	1.5	0.8	1.0	1.0	59.8	62.1	65.1	52.5	62.5	58.6	391.8	223.8	301.3	NM	2528.2	4224.1
TAIWAN MOBILE CO., LTD.	Taiwan		DEC	0.6	0.6	0.5	0.7	0.7	0.6	55.5	59.6	58.5	43.2	44.5	46.5	NM	NM	NM	NM	NM	NM
VODAFONE IDEA LIMITED	India	#	MAR	0.0	0.3	0.2	0.2	0.3	0.9	NA	156.3	132.1	94.2	66.2	67.6	NA	NM	NM	NM	NM	NM
INTEGRATED TELECOMMUNICATION SERVICES																					
CHINA TELECOM CORPORATION LIMITED	China		JAN	0.0	0.0	0.5	0.3	0.3	0.3	NA	NA	2.3	13.4	19.3	24.3	NA	NA	(7.4)	(27.9)	(38.9)	(50.8)
CHINA UNICOM (HONG KONG) LIMITED	Hong Kong		JAN	0.0	0.0	0.5	0.5	0.4	0.4	NA	NA	2.9	4.8	7.4	7.0	NA	NA	(8.9)	(14.3)	(20.1)	(16.1)
CHUNGHWA TELECOM CO., LTD.	Taiwan		DEC	1.6	1.4	1.1	1.4	1.5	1.2	7.7	6.8	6.6	0.4	0.4	0.5	90.6	107.2	260.9	6.1	6.0	10.8
HKT TRUST AND HKT LIMITED	Hong Kong		DEC	0.5	0.7	0.6	0.8	0.9	0.9	57.6	54.2	53.9	51.5	51.7	50.9	NM	NM	NM	NM	NM	NM
KT CORPORATION	South Korea		DEC	1.2	1.2	1.2	1.2	1.3	1.0	37.6	30.3	27.9	29.2	26.9	28.6	504.8	394.5	305.5	355.4	194.4	1478.3
LG UPLUS CORP.	South Korea	#	JAN	0.0	0.0	1.0	1.1	1.0	1.1	NA	NA	35.0	38.3	37.3	23.4	NA	NA	4721.7	758.2	3418.5	503.6
NIPPON TELEGRAPH AND TELEPHONE CORPORATION	Pakistan	#	MAR	0.0	0.9	0.7	1.0	1.3	1.3	NA	45.1	57.1	27.5	25.6	23.1	NA	NM	NM	3906.1	277.8	268.6
PAKISTAN TELECOMMUNICATION COMPANY LIMITED	Pakistan		DEC	0.0	0.8	0.9	0.8	0.9	0.9	0.0	43.3	31.0	23.5	24.7	24.0	NA	NM	NM	(69.9)	NM	NM
PERUSAHAAN PERSEROAN (PERSERO) PT TELEKOMUNIKASI INDONE	Malaysia	#	JAN	0.0	0.0	0.9	0.7	0.7	0.9	NA	NA	23.7	26.7	27.4	23.8	NA	NA	NM	NM	NM	NM
SINGAPORE TELECOMMUNICATIONS LIMITED	Malaysia	#	MAR	0.0	0.9	0.7	0.7	0.8	0.8	NA	20.4	25.4	24.1	22.7	22.4	NA	NM	NM	NM	NM	NM
TELEKOM MALAYSIA BERHAD	Malaysia	#	JAN	0.0	0.0	1.1	1.3	1.3	1.2	NA	NA	42.2	49.4	54.0	54.2	NA	NA	722.5	416.7	364.1	689.7
TELSTRA GROUP LIMITED	Malaysia		JUN	0.6	0.7	0.6	0.8	0.8	0.9	34.5	43.9	48.2	51.4	53.6	55.8	NM	NM	NM	NM	NM	NM

Note: Data as originally reported. CAGR-Compound annual growth rate. #Of the following calendar year.
Souce: S&P Capital IQ.

Company	Country	Yr. End	Price/Earnings Ratio (High-Low)						Dividend Payout Ratio (%)						Dividend Yield (High-Low, %)											
			2022	2021	2020	2019	2018	2017	2022	2021	2020	2019	2018	2017	2022		2021		2020		2019		2018		2017	
WIRELESS TELECOMMUNICATION SERVICES																										
ADVANCED INFO SERVICE PUBLIC COMPANY LIMITED	Thailand	DEC	27 - 21	25 - 18	NA - NA	NA - NA	NA - NA	NA - NA	88	79	74	67	74	77	4.2 -	3.6	4.2 -	3.0	4.2 -	3.2	4.3 -	3.2	4.4 -	3.0	4.2 -	3.3
AXIATA GROUP BERHAD	Malaysia	DEC	4 - 2	47 - 36	115 - 67	33 - 23	NM - NM	54 - 42	5	101	151	37	NM	42	3.5 -	3.1	3.6 -	0.0	2.4 -	1.5	3.0 -	1.6	2.5 -	1.8	2.6 -	1.4
BHARTI AIRTEL LIMITED	India	MAR	100 - 67	NM - NM	NM - NM	410 - 279	197 - 123	40 - 31	0	34	NM	NM	1138	297	0.4 -	0.0	0.4 -	0.0	0.5 -	0.0	1.6 -	0.0	1.7 -	0.7	0.7 -	0.2
CHINA MOBILE LIMITED	Hong Kong	JAN		12 - 7	17 - 11	16 - 13	16 - 13	18 - 14	0	0	50	55	50	51	8.8 -	5.9	8.5 -	6.2	8.0 -	4.2	5.0 -	3.8	4.8 -	3.5	3.8 -	3.0
DIGI.COM BERHAD	Malaysia	DEC	46 - 33	30 - 24	30 - 24	28 - 24	26 - 20	27 - 23	132	98	104	101	98	100	4.0 -	2.8	4.8 -	3.5	4.6 -	3.5	4.8 -	3.9	4.5 -	3.9	4.7 -	3.8
FAR EASTONE TELECOMMUNICATIONS CO., LTD.	Taiwan	DEC	30 - 22	24 - 21	29 - 23	29 - 26	28 - 24	24 - 21	111	116	127	140	130	113	5.0 -	4.7	5.2 -	3.7	5.4 -	4.9	6.3 -	4.6	5.3 -	4.8	5.3 -	4.7
GLOBE TELECOM, INC.	Philippines	JAN		13 - 10	17 - 13	14 - 9	16 - 12	22 - 12	0	0	63	81	57	68	5.4 -	3.2	6.0 -	3.0	6.5 -	4.3	5.2 -	4.0	6.2 -	3.9	5.8 -	4.1
HUTCHISON TELECOMMUNICATIONS HONG KONG HOLDINGS LIMITED	Hong Kong	JAN		1867 - 1386	46 - 17	39 - 31	38 - 27	3 - 2	0	0	9025	81	69	91	7.2 -	4.3	6.3 -	4.2	5.8 -	3.9	4.8 -	1.8	3.5 -	2.4	5.9 -	3.4
INTOUCH HOLDINGS PUBLIC COMPANY LIMITED	Thailand	DEC	24 - 20	27 - 16	18 - 12	20 - 14	17 - 13	18 - 15	0	77	71	73	78	92	4.6 -	4.3	4.9 -	3.2	4.6 -	2.9	6.2 -	4.2	8.9 -	3.7	8.4 -	4.3
KDDI CORPORATION	Japan	MAR	14 - 11	13 - 9	12 - 9	12 - 9	14 - 11	15 - 13	0	40	42	40	37	38	3.6 -	2.9	4.0 -	3.2	4.5 -	3.3	4.2 -	3.2	4.2 -	3.1	3.5 -	2.8
MAXIS BERHAD	Malaysia	DEC	32 - 21	32 - 25	32 - 26	30 - 26	27 - 23	23 - 19	132	72	68	103	88	70	5.6 -	5.0	6.6 -	3.3	3.8 -	3.0	4.3 -	2.9	3.9 -	3.4	3.9 -	3.3
PLDT INC.	Philippines	JAN		12 - 7	12 - 9	15 - 11	22 - 16	38 - 21	0	0	67	69	69	74	7.9 -	4.2	6.6 -	4.3	9.1 -	5.2	7.3 -	4.6	6.7 -	4.4	7.7 -	2.9
PT INDOSAT OOREDOO HUTCHISON TBK	Indonesia	DEC	13 - 9	7 - 4	NM - NM	13 - 6	NM - NM	36 - 23	42	141	0	0	NM	34	21.7 -	17.1	20.0 -	11.4	11.7 -	0.0	0.0 -	0.0	4.4 -	0.0	3.7 -	1.2
PT XL AXIATA TBK	Indonesia	DEC	32 - 19	27 - 16	96 - 40	54 - 30	NM - NM	115 - 64	49	26	57	0	0	0	2.5 -	2.1	2.4 -	1.0	1.6 -	0.7	1.4 -	0.7	0.0 -	0.0	0.0 -	0.0
SK TELECOM CO.,LTD	South Korea	DEC	15 - 12	10 - 5	12 - 8	23 - 19	7 - 5	8 - 6	101	43	50	83	23	27	14.5 -	7.0	13.7 -	5.3	6.0 -	3.0	6.0 -	4.0	4.3 -	3.5	4.5 -	3.5
SOFTBANK CORP.	Japan	MAR	15 - 13	14 - 11	16 - 12	16 - 14	NA - NA	NA - NA	0	78	83	84	0	0	6.1 -	5.5	6.2 -	5.3	7.3 -	5.7	6.5 -	2.8	3.0 -	2.7	0.0 -	0.0
STARHUB LTD	Singapore	DEC	44 - 33	17 - 15	18 - 13	19 - 12	27 - 14	20 - 16	191	63	57	104	141	109	6.2 -	4.5	6.4 -	3.6	4.2 -	3.6	8.0 -	3.8	10.7 -	5.7	9.9 -	5.4
TAIWAN MOBILE CO., LTD.	Taiwan	DEC	28 - 23	28 - 25	29 - 24	27 - 24	22 - 21	22 - 19	122	117	124	129	116	112	4.6 -	4.4	4.7 -	3.9	4.9 -	4.0	5.7 -	4.1	5.3 -	4.5	5.3 -	5.0
VODAFONE IDEA LIMITED	India	MAR	NM - NM	NM - NM	NM - NM	NM - NM	NM - NM	NM - NM	0	0	0	0	0	0	0.0 -	0.0	0.0 -	0.0	0.0 -	0.0	0.0 -	0.0	0.0 -	0.0	0.8 -	0.0
INTEGRATED TELECOMMUNICATION SERVICES																										
CHINA TELECOM CORPORATION LIMITED	China	JAN		10 - 6	17 - 11	17 - 13	16 - 14	19 - 14	0	0	33	44	43	36	10.3 -	3.9	7.0 -	3.9	6.3 -	3.8	4.2 -	2.4	3.5 -	2.5	3.0 -	2.4
CHINA UNICOM (HONG KONG) LIMITED	Hong Kong	JAN		15 - 8	26 - 16	32 - 22	37 - 28	138 - 104	0	0	60	44	36	16	9.3 -	5.8	7.7 -	3.3	4.1 -	2.0	2.2 -	0.6	0.7 -	0.0	2.2 -	0.0
CHUNGHWA TELECOM CO., LTD.	Taiwan	DEC	28 - 23	26 - 23	27 - 24	27 - 25	24 - 22	22 - 20	98	93	98	105	99	98	4.2 -	4.0	4.3 -	3.4	3.9 -	3.6	4.3 -	3.6	4.5 -	3.9	4.8 -	4.2
HKT TRUST AND HKT LIMITED	Hong Kong	DEC	17 - 13	18 - 16	18 - 14	19 - 16	19 - 15	18 - 15	0	113	101	100	103	100	7.8 -	6.8	8.6 -	6.5	7.1 -	6.1	7.4 -	5.5	6.0 -	5.1	6.7 -	5.6
KT CORPORATION	South Korea	DEC	8 - 6	6 - 4	10 - 7	12 - 11	12 - 10	19 - 15	0	26	41	44	38	42	6.4 -	5.0	5.6 -	3.8	5.6 -	3.9	6.2 -	4.0	4.2 -	3.2	3.7 -	2.6
LG UPLUS CORP.	South Korea	JAN		9 - 6	16 - 11	18 - 12	15 - 10	10 - 7	0	0	40	38	40	36	5.9 -	2.9	3.8 -	2.6	4.2 -	2.8	3.3 -	2.7	0.0 -	0.0	0.0 -	0.0
NIPPON TELEGRAPH AND TELEPHONE CORPORATION	Pakistan	MAR	11 - 8	12 - 9	12 - 10	12 - 9	13 - 10	13 - 11	0	34	39	41	37	30	3.6 -	2.9	4.3 -	3.3	4.7 -	3.5	4.2 -	3.3	4.2 -	2.8	3.3 -	2.3
PAKISTAN TELECOMMUNICATION COMPANY LIMITED	Pakistan	DEC		27 - 16	18 - 11	23 - 14	12 - 8	23 - 14	0	0	78	110	88	118	0.0 -	0.0	0.0 -	0.0	11.3 -	0.0	14.6 -	4.8	11.4 -	5.3	11.0 -	7.2
PERUSAHAAN PERSEROAN (PERSERO) PT TELEKOMUNIKASI INDONESIA TBK	Malaysia	JAN		16 - 10	21 - 17	22 - 17	26 - 21	20 - 14	0	0	50	54	58	74	4.3 -	3.5	5.6 -	4.0	6.3 -	4.1	4.8 -	3.7	5.1 -	3.1	4.0 -	2.4
SINGAPORE TELECOMMUNICATIONS LIMITED	Malaysia	MAR	22 - 19	84 - 59	54 - 35	19 - 15	12 - 10	18 - 15	0	59	230	266	92	52	3.9 -	2.7	4.4 -	2.9	7.7 -	4.1	6.0 -	4.9	6.1 -	4.9	5.3 -	4.4
TELEKOM MALAYSIA BERHAD	Malaysia	JAN		27 - 14	17 - 10	37 - 13	163 - 146	28 - 24	0	0	61	62	12	297	3.0 -	2.2	2.9 -	2.0	3.4 -	0.5	0.8 -	0.0	7.1 -	0.0	3.6 -	3.2
TELSTRA GROUP LIMITED	Malaysia	JUN	30 - 25	23 - 17	26 - 20	21 - 14	15 - 9	18 - 12	91	64	65	105	88	96	4.8 -	4.0	4.6 -	3.8	6.0 -	4.5	5.4 -	3.3	5.7 -	3.6	9.2 -	4.3

Note: Data as originally reported. CAGR-Compound annual growth rate. #Of the following calendar year.
Souce: S&P Capital IQ.

Company	Yr. End	Earnings per Share ($)						Tangible Book Value per Share ($)						Share Price (High-Low, $)											
		2022	2021	2020	2019	2018	2017	2022	2021	2020	2019	2018	2017	2022		2021		2020		2019		2018		2017	
WIRELESS TELECOMMUNICATION SERVICES																									
ADVANCED INFO SERVICE PUBLIC COMPANY LIMITED	DEC	0.25	0.27	0.31	0.35	0.31	0.31	(0.52)	(0.65)	(0.50)	(0.48)	(0.65)	(0.64)	7.00	5.25	6.96	4.94	7.46	5.21	8.06	5.58	6.65	5.10	6.17	4.51
AXIATA GROUP BERHAD	DEC	0.24	0.02	0.01	0.04	(0.13)	0.02	0.26	(0.10)	(0.08)	(0.12)	(0.09)	0.07	0.91	0.54	1.02	0.78	1.18	0.66	1.29	0.90	1.41	0.77	1.35	1.04
BHARTI AIRTEL LIMITED	MAR	0.00	0.10	(0.38)	(0.84)	0.01	0.04	0.00	(1.26)	(1.28)	(0.94)	(1.76)	(1.98)	10.60	7.60	10.49	6.70	8.38	5.22	6.83	4.12	7.79	3.98	8.85	4.69
CHINA MOBILE LIMITED	JAN	0.00	0.00	0.89	0.81	0.74	0.84	0.00	0.00	8.82	8.16	7.35	7.09	7.52	6.00	7.59	5.00	9.03	5.64	11.26	7.48	10.73	8.66	11.68	9.70
DIGI.COM BERHAD	DEC	0.02	0.04	0.04	0.05	0.05	0.05	(0.05)	0.01	0.01	0.01	(0.01)	(0.01)	0.97	0.71	1.08	0.82	1.16	0.93	1.25	1.05	1.21	0.95	1.28	1.07
FAR EASTONE TELECOMMUNICATIONS CO., LTD.	DEC	0.10	0.10	0.09	0.09	0.09	0.11	(0.15)	(0.21)	(0.24)	0.20	0.20	0.14	2.88	2.06	2.41	2.16	2.58	2.07	2.64	2.37	2.59	2.28	2.69	2.37
GLOBE TELECOM, INC.	JAN	0.00	0.00	3.35	2.80	3.20	2.58	0.00	0.00	13.31	9.94	9.44	8.26	61.26	35.00	71.28	34.88	47.88	33.10	45.50	34.60	45.38	28.12	45.06	29.01
HUTCHISON TELECOMMUNICATIONS HONG KONG HOLDINGS LIMITED	JAN	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.12	0.20	0.20	0.30	0.23	0.13	0.23	0.15	0.21	0.15	0.45	0.16	0.45	0.35	0.42	0.28
INTOUCH HOLDINGS PUBLIC COMPANY LIMITED	DEC	0.10	0.10	0.11	0.12	0.11	0.10	0.33	0.38	0.39	0.34	0.26	0.23	2.34	1.94	2.73	1.64	2.03	1.28	2.32	1.56	1.85	1.42	1.86	1.53
KDDI CORPORATION	MAR	0.00	2.47	2.57	2.56	2.34	2.22	0.00	13.01	13.00	11.35	10.35	8.98	35.16	25.65	33.86	26.24	33.44	25.23	30.48	21.66	29.05	21.25	28.94	24.89
MAXIS BERHAD	DEC	0.03	0.04	0.04	0.05	0.05	0.07	(0.15)	(0.15)	(0.15)	(0.13)	(0.12)	(0.13)	1.06	0.72	1.27	1.02	1.42	1.14	1.42	1.24	1.48	1.24	1.62	1.35
PLDT INC.	JAN	0.00	0.00	2.36	2.33	2.05	1.66	0.00	0.00	5.41	4.78	3.98	3.82	35.64	20.30	37.75	23.21	30.95	16.76	27.33	19.29	30.52	20.97	38.90	27.21
PT INDOSAT OOREDOO HUTCHISON TBK	DEC	0.04	0.09	(0.01)	0.02	(0.03)	0.02	0.07	0.10	0.13	0.15	0.09	0.17	0.49	0.32	0.58	0.33	0.46	0.09	0.29	0.12	0.46	0.12	0.55	0.34
PT XL AXIATA TBK	DEC	0.01	0.01	0.00	0.00	(0.02)	0.00	0.06	0.05	0.05	0.05	0.04	0.06	0.22	0.13	0.23	0.14	0.24	0.09	0.27	0.14	0.23	0.12	0.30	0.17
SK TELECOM CO.,LTD	DEC	3.27	9.23	6.19	3.46	13.03	11.28	21.58	21.75	67.70	67.43	57.73	53.89	50.17	37.69	93.85	41.98	76.10	49.62	80.29	65.32	86.08	64.78	88.78	66.74
SOFTBANK CORP.	MAR	0.00	0.89	0.93	0.91	0.81	0.95	0.00	(3.21)	(3.58)	(2.59)	0.00	(1.05)	11.84	10.70	14.07	11.23	14.69	11.22	14.30	11.18	13.34	10.72	0.00	0.00
STARHUB LTD	DEC	0.02	0.06	0.07	0.08	0.08	0.12	(0.12)	(0.05)	(0.08)	(0.07)	(0.08)	0.02	1.02	0.76	1.04	0.88	1.17	0.82	1.45	0.94	2.19	1.16	2.36	1.90
TAIWAN MOBILE CO., LTD.	DEC	0.13	0.14	0.14	0.15	0.16	0.17	(0.14)	(0.20)	(0.26)	0.11	(0.00)	(0.07)	3.60	2.94	3.95	3.45	4.15	3.38	4.11	3.54	3.66	3.41	3.93	3.44
VODAFONE IDEA LIMITED	MAR	0.00	(0.13)	(0.21)	(0.36)	(0.31)	(0.17)	0.00	(0.68)	(0.70)	(0.52)	(1.17)	(1.09)	0.19	0.09	0.23	0.06	0.18	0.04	0.54	0.03	1.71	0.46	1.93	1.04
INTEGRATED TELECOMMUNICATION SERVICES																									
CHINA TELECOM CORPORATION LIMITED	JAN	0.00	0.00	0.05	0.04	0.04	0.04	0.00	0.00	0.65	0.60	0.54	0.54	0.43	0.33	0.42	0.23	0.43	0.26	0.58	0.37	0.55	0.41	0.54	0.45
CHINA UNICOM (HONG KONG) LIMITED	JAN	0.00	0.00	0.07	0.06	0.05	0.05	0.00	0.00	1.63	1.57	1.44	1.38	0.66	0.42	0.71	0.49	0.95	0.50	1.37	0.84	1.52	1.03	1.69	1.11
CHUNGHWA TELECOM CO., LTD.	DEC	0.15	0.17	0.15	0.14	0.16	0.17	1.27	1.37	1.32	1.41	1.36	1.33	4.31	3.43	4.28	3.90	4.16	3.67	3.81	3.54	3.76	3.41	3.74	3.35
HKT TRUST AND HKT LIMITED	DEC	0.08	0.08	0.09	0.09	0.08	0.08	(0.52)	(0.49)	(0.41)	(0.38)	(0.36)	(0.35)	1.46	1.08	1.48	1.26	1.66	1.21	1.67	1.41	1.55	1.20	1.45	1.18
KT CORPORATION	DEC	3.92	4.82	2.47	2.17	2.37	1.76	57.19	41.86	46.09	39.21	36.85	36.58	31.25	23.85	29.55	19.77	24.76	15.85	26.89	22.95	28.07	23.85	33.28	26.82
LG UPLUS CORP.	JAN	0.00	0.00	1.38	0.98	0.87	0.99	0.00	0.00	10.49	12.28	9.65	10.59	11.77	8.15	13.60	9.70	13.46	8.46	16.20	10.39	16.44	10.51	16.76	10.44
NIPPON TELEGRAPH AND TELEPHONE CORPORATION	MAR	0.00	2.71	2.24	2.15	1.99	2.12	0.00	11.90	11.83	16.33	15.89	15.81	31.30	23.89	28.77	22.69	28.18	20.61	26.25	20.30	24.84	18.46	26.21	20.74
PAKISTAN TELECOMMUNICATION COMPANY LIMITED	DEC	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.02	0.08	0.07	0.07	0.09	0.04	0.03	0.08	0.04	0.08	0.04	0.07	0.04	0.10	0.06	0.18	0.11
PERUSAHAAN PERSEROAN (PERSERO) PT TELEKOMUNIKASI INDONESIA TBK	JAN	0.00	0.00	0.02	0.02	0.01	0.01	0.00	0.00	0.08	0.07	0.07	0.06	0.31	0.23	0.30	0.21	0.29	0.18	0.33	0.25	0.31	0.23	0.36	0.28
SINGAPORE TELECOMMUNICATIONS LIMITED	MAR	0.00	0.09	0.03	0.05	0.14	0.26	0.00	0.72	0.60	0.56	0.72	0.74	2.15	1.72	1.95	1.64	2.59	1.51	2.65	2.10	2.68	2.11	3.01	2.66
TELEKOM MALAYSIA BERHAD	JAN	0.00	0.00	0.06	0.07	0.04	0.01	0.00	0.00	0.43	0.42	0.44	0.45	1.39	1.07	1.64	1.24	1.39	0.77	1.14	0.63	1.50	0.51	1.65	1.44
TELSTRA GROUP LIMITED	JUN	0.10	0.12	0.11	0.13	0.22	0.25	0.43	0.47	0.41	0.40	0.42	0.40	2.93	2.46	3.05	2.17	3.04	2.05	2.82	1.95	2.67	1.83	4.13	2.61

Note: Data as originally reported. CAGR-Compound annual growth rate. #Of the following calendar year.
Souce: S&P Capital IQ.

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