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Market forces create technology ecosystem diversity in network markets, 2H23 update

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Summary

This white paper identifies key players across 22 technology domains in fixed and mobile networks, cloud, devices, semiconductors, and digital services and shows that technology ecosystems are complex and interdependent. Market leadership is shared between companies, and it also varies by region. This is the third update of the *Market forces create technology ecosystem diversity* white paper initially published in June 2021, and updated in April 2022 and April 2023.

Omdia used the Herfindahl–Hirschman Index (HHI) to compare the level of concentration in these 22 technology markets. Most technology markets are moderately to highly concentrated, and only a few can be considered as unconcentrated. Note that due to the lack of half-year data, seven out of the 22 categories covered in this report have not been updated in this half-year report, but they will be updated again in the next update based on full year 2023 data (see **Figure 3**).

A change in this edition is that the computing and storage SoC category has been replaced by the broader and more generic computing and storage processor category (see appendix for definition).

Mobile radio access network (RAN) and mobile core are moderately concentrated markets, and for these two categories, the level of concentration has again decreased in the first half of 2023, with the HHI in 1H23 lower than in 2022.

The level of concentration in technology markets is also continuously changing. For example, the RAN market consolidated during the 4G era, but more recently, the number of RAN vendors has been increasing again. The open RAN movement brought a few new entrants, but it mostly gave visibility to existing smaller vendors that have been in this industry for years and are now enjoying renewed interest from service providers. Of course, many of these new entrants and challengers currently have minimal market share, but market shares do not always reflect vendor diversity.

Omdia also warns that vendor diversity has limitations as well as benefits. At operator level, the right balance between diversity and efficiency must be found, and operators themselves are in the best position to decide the number of vendors they should partner with. At industry level, in RAN as in many other tech industries, suppliers need to achieve economies of scale to bring costs down and fund the expensive R&D required for continuous innovation in performance, functionality, energy, efficiency, and security.

This report also looks at the number of vendors currently active in fixed and mobile networks in eight countries, of which all have some form of vendor or market access restrictions in place. Despite those barriers to market access, there is still diversity, and operators are left with a sufficient pool to choose from.

Using examples, Omdia also shows that market concentration and vendor diversity are not well correlated. And while excessive levels of concentration should be regulated, ecosystem diversity should be left to market forces.

The network, device, and cloud ecosystems are complex, with multiple leaders

In most tech ecosystems, leadership is shared, and even leaders are dependent on partners

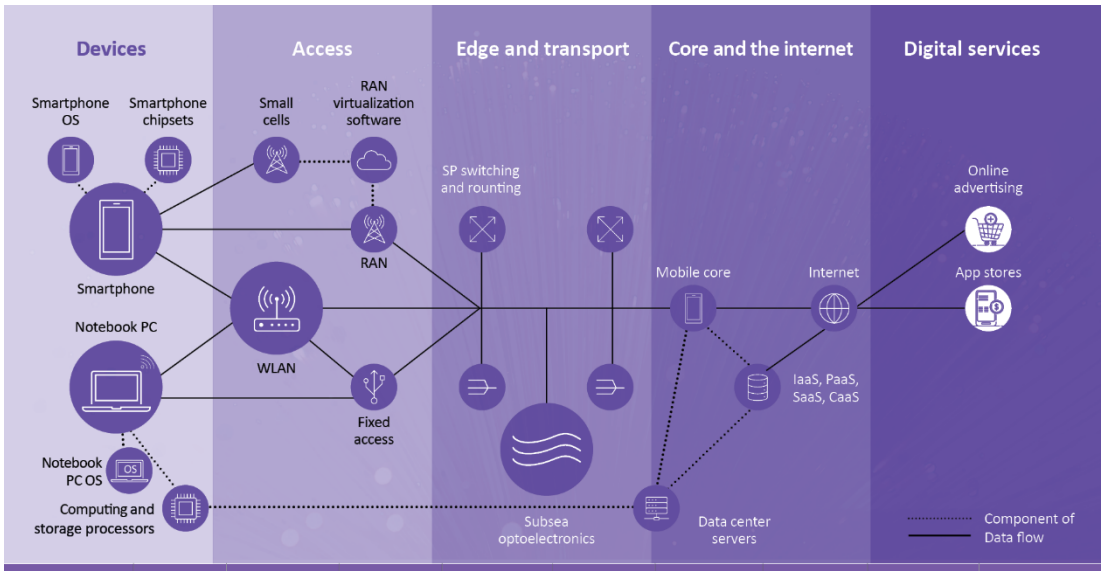
Figure 1 illustrates in a simplified manner the key domains that constitute mobile and fixed networks and adjacent technology domains such as devices, components, and cloud services and shows some of the links that tie them together. The reality is much more complex, and there are many more technology areas, each with their own subsegments, markets, sets of players, supply chains, and links of dependence.

Market leaders, in terms of revenue market share for the first half of 2023 (or for the full year 2022 when more recent data is not available), are listed for the different categories. Some companies are present in multiple areas, but overall global technology leadership is shared across companies and countries. Even category leaders have limited influence over the entire tech ecosystem.

For example, Apple, the leader in smartphone, is not involved in mobile or fixed networks, and Ericsson, a leader in mobile access networks, is not involved in smartphones and their components (despite its history in mobile devices). There are also countless intricate links of dependencies between those leaders themselves and with hundreds of less visible smaller companies in the value chain, which simply cannot be shown in a single picture.

In the first half of 2023, the top-five vendors have changed in a few categories studied: smartphones, notebook PC, fixed access, subsea optoelectronics, and datacenter servers (categories with an asterisk* on **Figure 1**).

Figure 1: Fixed and mobile networks, devices, components, and cloud ecosystems



Smartphones*	Smartphones OS	Smartphone chipsets	Indoor small cells	Mobile access (RAN)	RAN virtualization software	Mobile core	WLAN	Online advertising	Smartphone apps
Apple	Google	Mediatek	Huawei	Huawei	Wind River	Huawei	Cisco	Google	Apple
Samsung	Apple	Qualcomm	Ericsson	Ericsson	VMware	Ericsson	HPE	Facebook	Google
Oppo	Huawei	Apple	Nokia	Nokia	Red Hat	Nokia	Huawei	Alibaba	Tencent
Xiaomi		Unisoc	ZTE	ZTE	Robin.io	ZTE	Ubiquiti	Amazon	Alibaba
Vivo		Samsung	Corning	Samsung		Samsung	H3C	Tencent	Amazon

Notebook PC*	Notebook PC OS	Computing and storage processors	Fixed access*	SP switching & routing	Optical networking	Subsea optoelectronics*
Apple	Microsoft	Intel	Huawei	Cisco	Huawei	Nokia-ASN
Lenovo	Apple	AMD	ZTE	Huawei	Ciena	Ciena
Dell	Google	Broadcom	Nokia	Nokia	Nokia	Infinera
HP		Apple	FiberHome	Juniper	ZTE	NEC
Asus		Infineon	Calix	ZTE	Infinera	SubCom

Data center servers*	IaaS	PaaS	Saas	CaaS
Dell	Amazon	Amazon	Microsoft	Amazon
HPE	Microsoft	Google	IBM	Microsoft
Lenovo	Google	Microsoft	Salesforce	IBM
Inspur	Alibaba	Salesforce	ADP	Google
Huawei	China Telecom	IBM	Adobe	Oracle

Source: Omdia

Technology market leadership is largely shared between US and Chinese companies

A glance at the national flags of the market leaders makes it obvious that the US and China enjoy something akin to a duopoly in technology ecosystems and have a high number of champions, while Europe and other regions only have a few.

When looking at the question of market leadership, it is nonetheless helpful to consider regional- or country-level specificities. Omdia observes that only in some categories does a single company dominate in each of the three largest regions (Europe, Middle East, and Africa [EMEA]; North America; and Asia & Oceania). It is not the case in RAN, mobile core, and small cells, where leadership also differs between regions.

This is only a comparison at the top of the pyramid. Behind those leaders, local ecosystems are often rich, with dozens—sometimes hundreds—of companies competing in each field and having more or less presence and commercial success from one region to the other.

Figure 2: Global and regional leadership in selected markets (based on 1H23 or FY2022 revenue)

	Global market leader	EMEA market leader	North America market leader	Asia and Oceania market leader
Smartphones	Apple	Apple	Apple	Apple
Smartphone OS	Google	Google	Apple	Google
Indoor small cells	Huawei	Nokia	Ericsson	Huawei
Mobile access (RAN)	Huawei	Nokia	Ericsson	Huawei
Mobile core	Huawei	Ericsson	Ericsson	Huawei
WLAN	Cisco	Cisco	Cisco	Cisco
Notebook PC	Apple	Apple	Apple	Lenovo
Notebook PC OS	Microsoft	Microsoft	Microsoft	Microsoft
Fixed access (fiber and copper)	Huawei	Huawei	Nokia	Huawei
SP Switching and routing	Cisco	Cisco	Cisco	Huawei
Optical networking	Huawei	Huawei	Ciena	Huawei
Datacenter servers	Dell	HPE	Dell	Inspur
IaaS	Amazon	Microsoft	Amazon	Alibaba
PaaS	Amazon	Amazon	Amazon	Google
Cloud-aaS	Amazon	Microsoft	Amazon	Microsoft
SaaS	Microsoft	Microsoft	Salesforce	IBM
Online advertising	Google	Google	Google	Google
Smartphone applications	Apple	Apple	Apple	Apple

Source: Omdia

Market concentration is common in technology markets

The HHI is commonly used to assess the level of concentration in a market or industry. It is calculated by squaring the market share of each company in the market then summing the resulting numbers.

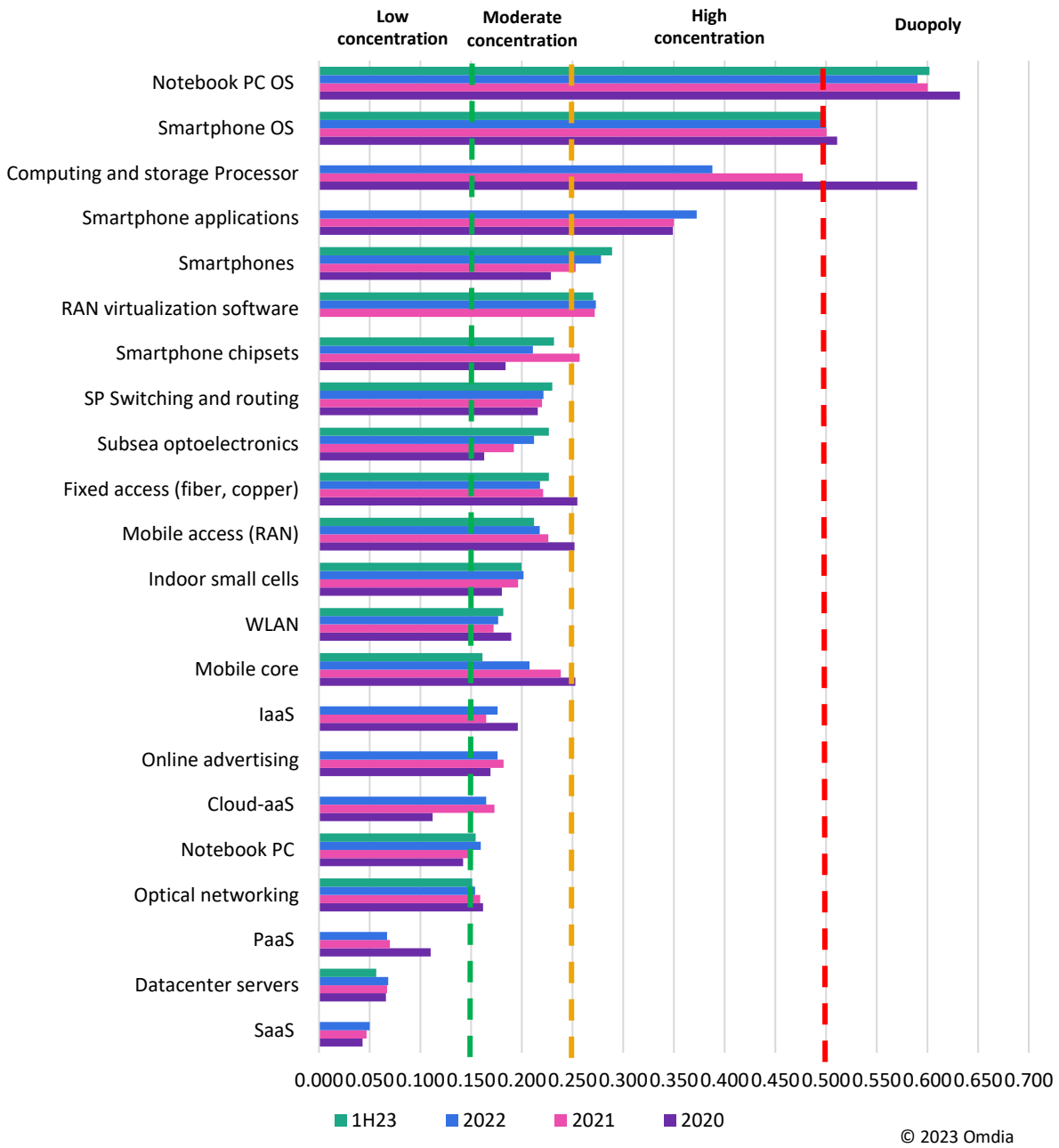
According to Omdia's HHI calculations (results shown in **Figure 3**), of the 22 technology markets studied, three were considered unconcentrated (HHI below 0.15), of which none among the mobile and fixed network categories. 13 were moderately concentrated (HHI between 0.15 and 0.25), four were highly concentrated (HHI between 0.25 and 0.50), and two were duopolies (HHI above 0.50).

Four out of the five categories with the highest level of concentration are consumer categories rather than B2B ones (notebook PC OS, smartphones, smartphone OS, and smartphone applications).

For the first half of 2023, mobile core and access networks were moderately concentrated, with HHIs of 0.161 and 0.212, respectively, which was lower than in 2022, when their HHIs were 0.208 and 0.218, respectively. This can be explained by the lower market share of the leading vendor in 1H23 compared to 2022 and, at the same time, the higher market shares of challengers. This is particularly true of the mobile core networks market where Omdia now includes private networks pure players in the market shares calculation.

It is also important to keep in mind that mobile RAN and mobile core have their own subsegments. Omdia has included indoor small cells in the comparison as an example of a subsegment of the RAN where concentration is lower. It means that challengers and smaller vendors can capture higher market shares in specific subsegments. Inversely, the HHI is relatively high for the RAN virtualization software category where four main companies capture most of the market. This example shows that while network disaggregation will lead to a higher number of players at system level, specific sub-systems or "layers" in the network may in the meantime see a relatively small number of highly specialized players and a relatively high level of concentration. In other words, it is worth considering not only the diversity of network equipment vendors but also the diversity of vendors in their own supply chain. It is also important to note that the disaggregated RAN is a nascent market, and the situation could change over time.

Figure 3: HHI by markets (based on 2020, 2021, 2022, and 1H23 revenue market shares)



Source: Omdia

In network equipment markets, operators have choice

The number of vendors active in the RAN, core and telecom cloud markets is not as small as many think. When looking at the ecosystem of vendors, Omdia identified at least 15 competitors in each category (**Figure 4**). Given that an operator typically selects between one and three vendors in each domain, this is a sufficient pool for the operators to choose from. And while not all vendors are present in all countries, no operator uses all the vendors present in the country where it operates.

Figure 4: Examples of current 5G RAN and core and telco cloud solution suppliers (list is not comprehensive)

RAN systems and RAN network functions	Core systems and core network functions	RAN and core virtualization and cloud infrastructure
Airspan	Alepo	AWS
Baicells	Casa Systems	Dell
Comba	Cisco	Google Cloud
CommScope	Ericsson	HPE
Corning	HPE	Fujitsu
Ericsson	Huawei	Kontron
Fujitsu	Mavenir	Microsoft
Huawei	Microsoft	Mitac
Nokia	NEC	Quanta
Mavenir	Nokia	Rakuten Symphony
NEC	Oracle	Red Hat
Parallel Wireless	QCT	SuperMicro
Rakuten Symphony	Samsung	VMware
Samsung	Tecore Networks	Wind River
ZTE	ZTE	Wiwynn

Procurement processes systematically involve a selection phase and the elimination of less competitive vendors. Market shares reflect the results of the selection process, not the number of vendors (diversity) that have participated. These decisions are usually based on solutions performance, reliability, price, security, power efficiency, and other criteria of that sort rather than on a mandated obligation of vendor diversity.

Assuming that the number of RAN vendors were to increase significantly, it is improbable that an operator would multiply the number of suppliers it uses in its network at a given time. As mentioned before, the right number of RAN vendors is generally between one and three, possibly up to four in the largest markets. Beyond that, multiplying vendors in a single network will be counterproductive, because it will not only increase operational complexity but also reduce the bargaining power of the operator in negotiations with vendors.

A multi-vendor approach has its pros—such as reducing dependence on a single supplier—but also its cons, including integration and interoperability issues that can lead to suboptimal performance and ultimately disadvantage the operator and end consumers. The right balance between diversity, efficiency, and the economic optimum must be found. In January 2021, the chief technology officer of British operator BT, Howard Watson, publicly commented, “It’s unlikely that all of us will start deploying equipment from four or five different vendors, because the operational challenge of the person in the van maintaining that tends to limit you to a choice of two.”

In the meantime, RAN vendors also need to achieve economies of scale to spread their costs and achieve the margins necessary to finance research and development that enable innovation. Economies of scale also lead to lower prices of equipment and should in theory contribute to lower prices of services for end-users.

We have seen that intradomain diversity (diversity of vendors within one network domain) has its limits and that beyond a certain point, it can have a negative impact on performance or costs. Interdomain vendor diversity (diversity of vendors across network domains) is another topic that we will not explore extensively here, but it is another aspect that integrated operators should take into consideration when seeking to reduce their dependence on their vendors. This may seem obvious, but selecting different vendors for mobile and fixed networks, for example, is one way to reduce this dependence and mitigate risks.

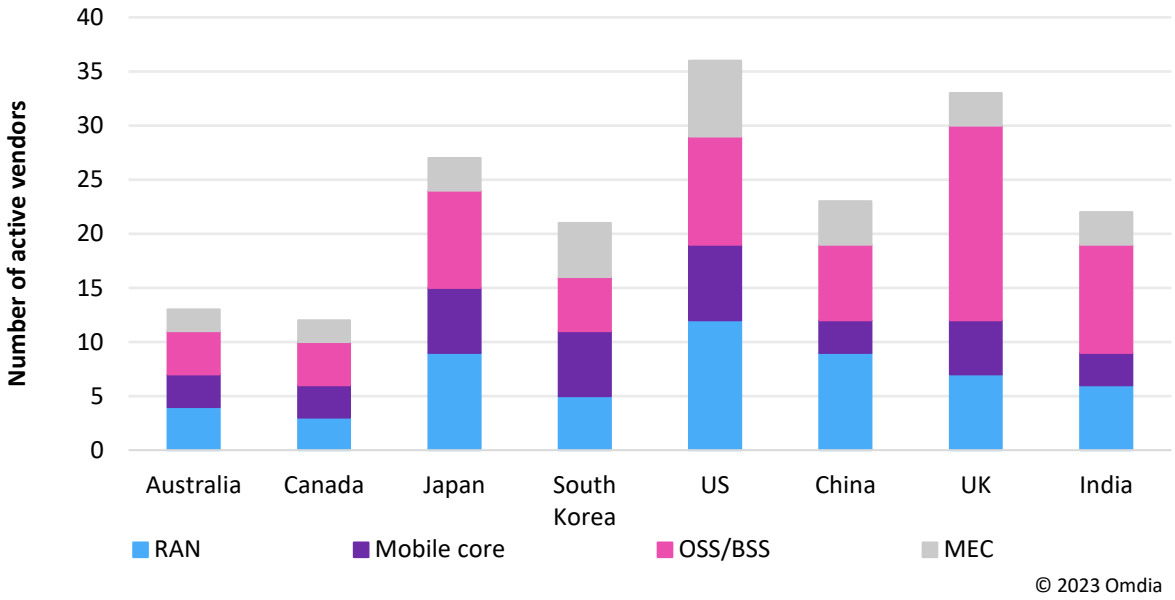
Market forces constantly drive changes in the vendor ecosystem

Omdia also tracks the vendors active across different network domains that are currently supporting live commercial networks in eight countries where network rollouts are in advanced stages: Australia, Canada, China, Japan, South Korea, the UK, the US, and India. Vendor data was gathered using Omdia’s sources, including the *Telecoms Vendor Contract Database*, which captures publicly available service provider contract information.

Several vendors provide products and solutions across several mobile network domains. Vendors that operate in multiple domains are counted for each domain where we have identified an active

partnership. Overall, as of September 2023, the US had 36 active vendor partnerships across the four mobile network domains; the UK had 33, Japan 27, China 23, India 22, South Korea 21, Australia 13, and Canada 12. The ecosystem of vendors remains largely the same as in 2022, but a few new active vendors were identified in the UK, India, and South Korea.

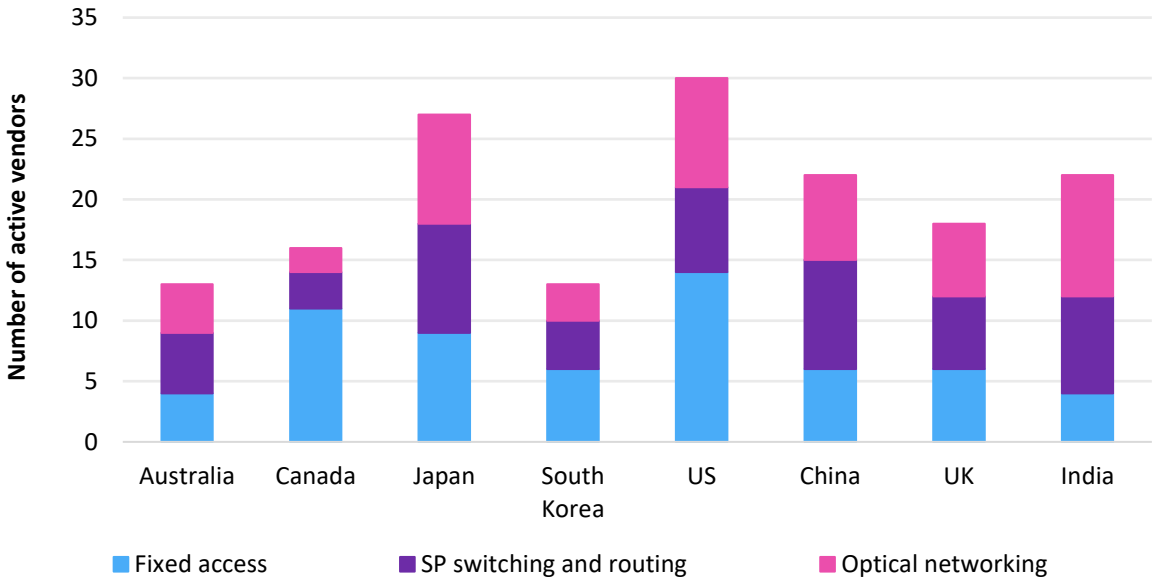
Figure 5: Active vendors in the mobile ecosystem, by domain and by country



Source: Omdia

Omdia conducted a similar assessment in the same countries for three fixed network domains: copper and fiber access, switching and routing, and optical networking. As in mobile domains, in fixed domains there were, unsurprisingly, more active vendors in the larger markets (the US, China, India, Japan and the UK) than in the smaller markets.

Figure 6: Active vendors in the fixed ecosystem, by domain and by country



Source: Omdia

It is interesting to draw a parallel between fixed access and mobile access. The fixed access equipment vendor landscape went through significant concentration via mergers and acquisitions over 10 years ago, but recently more vendors have entered the market because of new opportunities. With new technology developments, there have been, for example, several new entrants to the fixed access market (particularly the passive optical network subsegment) in recent years. As a result, there is a higher vendor diversity in this domain. The same trend is now happening in mobile and the number of active vendors for the eight countries in the mobile access domain (55) is relatively close to the number of active vendors in fixed access (60).

However, vendor diversity is not always correlated with a lower level of concentration. Optical networking, for example, does not have a particularly high number of active vendors, but the level of concentration is the lowest of all the network categories by a significant margin. This is because market shares are more evenly distributed between vendors. HHI is calculated at global level because of market share data availability, but vendor diversity should be evaluated at country level since situations will vary.

It is also worth noting that concentration in the RAN industry has come to a stop. Following a series of four major deals that led to increasing concentration during the 2006–15 period (Nokia-Siemens, Nokia-Motorola, Ericsson-Nortel, and Nokia–Alcatel-Lucent), there have been no significant new operations of concentration in this domain over the last seven years. On the other hand, Omdia is now observing new entrants in mobile access along with the development of open RAN and virtual RAN.

In summary, monopolies and duopolies should be avoided, and the level of concentration is an indicator that competition authorities should watch closely. Vendor diversity, however, varies significantly from market to market and from country to country. It tends to fluctuate over time in response to natural market forces, competition, business opportunities, and technological evolution.

As long as they don't lead to further market concentration, the choice of vendors, of technologies or of specific network deployment models and architectures should be left to be made by mobile and fixed network operators based on their respective technological and business merits.

Appendix

Category	Definition	Noncomprehensive list of companies
Smartphones	A mobile phone with an advanced mobile operating system, which combines features of a cell phone with other features useful for mobile or handheld use	Apple, Coolpad, Google, HTC, Huawei, Infinix, Itel, Lenovo, LG Electronics, Meizu, Micromax, Motorola, Nokia, Nubia, OnePlus, Oppo, realme, Samsung Electronics, Sony, TCL-Alcatel, Tecno, vivo, Xiaomi, ZTE
Smartphone OS	Smartphone operating system	Android, iOS, Harmony, Tizen
Smartphone chipsets	Smartphone application processor	Apple, Broadcom Limited, HiSilicon Technologies, MediaTek, Qualcomm, Samsung Electronics, Tsinghua Unigroup
Indoor small cells	Generic term for equipment that complements the macrocellular network and serves to enhance coverage and capacity and is deployed indoors. The radio unit can be integrated with the baseband function, or they can be separated. Antennas may be built in or external. Such equipment can be deployed in a standalone manner or be part of a distributed system	Airspan, Baicells, Comba, CommScope, Corning, Ericsson, Huawei, Nokia, Samsung Electronics, ZTE
Mobile access (RAN)	Radio access network hardware and software for 2G, 3G, LTE, and 5G NR	Airspan, Casa Systems, CICT, CommScope, Corning, Dell, Ericsson, Fujitsu, HPE, Huawei, Nokia, Mavenir, NEC, Parallel Wireless, Rakuten Symphony, Red Hat, Samsung Electronics, VMware, Wind River, ZTE
Mobile access processors	Equipment providing network connectivity for mobile technologies, including macrocells, small cells, and Wi-Fi access points	Advanced Micro Devices (AMD), Analog Devices, Broadcom Limited, Cisco, Espressif, HiSilicon Technologies, IBM, Intel, M/A-COM Technology Solutions, Marvell Technology Group, Melfas, Microchip Technology, Nokia, Nuvoton Technology, NXP, ON Semiconductor, Realtek Semiconductor, Texas Instruments
Mobile core	Evolved Packet Core (EPC) and 5G next-generation core	Affirmed, Casa, Cisco, Ericsson, HPE, Huawei, Mavenir, Microsoft (Metaswitch), NEC, Nokia, Oracle, Samsung Electronics, ZTE
RAN virtualization software	Cloud infrastructure software for the virtualization or containerization of radio access network functions	Red Hat, Robin.io, VMware, Wind River

WLAN	Access points (enterprise-class or carrier-class wireless networking devices based on the 802.11 standard, typically configured for Wi-Fi client access but can also be configured to backhaul traffic wirelessly between two nodes) and controllers (appliances, software, and/or services that provide centralized control of Wi-Fi networks, including configuration and management of access points; management of wireless traffic, clients, and RF environment; network access; security; and roaming)	Alcatel-Lucent Enterprise, Cambium, Cisco, CommScope (Ruckus), D-Link, Extreme, Fortinet, H3C, HPE (Aruba), Huawei, Lancom, Mist, NETGEAR, Ubiquiti
Notebook PC	Traditional clamshell notebook PCs and convertible notebook PCs where the display and keyboard cannot be physically separated but the display can be flipped, rotated, swiveled, or slid, allowing the unit to convert from laptop to tablet for touch input	Lenovo, HP, Apple, Dell, Asus, Acer, Huawei, Microsoft, Samsung Electronics, Fujitsu, MSI, NEC, Toshiba, LG Electronics, Panasonic, Xiaomi, Haier, Positivo, RCA
Notebook PC OS	Notebook PC operating systems	Microsoft, Apple, Google
Computing and data storage processors	The term "processor" is a useful generic description to aggregate or collectively describe the many classifications of integrated circuits designed to act upon incoming data or signals, utilizing logical and arithmetic instructions (primarily in the form one or more layers of software), to provide a desired data or signal output. The output can be a control function, a mathematical resultant, a conditioned signal, an input to another process, a coded sequence, or similar system function.	AMD, Apple, Broadcom Limited, Infineon, Intel, NXP, STMicroelectronics, Marvell, MediaTek, Microchip Technology
Fixed access (fiber and copper)	OLT, ONT/ONU, P2P, DSL	Adtran, Calix, Casa Systems, CommScope, Corning, DZS, FiberHome, Fujitsu, Huawei, Iskratel, Mitsubishi, NEC, Nokia, Ribbon, Sagemcom, Sercomm, Sumitomo, Technicolor, Tejas Networks, Ubiquoss, ZTE, ZyXel
Fixed access processors	Processors for broadband access, also called “last-mile” equipment, which provide the final link between the telecommunications backbone network to customer premises; excludes the customer premises equipment such as modems and cable boxes; includes gateway-type devices categorized here depending on whether they are connections on the service provider network or customer premises side	AMD, Broadcom Limited, Cisco, GLOBALFOUNDRIES, HiSilicon Technologies, IBM, Inphi, Intel, Juniper, Marvell Technology Group, MaxLinear, Microchip Technology, Netronome, NXP, Realtek Semiconductor, Renesas Electronics Corporation, Texas Instruments, Xilinx
Service provider (SP) switching and routing	IP edge routers, IP core routers, carrier Ethernet switches.	Alaxala, Apresia, Brocade (Broadcom), Ciena, Cisco, Ericsson, FiberHome, Fujitsu, Huawei, Infinera, Juniper, NEC, Nokia, ZTE
Optical networking	Aggregation (TDM, CPO-A, and bandwidth management), wavelength-division multiplexing (WDM) (access WDM, metro WDM, backbone WDM, SLTE WDM), amplifiers/wet plant	Adva, Ciena, Cisco, FiberHome, Ekinops, Fujitsu, Huawei, Infinera, NEC, Nokia, Padtec, Ribbon, SubCom, Tejas, ZTE
Subsea optoelectronics	Optical networking equipment for submarine line terminal equipment including transponders and SLTE commons (terrestrial ROADMS, Mux/DeMux filters, Pre/Post amplifiers, and software) but excluding cable, installation, maintenance, or other associated costs.	Ciena, Cisco, Fujitsu, Infinera, NEC, Nokia (ASN), SubCom, HMN Tech
Infrastructure as a service (IaaS)	Includes servers, network, storage, database, network (Layer 4) applications, and management; does not include CaaS.	Alibaba, Amazon, Baidu, BT, China Telecom, China Unicom, Deutsche Telekom, Google, IBM, Jingdong (JD), Microsoft, NTT, Oracle, Orange, SAP, Tata Communications, Telefónica, Tencent

Cloud as a service (CaaS)	Provides an application execution environment; includes servers, network, storage, management, and DC orchestration software (cloud OS); purchased as a bundle and priced based on usage	Alibaba, Amazon, Baidu, Google, IBM, Microsoft, NTT, Oracle, SAP, Tata Communications, Telefónica, Tencent
Platform as a service (PaaS)	Provides an application development and execution environment; includes application run-time and middleware (web servers, database management systems), servers, network, storage, management, and DC orchestration software (cloud OS); purchased as a bundle and priced based on usage	Alibaba, Amazon, Baidu, Deutsche Telekom, Google, IBM, Microsoft, NTT, Oracle, Salesforce, SAP, Tencent
Software as a service (SaaS)	Provides a complete application with a pay-per-use pricing model; includes applications such as customer relationship management (CRM), enterprise resource planning (ERP), collaboration, security, management, virtual desktop, and business analytics	Amazon, BT, Cisco, Citrix, Deutsche Telekom, Google, IBM, Microsoft, NTT, Oracle, Orange, Salesforce, SAP, Tata Communications, Telefónica, Tencent, Workday
Data center servers	A networked physical device that provides shared general-purpose compute functionality; typically contains a centralized processing unit (CPU), random access memory (RAM), storage, physical network interface, power supply, and management; does not have more than seven large form factor (LFF) 3.5" HDD/SSD slots or 14 small form factor (SFF) 2.5" HDD/SSD slots per 1.75" (1U) of server enclosure height (i.e., no more than 14 LFF HDDs in a 2U rack server)	Cisco, Dell EMC, H3C, HPE, Huawei, IBM, Inspur, Lenovo, Supermicro, white-box vendors
Online advertising	Includes revenue derived from display ads placed on websites and inside apps and sponsored search results appearing in online search pages (e.g., Google and Apple Search Ads). Revenue numbers comprise the full value of what advertisers pay to place these ads, not just the cut taken by advertising platforms. Not included is what advertisers pay for the creation of ad campaigns.	Alibaba, Amazon, Apple, Facebook (Meta), Google (Alphabet), Tencent
Smartphone and tablet applications	Revenue from mobile app stores (e.g., Apple App Store and Google Play), via which smartphone and tablet users download applications to their devices. The revenue numbers correspond to the full retail value of what consumers pay, via app-store billing, to download premium apps and make in-app purchases.	Alibaba, Amazon, Apple, Facebook (Meta), Google (Alphabet), Tencent

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