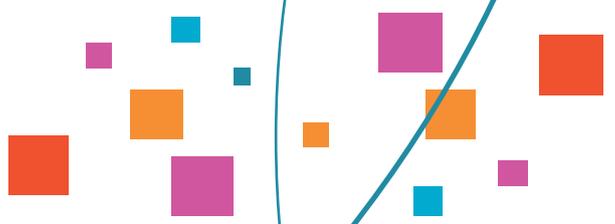




Device Technology
TRENDS
REPORT 2025



An analysis of GCF device certifications in 2024

By combining conformance and interoperability tests undertaken in laboratories with field trials on multiple commercial networks, the Global Certification Forum (GCF) certification verifies the quality of the interoperability of wireless devices, including mobile phones and IoT devices with different network elements, vendors' infrastructure, and services – such as VoLTE, VoNR, MC-PTT, and Remote SIM provisioning for eSIM.

Each year, GCF certifies hundreds of different products, most of them devices. This report is an analysis of GCF's certification listings from 2024 to provide insight into current trends in the wireless cellular device market, as well as some thoughts on likely trends in 2025.



Executive SUMMARY

Over **170 device manufacturers, across 27 countries**, participated in GCF during 2024. The GCF suite of certification solutions is **recognised by network operators and service providers** with interests in markets all **around the world**.

This review of device technology trends is based on an analysis of device certifications published by GCF in 2024. Our analysis provides insights into the **mobile technologies and functionalities** being requested by operators and end-users **across markets worldwide**.

In 2024, **GCF certified a total of 574 devices, from 90 manufacturers**. The following outlines some key findings:

5G

- 273 devices included 5G (48% of all 2024 certified devices, up from 38% in 2023). These 5G devices came from 55 vendors, down from 59 in 2023.
- Now in its sixth year, the integration of 5G into devices has continued to grow, and the speed of adoption has increased.
- Compared with LTE, the speed of 5G adoption, considering all types of GCF certified devices, seems to be lower at the same stage, as many use cases are being delivered perfectly over LTE or IoT LPWA connectivities, and therefore do not require 5G.
- In the past, the number of devices supporting 5G standalone (SA) was relatively low – 34% of 5G devices in 2020. This grew to 65% in 2021, 91% in 2022, and 96% in 2023. In 2024, **96.4% of 5G devices certified in 2024 supported SA** (5G NR SA Option 2).
- Looking specifically at smartphones, in 2020, many smartphone models came in two variants (LTE and 5G), which were certified separately. However, in 2021, we started to see manufacturers just releasing a unique variant, supporting both 5G and 4G, for their new smartphones, which contributed to a significant reduction in the number of total certifications from 2020 to 2023. This trend to a single variant has continued in 2024, as the lower cost of 5G SoCs meant it was cost-effective to include 5G functionality in all handset models in most cases.

Device types

- Smartphone certifications increased by 12.5% to 207 in 2024 (up from 184 in 2023 but still down from 260 in 2022), in line with the evolution of the global smartphone market (up 6% YoY).
- The **number of certifying smartphone vendors reached a record number of 32**, and the number of models per vendor reached 6.2, up from 5.4 in 2023 (but still below figures from previous years).
- Module certifications increased to 209, up from 193 in 2023. **Modules retained their narrow lead over smartphones as the category with most certified devices.**

LTE

- In 2024, as in 2023, **LTE was the most used wireless communications standard** in devices certified by GCF.
- LTE is a stable, mature technology, and 88% of all devices (504) supported it in 2024.
- 80.9% of all devices supported FDD-LTE. 60.8% supported TDD-LTE, slightly up from 60.5% in 2023, and 59.5% in 2022.
- An additional 45 devices incorporated the cellular IoT variant, LTE Cat M.

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IMS

- Voice over LTE (VoLTE) was certified in 365 devices, which represent 66.5% of all LTE devices and more than **99% of all LTE-capable smartphones**.
- Voice over NR (VoNR) had a significant growth, reaching 151 devices (up from 77 in 2023), representing more than 26% of all certified devices (22.40% in 2023) and more than 55% of all 5G devices (57% in 2023). This represents **almost 75% of all 5G smartphones** (similar to 2023, well above 14.6% in 2022).

Cellular IoT

- 2024 saw a slight increase in the total number of devices incorporating a cellular LPWA (low-power wide area) IoT standard.
- As in 2023 and 2022, two standards dominated these certifications, NB-IoT and LTE Cat M (FDD). These were incorporated in 59 and 45 devices respectively.
- LTE Cat M (TDD) and EC-GSM were not included in any devices in 2024.

Non-terrestrial networks (NTN)

- 2024 saw one device certifying NTN NB-IoT (GSO, ready to connect with Geostationary satellites), following activation of the certification program in July.

Mission critical services (MCS)

- Certification of the first Mission Critical Service, MC-PTT (Push to talk), started also in 2024, with **one client platform already certified** during the year.

Remote SIM Provisioning (RSP) for eSIM

- This was the sixth full year that the certification of Remote SIM Provisioning (RSP) for consumer devices has been possible as part of a device certification or as a standalone certification.

- For the first time, **more than half of the certified smartphones (51.7%) certified RSP for consumer eSIM**, up from 34.8% in 2023 and less than 15% in 2022.
- In total, 142 devices were certified supporting RSP for consumer eSIM. This compares with 97 devices in 2023, 66 in 2022, and 38 in 2021.
- Additionally, 54 devices certified compliance of RSP for eSIM exclusively, most of them being connected PCs / laptops. This is down from 73 in 2023 and 68 in 2022.

Complexity / multi-mode devices

- 88.7% of all devices certified in 2024 incorporated more than one radio bearer technology, similar to 88.8% in 2023.
- The number of **devices supporting four or more radio bearers grew to 32.4%**, up from 26% in 2023.
- 69% of devices incorporated three or more RAN technologies, up slightly from 66% in 2023 but down on 73% in 2022, reflecting the continuing sunset of 2G and 3G.
- The number of LTE frequency bands supported on average by devices remained stable at 12.6 (up from 10.9 in 2020). The maximum number of supported LTE bands by a single device was 29 (same as in 2023 or 2022).
- However, the **number of supported 5G bands grew significantly**, up to 7.2 bands in average per product (up from 5.4 in 2023) and with a maximum of 32 5G bands supported by a single product (up from 29 in 2023).
- Legacy technologies, **3G and GSM, continue to decline** in certification numbers, as operators sunset these services and re-farm the frequency bands. GSM is proving more resilient than 3G, as it is retained as a backup technology for voice, emergency and M2M services. This aligns with the trend of more operators launching 5G services and more frequency bands (new or re-farmed from previous generations) being used for these services.

The **Global Certification Forum (GCF)** is the globally recognised **quality mark** for the **interoperability of mobile phones and other devices** that incorporate mobile connectivity. With **over 350 members**, GCF has helped shape the mobile communications industry since 1999.

Download a digital copy of this report at:

<https://www.globalcertificationforum.org/news/downloads.html>

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1. General device trends

1.1. Year on year growth in manufacturers

2024 saw 90 device manufacturers undergoing certification of at least one device with GCF. This is down slightly, versus the record number of 99 in 2023, driven mainly by a decline in certification from IoT manufacturers. The number of smartphone manufacturers is up slightly at 32, compared to 29 in 2023.

The number of devices certified (574) was nearly 7% higher than in 2023, where 536 devices were certified. This compares with the record number of devices (727) in 2020.

There were 207 smartphones certified in 2024, up from 184 in 2023 (a rise of 11%).

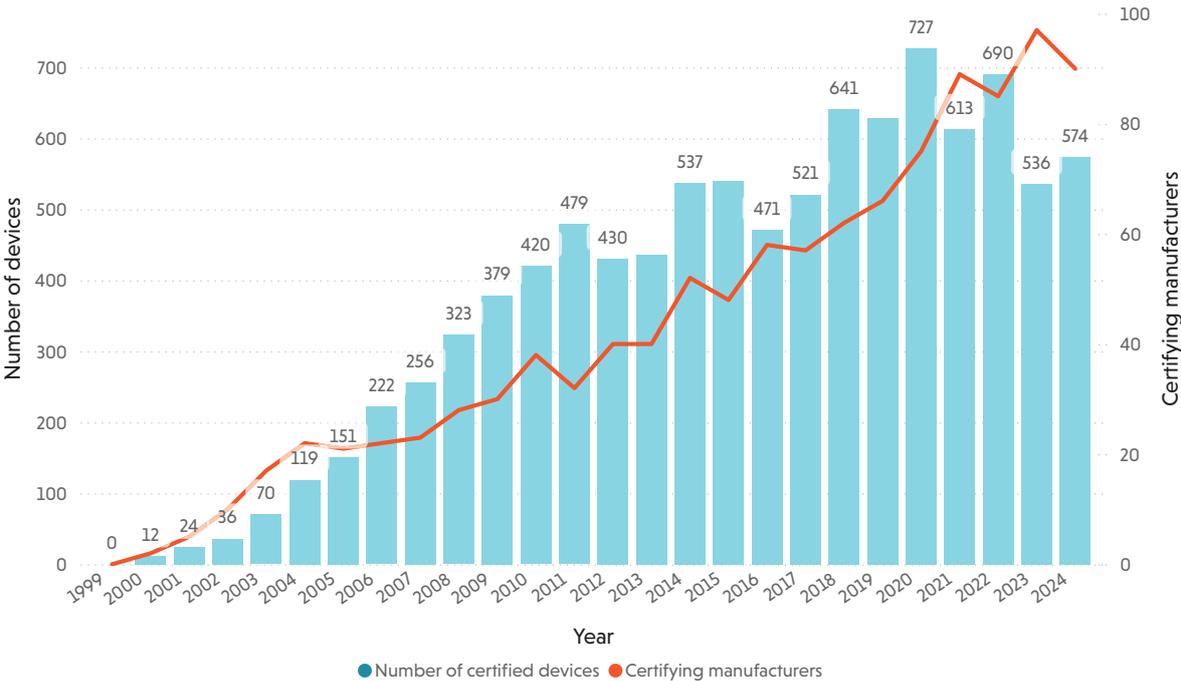


Fig 1: GCF certified devices & certifying manufacturers 2000-2024

The number of devices being certified per manufacturer has gone up to 6.4 in 2024, up from 5.4 in 2023, although this is still lower than the years between 2012 and 2020, when this figure varied between 8.1 and 11.3 devices per manufacturer.

For the numbers of smartphones the decline had been steeper – from 12.3 smartphones per manufacturer in 2020 to 6.3 in 2023 – but this number has increased slightly to 6.5 in 2024.

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GCF works with device manufacturers of all sizes, and five manufacturers certified 26 devices or more. Conversely, 59 manufacturers certified three devices or fewer. And of the 90 manufacturers certifying devices in 2024, 11 were new members.

Comparing annual certifications against global device sales suggests there is a relationship between the choice of devices in the global market and overall market size. We have also tracked certifications against sales for the dominant class of device, smartphones, which shows a similar relationship (see Figure 2). All the world's top-10 smartphone manufacturers are members of GCF and adhere to its principles.

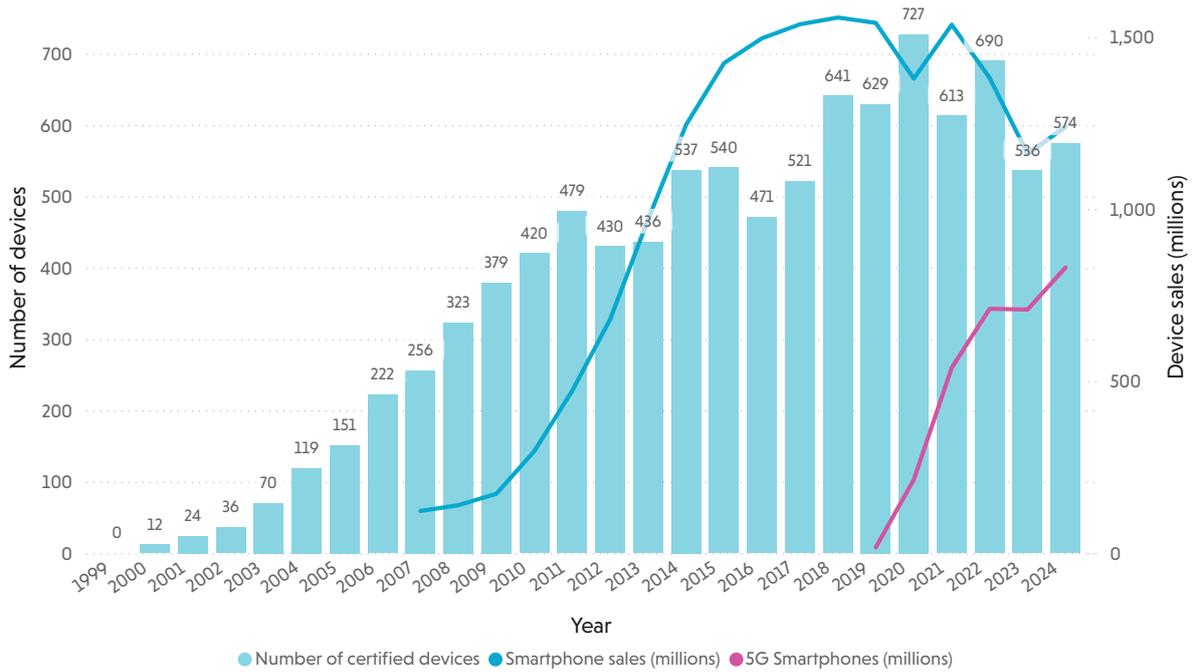


Fig 2: Global device sales and device certifications 2000-2024

Sources for 2024 data: Counterpoint research: <https://www.counterpointresearch.com/insight/post-insight-research-notes-blogs-smartphone-market-recovers-in-2024-after-two-years-of-decline> and IDC: <https://www.idc.com/getdoc.jsp?containerId=prUS53072325>

1.2. Certified devices by type

This year, modules were still slightly ahead of smartphones as the largest class of devices certified. In 2024, smartphones made up 36.1% of the devices certified, up three percentage points from 2023.

The proportion of modules certified stayed about the same in 2024, at 36.4%, compared to 35.6% in 2023.

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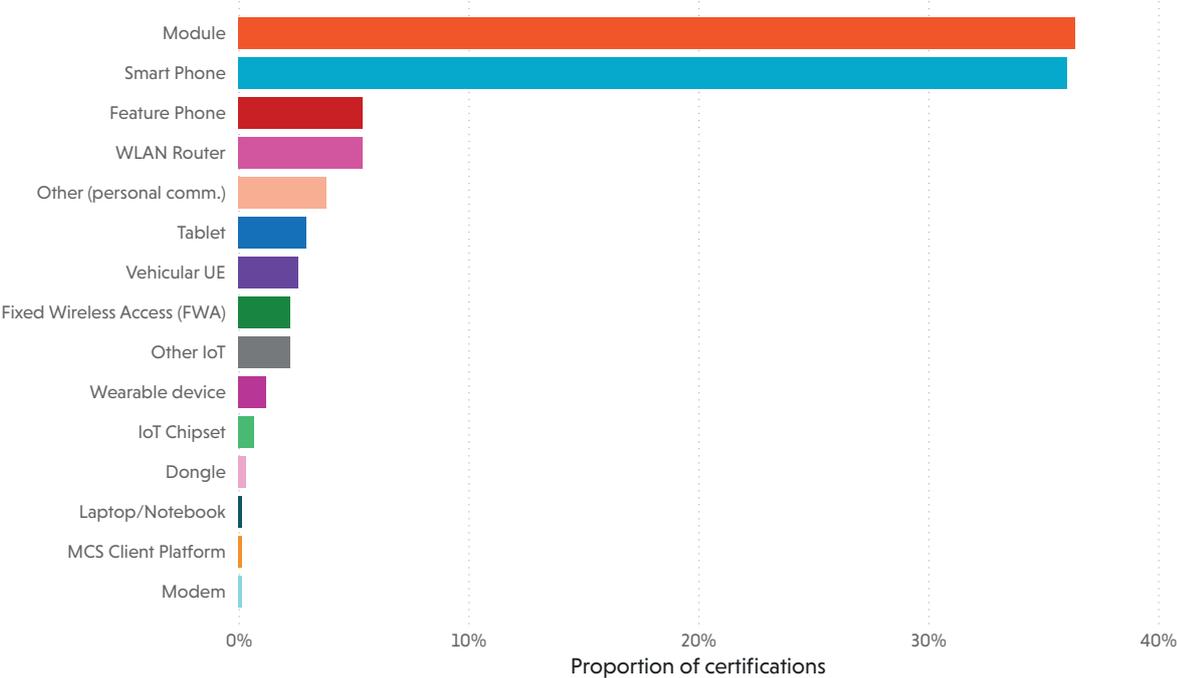


Fig 3: 2024 certified devices by type

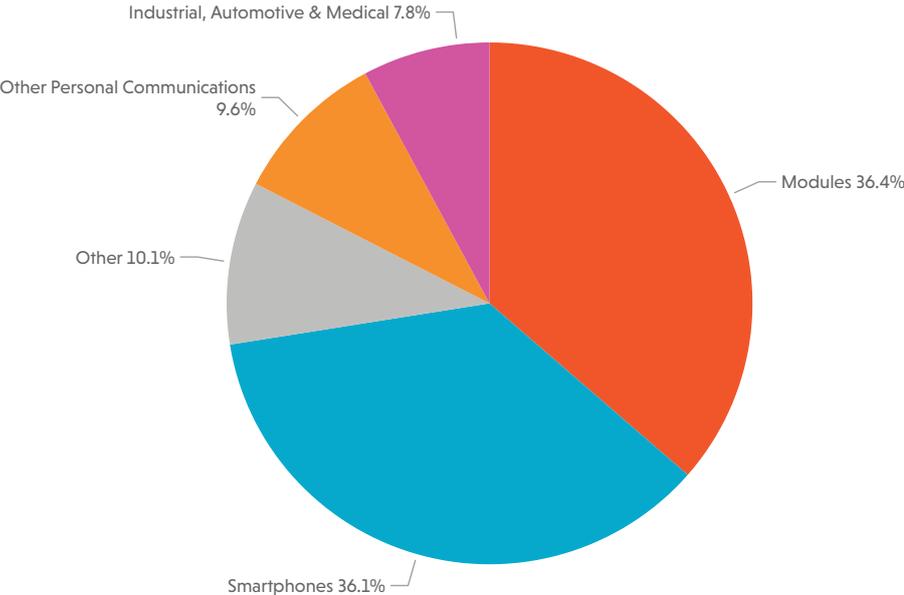


Fig 4: 2024 certified devices by parent category



As well as looking at the certified devices by type, we can see how the primary function of each device has changed over the years 2020–2024 – see Figure 5.

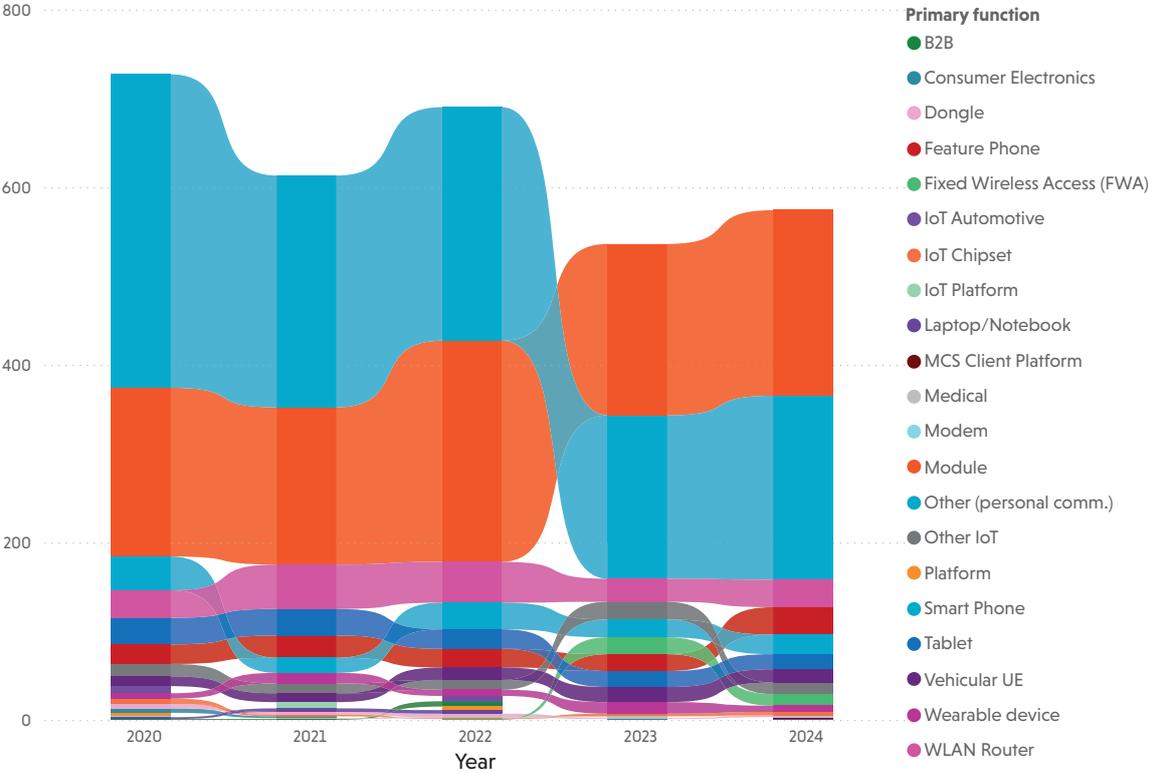


Fig 5: Certified devices by primary function, 2020–2024

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Of the 574 total devices certified, there were 207 smartphones. This is an increase compared to 167 in 2023, following a significant rise (over 6%) in global smartphone shipments. but still lower than the 260 smartphones certified in 2022 (and 340 in 2020). As previously mentioned, this is at least partly due to the continued trend of more devices being 5G-only, rather than having separate 4G and 5G versions that would be counted twice. In addition, model variants support, on average, a higher number of frequency bands, and are therefore suitable for more markets.

Around 15% of certifications were feature phones, tablets, laptops, mobile gateways/ portable hotspots, USB modems, wearables and other non-smartphone communication devices, up slightly from 14% in 2023.

This includes:

- Tablets with cellular connectivity, where the proportion of certifications fell slightly from 3.4% in 2023 to 3.0% in 2024 (and the actual number of devices certified fell from 18 to 17).
- Feature phones, where the proportion of certifications rose slightly from 3.8% in 2022 to 5.4% in 2024 (and the actual number of devices certified rose significantly, from 19 to 31). Most of them support LTE, and many no longer support 2G nor 3G technologies.

The number of devices that were not smartphones increased to 367 in 2024, although the percentage of devices that were non-smartphones was slightly down (three percentage points) in 2023 at 64%.

1.3. Certified devices by mobile technology used

As in 2023, LTE is still the most commonly integrated standard – see section 3. While 3G and GSM are still supported by many certified devices, they are usually present in addition to other technologies, and there are very few devices where 3G or GSM are the only RAN supported (none for 3G, and 4 for GSM), typically targeting low-cost devices with very limited capabilities.

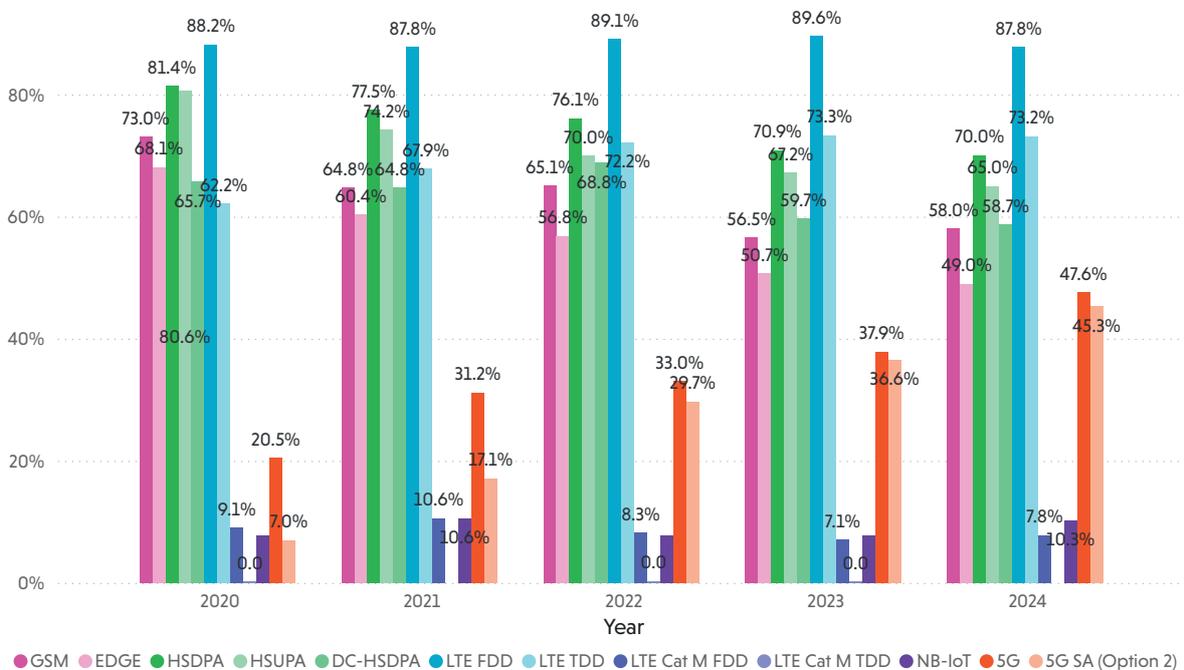


Fig 6: Proportion of certified devices incorporating each mobile technology 2020-2024

2. 5G

2.1. The rate of 5G incorporation

5G incorporation has continued to increase, with the technology included in 48% of devices certified, versus 38% in 2023, 33% in 2022, and just 2.5% in 2019.

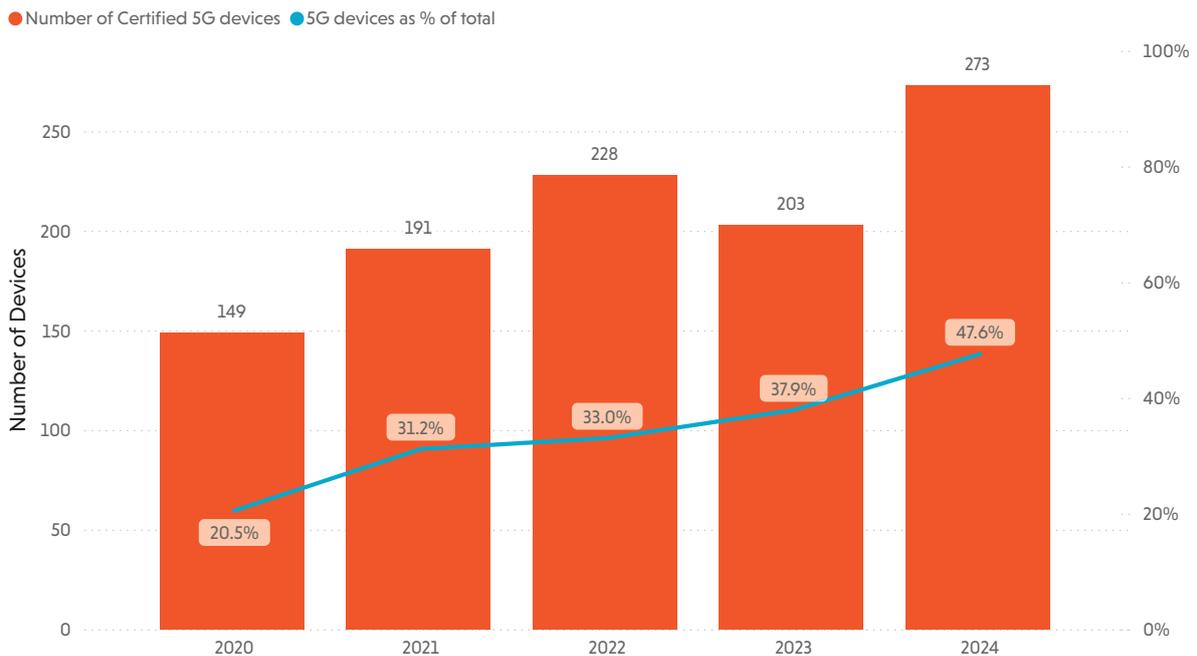


Fig 7: Evolution of 5G adoption, 2020-2024

In the early stages of 5G deployment, there was a high proportion of devices classed as NSA (Non-Standalone), while more recently there has been a shift with many more devices supporting 5G Standalone (SA) – now comprising 95% (260) of 5G devices certified, about the same as in 2023 (96%). This reflects the rollout of more 5G SA networks by mobile operators.

There were 14 5G devices certified in 2024 which enabled access to FR2 5G frequencies, also referred to as high, FR2, or mmWave bands.

GCF offers certification for standalone 5G as well as dual connectivity between 5G and LTE and the many inter-band configurations related to these.

In 2024, GCF certified 151 devices that support VoNR. Of these 150 devices, 104 were smartphones.

2.2. How this compares with LTE

This is the 6th year in which 5G services have been available to the public. In comparison, LTE was launched at the end of 2009, with the first LTE device certifications completed by GCF in Q1 2011, and the technology becoming a dominant standard in 2017.

GCF announced its first 5G certification in Q2 2019, with 16 devices certified through the year (2.5% of all certifications). In 2020, we saw a big jump to 20.8% of certified devices supporting 5G, thus outpacing the rise of LTE.



While the adoption of 5G is still fast, it is lagging behind LTE's progress if we consider the total number of certified devices. While most smartphones support 5G nowadays, the demand is still not that high for wireless modules, with many use cases not requiring high bandwidths and being delivered over LTE or LPWA cellular standards.

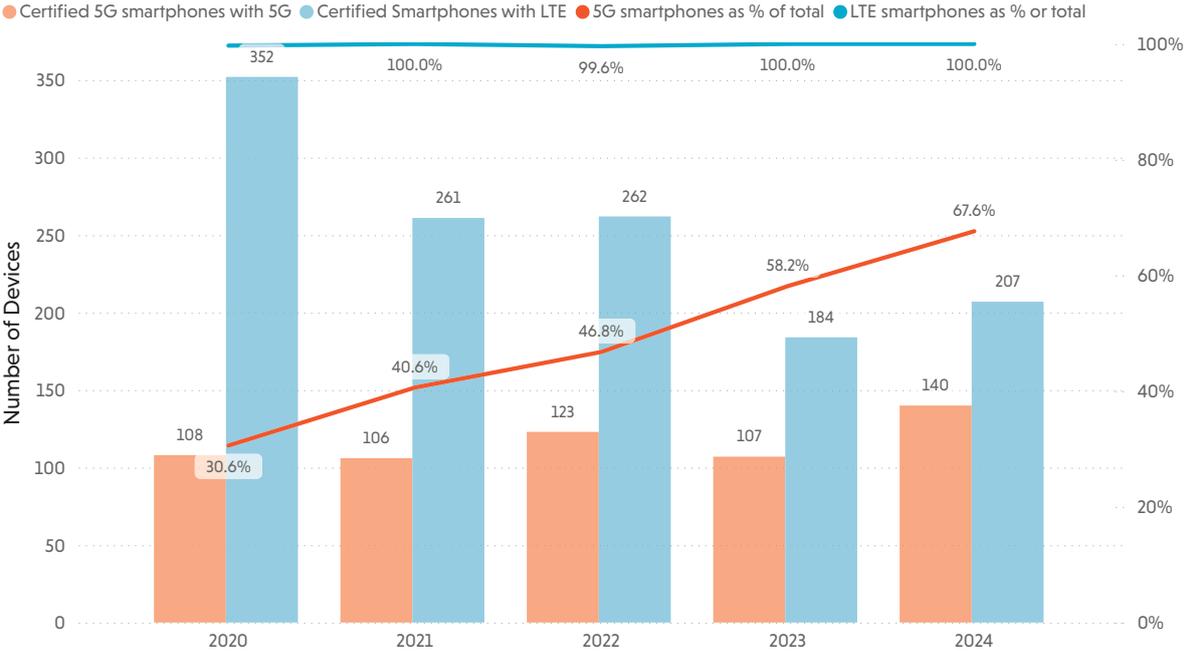


Fig 8: 5G adoption in smartphones 2020-2024

2.3. Number of 5G device manufacturers

In 2024, 49 device manufacturers certified 5G devices with GCF, and 37 submitted at least two. This is a decrease overall compared to 2023, when 59 device manufacturers developed and certified 5G devices with GCF, and 35 of these companies submitted at least two.

However, in 2024, eighteen manufacturers certified five or more devices, up from twelve manufacturers who certified five or more 5G devices in 2023.

2.4. 5G devices by type

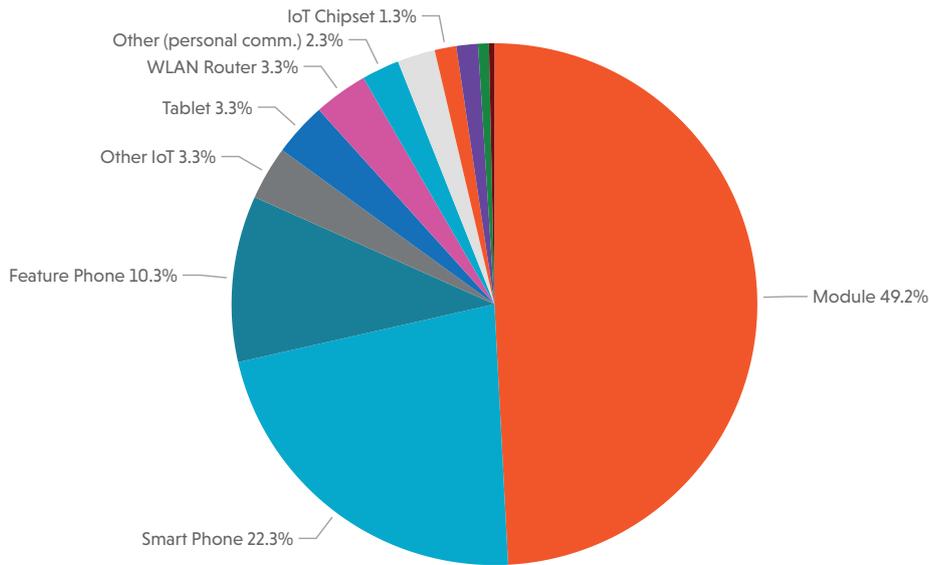


Fig 9: 5G certified devices by type

In 2024, the largest number of 5G certifications was for smartphones (136 of 243 certified 5G devices, 56%), while modules (46 devices, 19%) represented the second largest group.

This is a continuation of a trend over the last few years, where smartphones have accounted for the majority of 5G certifications, but there is an increasing number of modules, WLAN routers, and other devices with 5G capabilities. For reference, if we look back at 2020, most (84%) of 5G certifications in that year were for smartphones, and modules accounted for just 13%.

2.5. 5G NR bands

Incorporating multiple bands expands the potential market for a given device. With certification actively underway for 18 of the NR standalone bands defined by 3GPP, and another 14 5G bands used in 5G NSA combinations, GCF is being used to certify devices destined for use in all the leading mobile markets worldwide.

The GCF programme enables the certification of devices designed to operate in both FR1 and FR2 (also referred to as low and high bands), for both 5G NR (standalone) and 5G NSA (non-standalone) usage.

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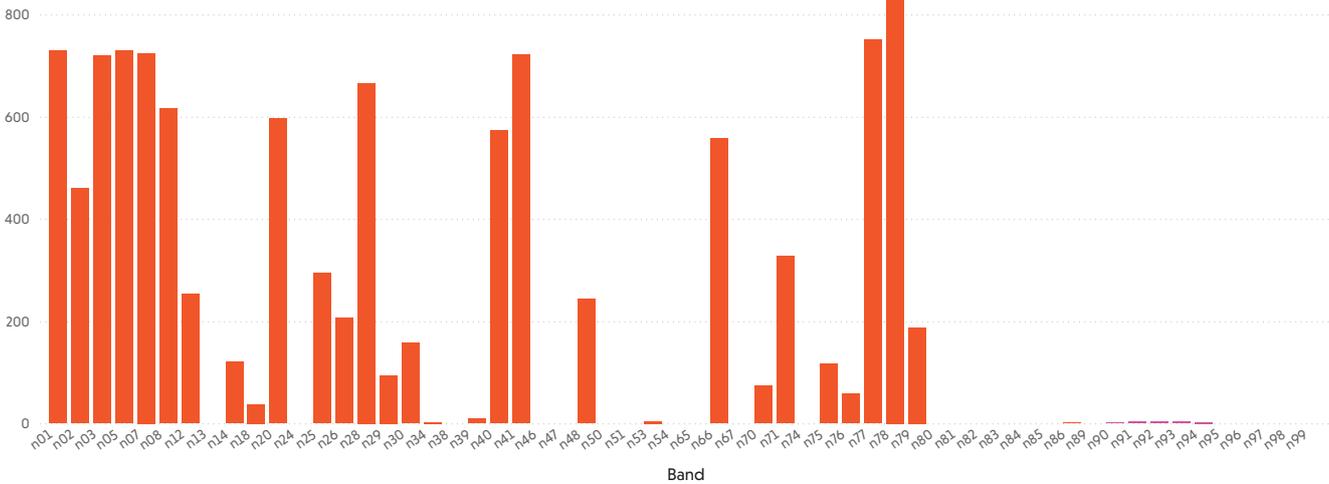


Fig 10: Number of 5G devices incorporating each band (FR1)

FR1 bands of particular note include:

- n78 (3500 MHz), which was in 255 certified devices (93% of the 273 5G devices), was the most commonly incorporated band.
- n1 (2100 MHz) and n5 (850 MHz) were the joint-second most commonly incorporated band in certified devices, both featuring in 224 certified devices (82% of 5G devices).
- n77 (3700 MHz) was the next most commonly incorporated band in certified devices, featuring in 222 certified devices (81% of 5G devices).
- There is strong support for bands n1, n3, n5, n7, n41, n77 and n78, which are supported in almost every 5G device.

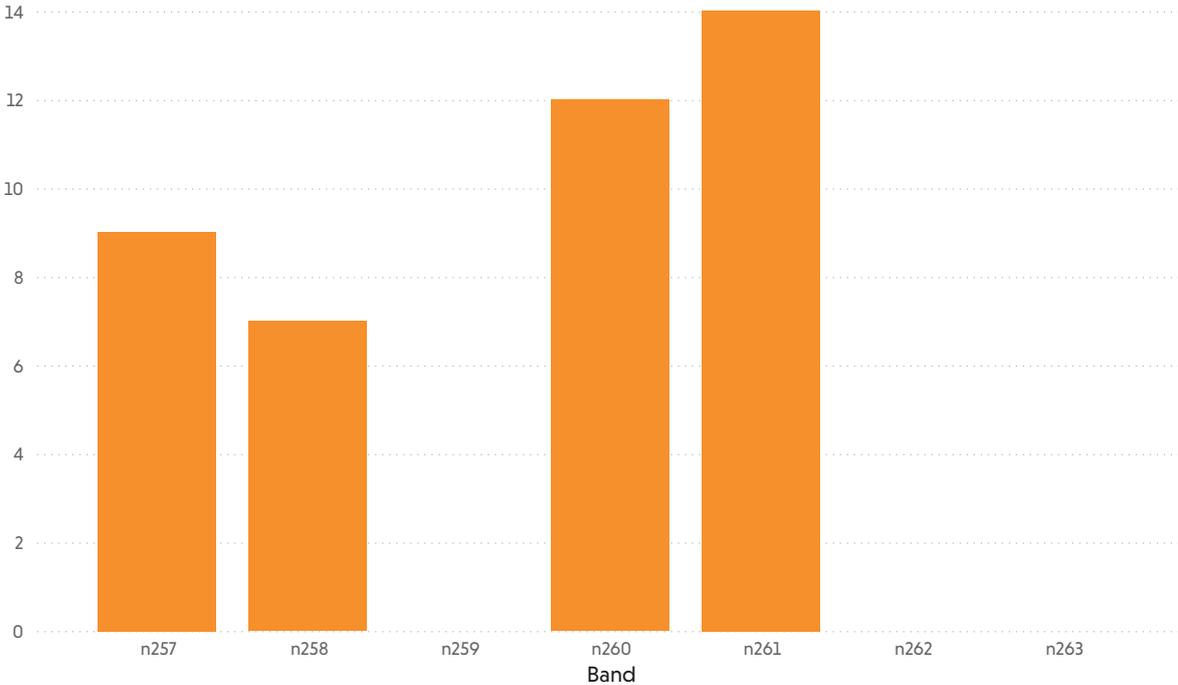


Fig 11: Number of 5G devices incorporating each band (FR2)

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In the FR2 spectrum, band n261 (28 GHz) was incorporated in all 14 FR2 certified devices, and band n260 (39 GHz) was incorporated in 12. The number of markets and networks supporting FR2 (mmWave) is not growing significantly, which is leading to a slow adoption of FR2-capable devices, with only four manufacturers certifying FR2 devices in 2024.

Since 2022, GCF has started tracking 5G NR bands supported (not included in the certification) and certified. In 2024:

- 24 FR1 bands were supported in the certifications, with an additional 4 FR1 bands supported by devices but not included in the certifications.
- 4 FR2 bands were supported and certified.

2.6. 5G device complexity

All 273 certified 5G devices supported E-UTRA-NR dual connectivity (Non-Standalone NSA EN-DC) with 4 devices supporting 5G Standalone (SA 5G NR only).

Looking at 5G SA devices that were certified, we can see that the median number of 5G bands per 5G SA device was 16, up from 14 in 2023, with 146 devices supporting 12 or more 5G bands, up from 139 devices in 2023.

Fourteen devices were able to use the FR2 frequency bands.

The average complexity of FR2 capable devices increased slightly, with these 14 devices allowing the use of 18 5G bands on average, up from 16 in 2023 and 11 in 2022 and less than 5 in 2021.

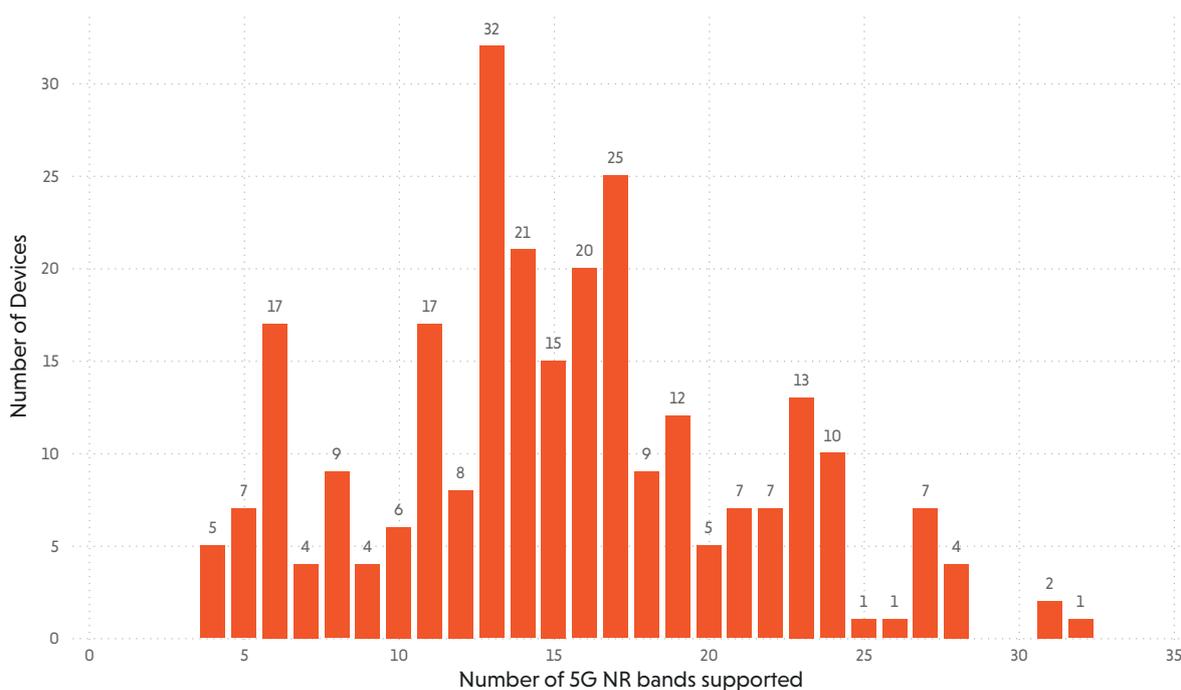


Fig 12: Multiband deployments of 5G NR (5G SA devices)

In 2024, GCF certified for the first time devices supporting 5G DL Carrier aggregation (28 devices - 20 of them smartphones) and 5G UL Carrier aggregation (11 devices - 5 of them smartphones).

3. LTE

3.1. LTE penetration decreased

The penetration of LTE in certified devices decreased slightly in 2024, with the standard being integrated into around 88% of all certified devices, down from nearly 90% in 2023 – with LTE penetration having been consistently above 87% every year since 2020. In 2024, LTE retained its position as the most integrated wireless communication standard.

LTE has been accepted worldwide, and LTE roaming is nowadays effectively ubiquitous. LTE penetration might remain at this kind of level for many, many years and co-exist with 5G standalone.

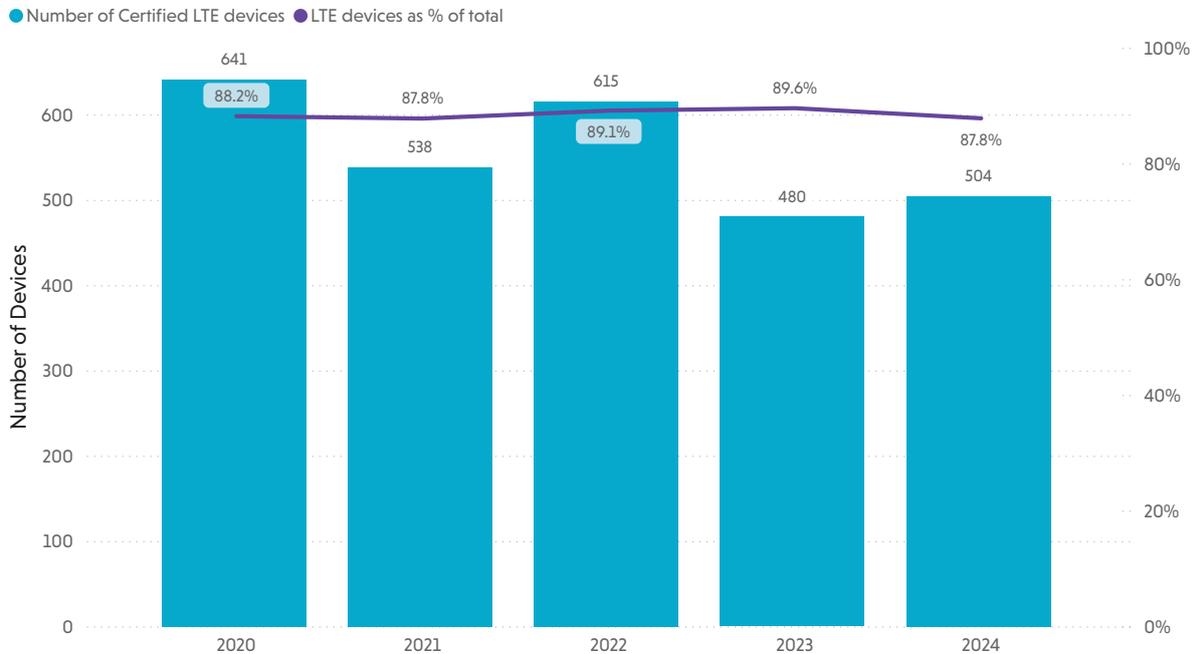


Fig 13: Devices incorporating LTE 2020-2024

In 2024, 504 certified devices supported LTE. An additional 45 devices incorporated LTE Cat. M as a cellular IoT variant.

As in 2022 and 2023, FDD-LTE was supported in more than 90% of all LTE capable devices (and 88% of all devices). TDD-LTE was incorporated into 76.5% of them, similar to in 2023, and up from 74% in 2022. And while all TDD-LTE capable devices also incorporated FDD-LTE, the proportion of LTE devices supporting

simultaneous FDD/TDD operation is 66.3%, up from 61.5% in 2023 and 57.2% in 2022.

There was also a significant increase in certifications supporting Gigabit LTE, with 187 devices certified with Category 16 or higher. This is nearly double the 89 devices in 2023 and up from 111 devices in 2022, and up as a percentage of all certified devices from 18% to 33%. This percentage is up substantially since 2017, when only just six Gigabit LTE devices were certified at GCF.

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VoLTE operation was certified in 66.5% of LTE devices, which is a slight decrease from 2023 (70%), and from 2022 when 70.3% of devices supported it. But its support in smartphones continues growing ,reaching more than 99% in both 2024 and 2023, showing a significant number of devices, such as modules, supporting LTE just for data communications.

3.2. LTE bands used

The GCF scheme enables the certification of devices designed to operate in 25 FDD-LTE and sub bands (from Band 1 to Band 32 inclusive, and Band 66) and nine TDD-LTE bands (from Band 34 to Band 48 inclusive).

During 2024, all bands covered by the GCF scheme had devices certified. Bands of note include:

- Band 7 (2600 MHz) was the most certified LTE band, the same as in 2023. It was incorporated in 453 devices (90% of the 504 LTE devices and 79% of all devices).
- Band 5 (850 MHz) was the second most certified LTE band, the same as in 2023. It was incorporated in 449 devices (89% of LTE devices and 78% of all devices).
- Band 3 (1800 MHz) was the third most certified LTE band, the same as in 2023. It features in 438 LTE devices (87% of LTE devices and 76% of all devices).
- Band 1 (2100 MHz) was the fourth most certified LTE band, the same as in 2023. It featured in 436 devices (87% of LTE devices and 76% of all devices).
- Band 28, the APT 700 MHz band, which has been allocated in major markets in Latin America and Asia Pacific for usage in LTE, was certified in 396 devices (79% of LTE devices and 69% of all devices), an increase on 2023 (which saw 75% of LTE devices able to utilise the band).

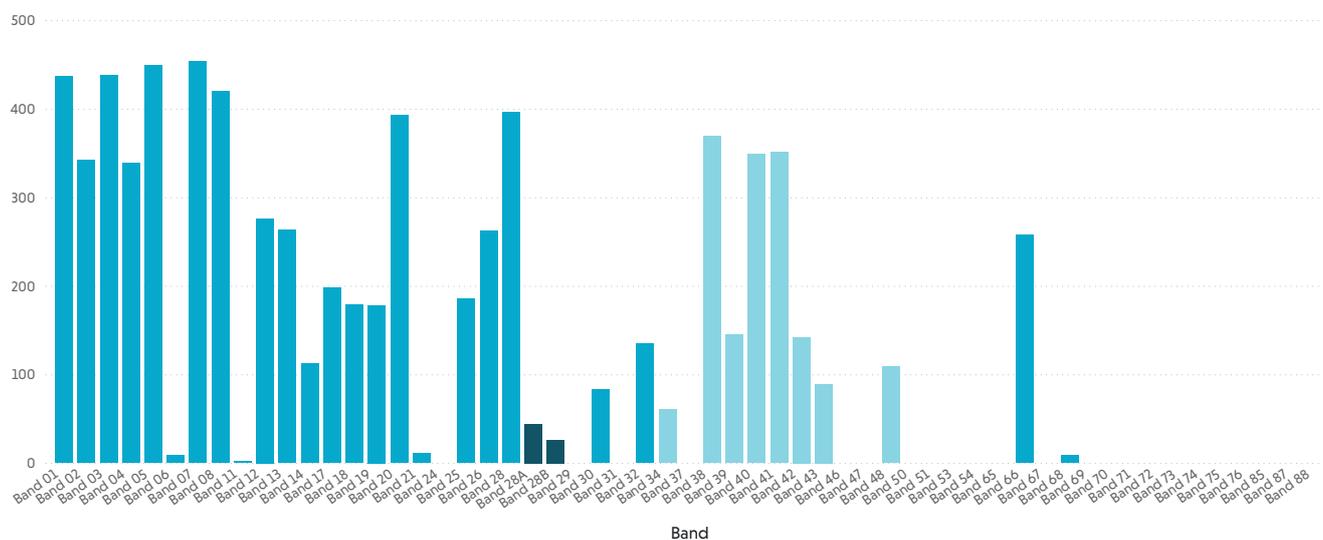


Fig 14: Number of LTE devices incorporating each band

3.3. LTE device complexity

In general, the number of supported bands in LTE devices continued to increase during 2024.

Of the 504 devices incorporating LTE, 99.8% of them incorporated four or more LTE bands, while 97.5% incorporated six or more bands (up from 93.9% in 2023).

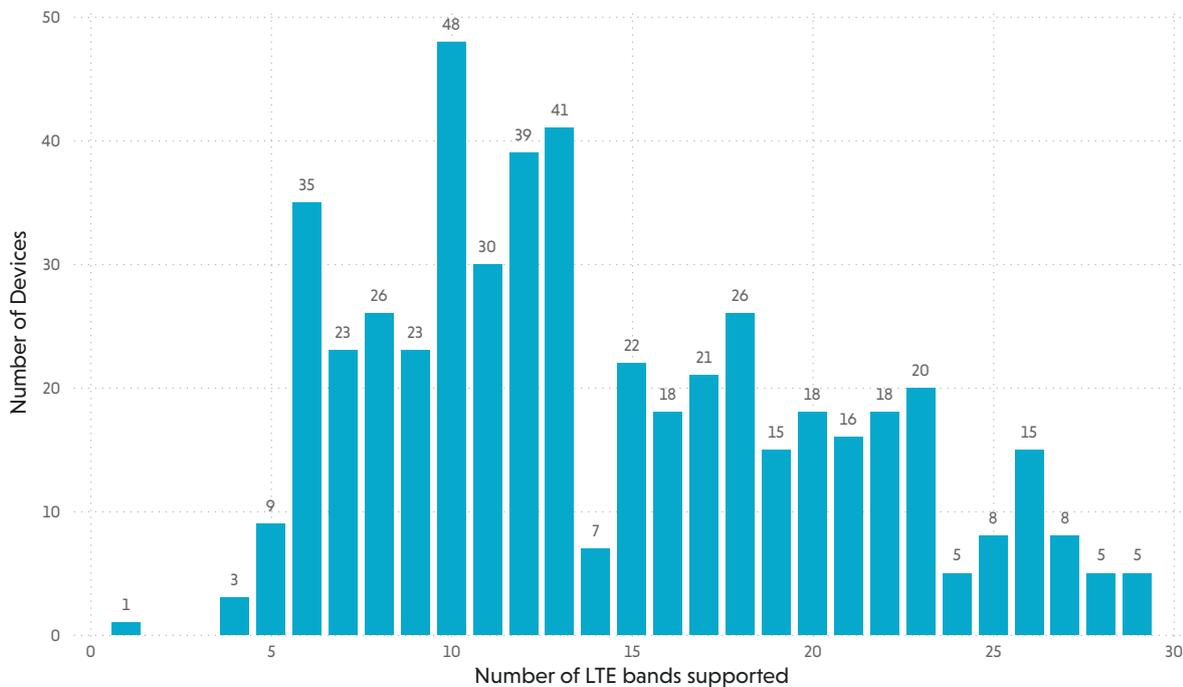


Fig 15: Multi-band deployment of LTE (excluding LTE Cat M)

The modal number of LTE (excluding LTE Cat M) bands is ten (similar to 2023), and a slightly bimodal distribution is occurring, with 84 devices deploying 22 or more bands (similar to 81 in 2023 and 79 in 2022). 408 (77.3% of LTE devices) incorporated 10 or more LTE bands, up from 73% in 2023 and 66% in 2022. 42% of all LTE devices incorporated 15 or more bands (similar to 2023, and up from 35% in 2022).

In 2024, the average (mean) LTE device incorporated 12.6 LTE bands, up slightly from 12.5 in 2023.

With such a wide diversity of bands, the number of potential inter-band and intra-band Carrier Aggregation (CA) combinations is enormous. GCF has developed a flexible certification framework which enables manufacturers to demonstrate their devices will work effectively in CA band combinations deployed by network operators. The number of devices deploying LTE Carrier Aggregation increased to 324 devices certified (59% of LTE device certifications), up from 294 in 2023 (57% of all LTE devices). Half of these devices supporting LTE CA were smartphones.

4. Cellular IoT

Cellular IoT technologies have been widely adopted globally, surpassing mobile phones and other consumer-oriented form factors in terms of installed base. While most of these devices are based nowadays mainly on LTE-based technologies (LTE Cat 1/1bis, LTE-M, NB-IoT), there is still a very significant installed base of 2G and 3G devices.

However, IoT devices are set to be enhanced further with the growth of 5G networks and the introduction of 5G RedCap in 3GPP Release 17 – improving not just in terms of speed, but also in latency, reliability, and simplicity compared to other 5G devices. Furthermore, GCF has also activated during 2024 a certification program for satellite-oriented NTN NB-IoT devices, being delivered to market in order to realise the promise of ubiquitous coverage – even from the middle of an ocean.

4.1. LPWA

This is the seventh year that GCF has certified the cellular LPWA IoT standards: LTE CAT M (both FDD and TDD), NB-IoT, and EC-GSM. In this time, the number of devices has increased significantly, with NB-IoT certifications increasing more than tenfold, and LTE CAT M (FDD) increasing more than twentyfold.

Both these figures increased in 2024, but were still below the levels achieved in 2021:

- NB-IoT was featured in 59 devices certified this year (up from 39 in 2023 and 53 in 2022, but down from 65 in 2021)
- LTE CAT M (FDD) featured in 45 devices (up from 36 in 2023, but down from 57 in 2022, and 65 in 2021)

However, these two standards dominate. Neither LTE CAT M in TDD bands or EC-GSM were included in any devices certified in 2024 (there were one and zero, respectively, in 2023).

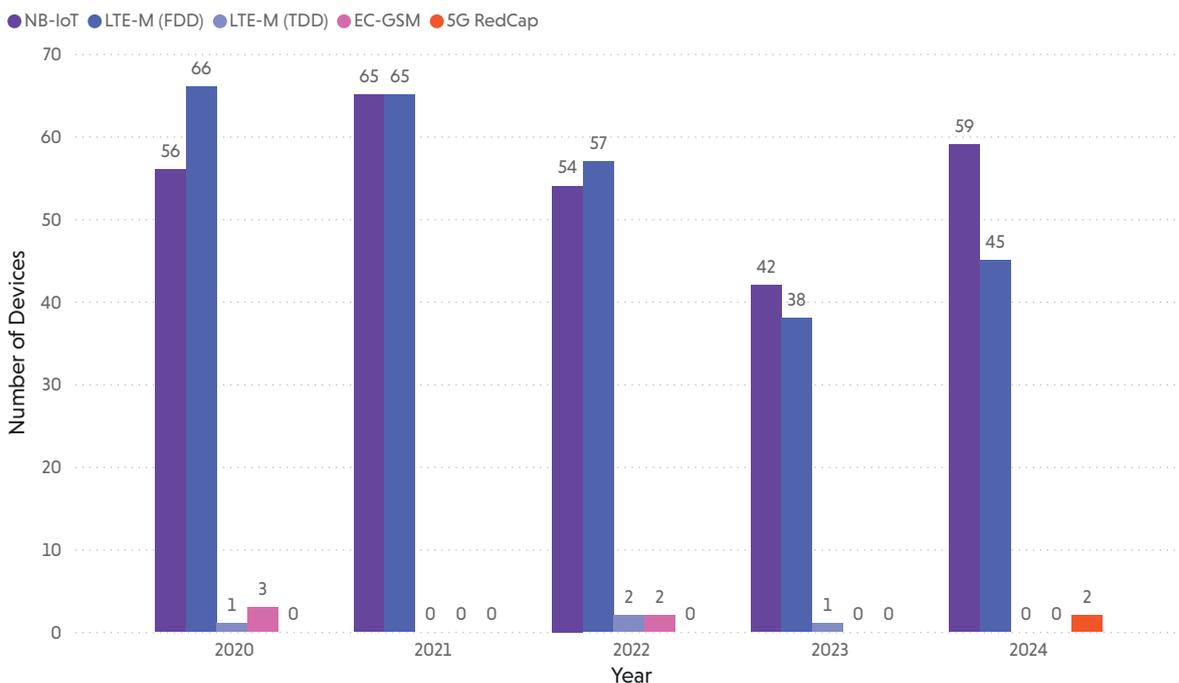


Fig 16: Cellular IoT standards evolution 2020-2024

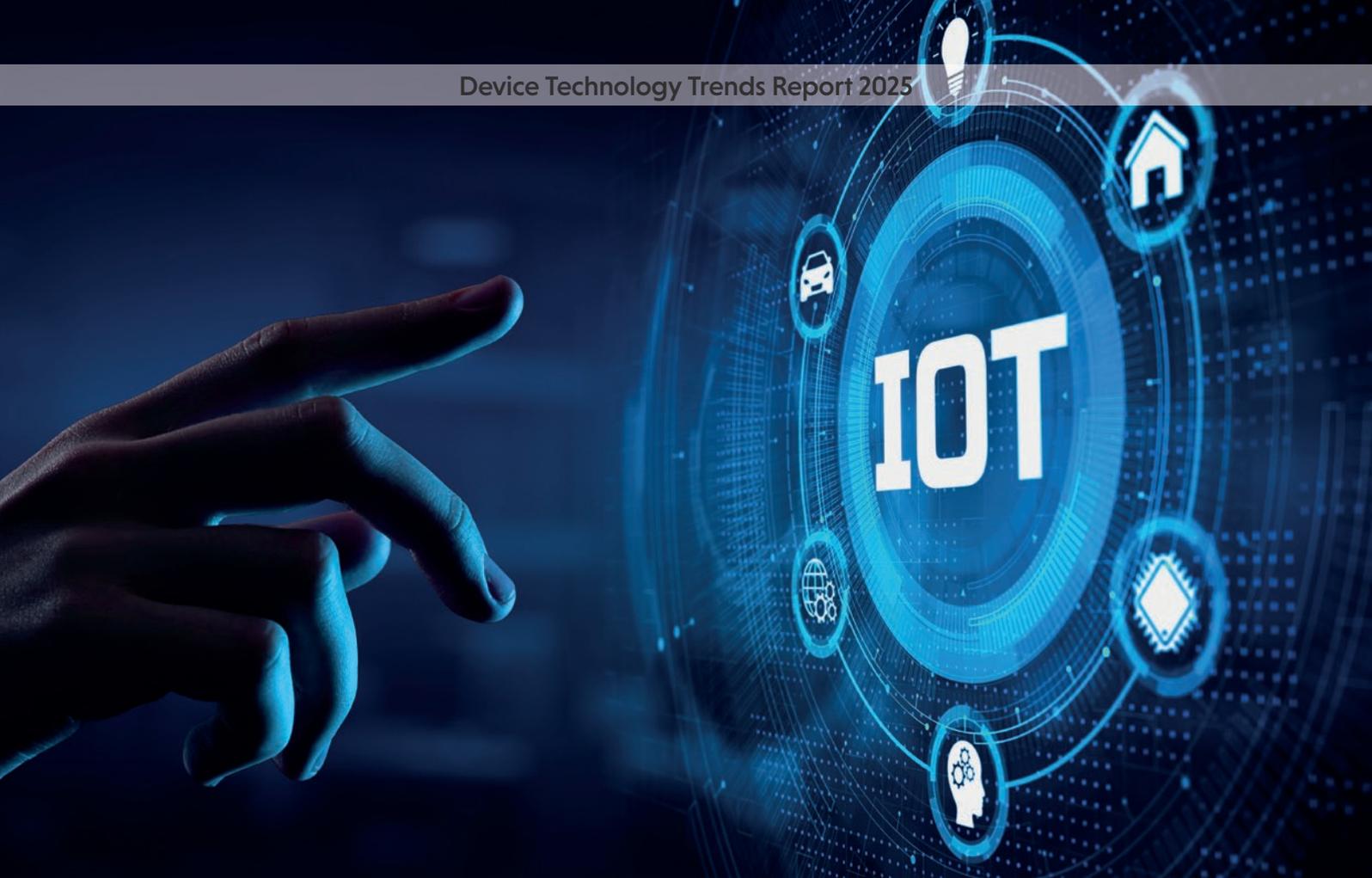


Figure 17 breaks down the LTE CAT M devices in more detail, showing how many devices were certified that incorporate each band.

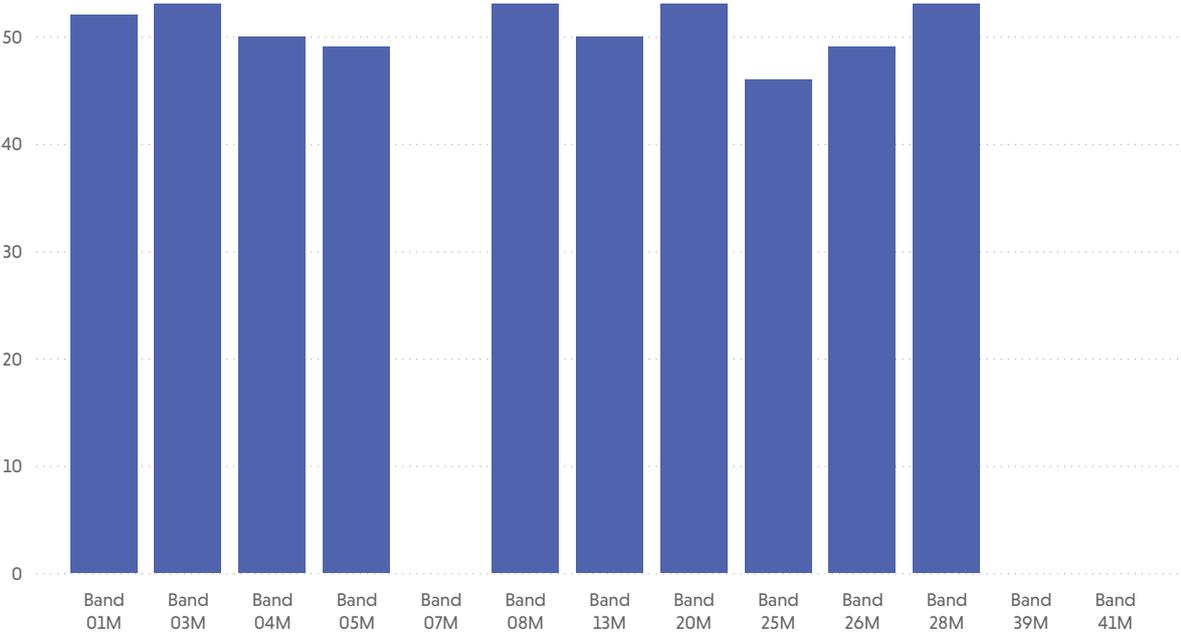


Fig 17: Number of LTE-M devices incorporating each band

4.2. 5G RedCap

There is an increasing interest for 5G devices with low power consumption, simplified bandwidth and antennas, and potentially lower cost, in markets including industrial and consumer. In recognition of this, 3GPP Release 17 introduced 5G RedCap, which opens up the advanced features and spectral efficiency of 5G NR to devices that do not require the standard's full high data rate capabilities.

Complementing other 5G NR areas that are already active within GCF certification, GCF now supports certification of 5G RedCap in multiple bands. Fig 18 shows the 5G FR1 and LTE bands supported by the 5G RedCap devices that GCF certified in 2024, following the activation of this technology for certification at GCF in 2023. Only two devices, supporting both LTE and 5G RedCap, have been certified for the moment, showing a slow start for this technology.

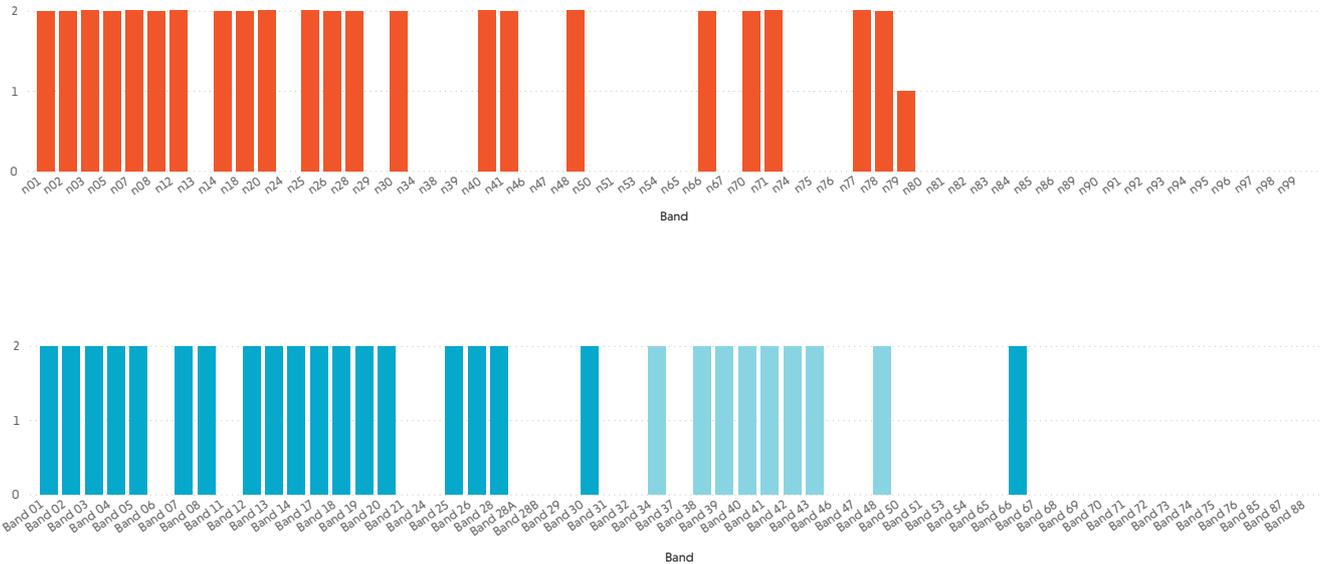


Fig 18: 5G FR1 and LTE bands supported by products supporting 5G RedCap that were certified in 2024 by GCF.



5. Non-terrestrial networks (NTN)

5.1. Satellite comms adopts 3GPP standards

Demand for satellite communications is growing fast. As with any mobile communications technology, standards are essential to guarantee good interoperability between devices and satellite networks. In order to provide operators the confidence that products meet these standards and can be safely deployed on their networks, certification is vital.

With the adoption of 3GPP standards-based satellite connectivity, manufacturers can now certify their devices for direct connection to various satellite operators. This facilitates the rapid launch of satellite-connected devices with guaranteed interoperability, enabling satellite communications in regions beyond the reach of terrestrial networks.

3GPP Rel. 17 has added two main specifications: NTN NB-IoT for IoT use cases, and NTN 5G NR for data and voice-oriented applications. Additional enhancements are being introduced in 3GPP Rel. 18.

5.2. GCF activates NB-IoT NTN support

In 2024, GCF's certification programme introduced NB-IoT support for Non-Terrestrial Networks (NTN). The certification program for NTN 5G NR devices will follow after NTN NB-IoT. With field trials for NTN still being analysed and developed, the initial focus is set on conformance testing.

Satellite-focused operators have started to join GCF and the first chipset supporting NB-IoT NTN was certified during 2024, paving the way for certification of future handsets and modules. Both satellite operators and NTN-oriented manufacturers are key to providing expertise to the development of certification capabilities for devices connecting to satellite networks, for both GEO (GSO) and LEO (NGSO) constellations.

6. Mission critical services (MCS)

6.1. Next-gen MCS moves to LTE and 5G

In the mission-critical sector, while narrowband communication technologies such as TETRA or P25 currently prevail, the next generation of broadband mission-critical services (MCS) is being deployed over LTE cellular networks and is expected to evolve towards 5G.

These newer technologies, governed by 3GPP standards, provide the necessary bandwidth for robust voice, video, and data communication with first responders, public safety services, transportation, and beyond.

6.2. GCF certifies MCS devices

To provide reliable communications, mission critical devices and networks must be interoperable. GCF and The Critical Communications Association (TCCA) have collaborated for several years on a joint initiative to establish a certification programme, aiming to certify MCS clients and devices that support MCS services.

The certification programme was activated in June 2024 and initially covers 3GPP Release 14 MC-PTT. The first MCS client was certified by GCF in July 2024.



7. Device complexity

7.1. A further rise in overall complexity

Devices on average have continued to increase in complexity for several years.

2024 continued this trend overall, and the proportion of certifications for devices supporting four or more bearer technologies rose to 32%, up from 26% in 2023 (and 23% in 2022).

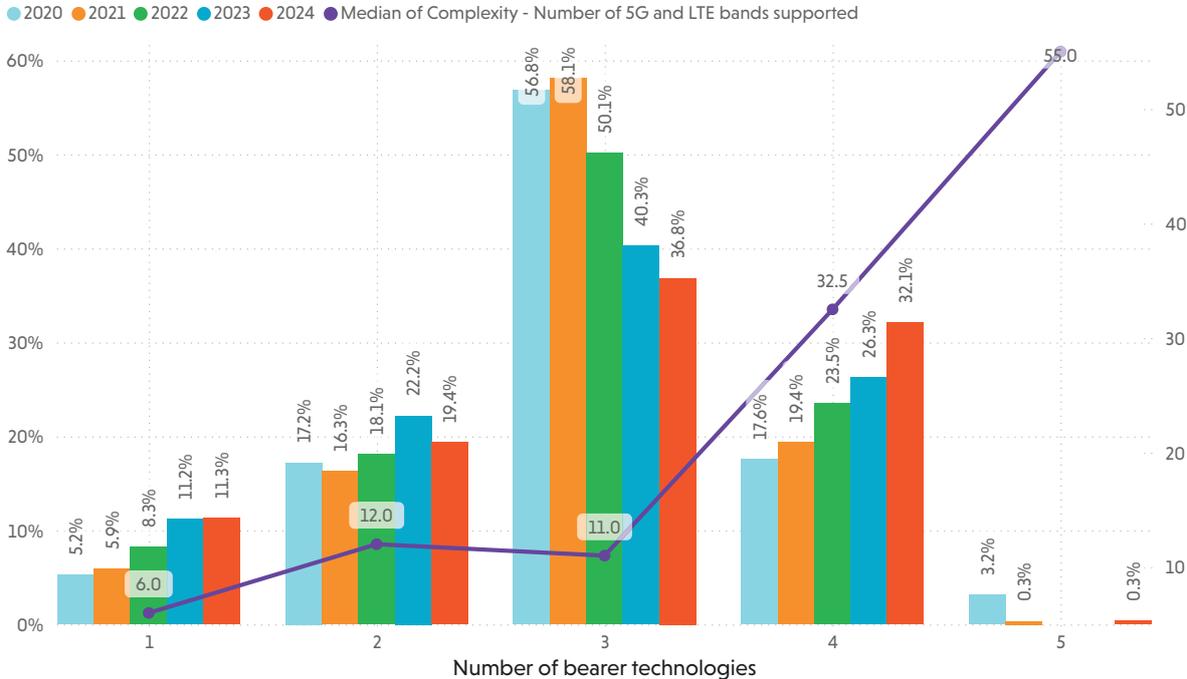


Fig 19: Incidence of multi-mode, multi-band devices 2020-2024

Bearer technologies have been classified as 2G (GSM/ EDGE), 3G (WCDMA/ UTRA/ HSDPA/ HSUPA), 4G (LTE FDD/ LTE TDD), 5G, NB-IoT, LTE M (TDD/ FDD) and EC-GSM

7.2. Single mode devices

The number of single mode devices (just one radio bearer supported) remains stable, with 49 devices in 2024, one more than in 2023. These single mode devices are predominantly LTE modules (30 devices), LTE-only smartphones (7 devices), and low-end feature phones (5 devices, 4 of them still GSM-only and one LTE).

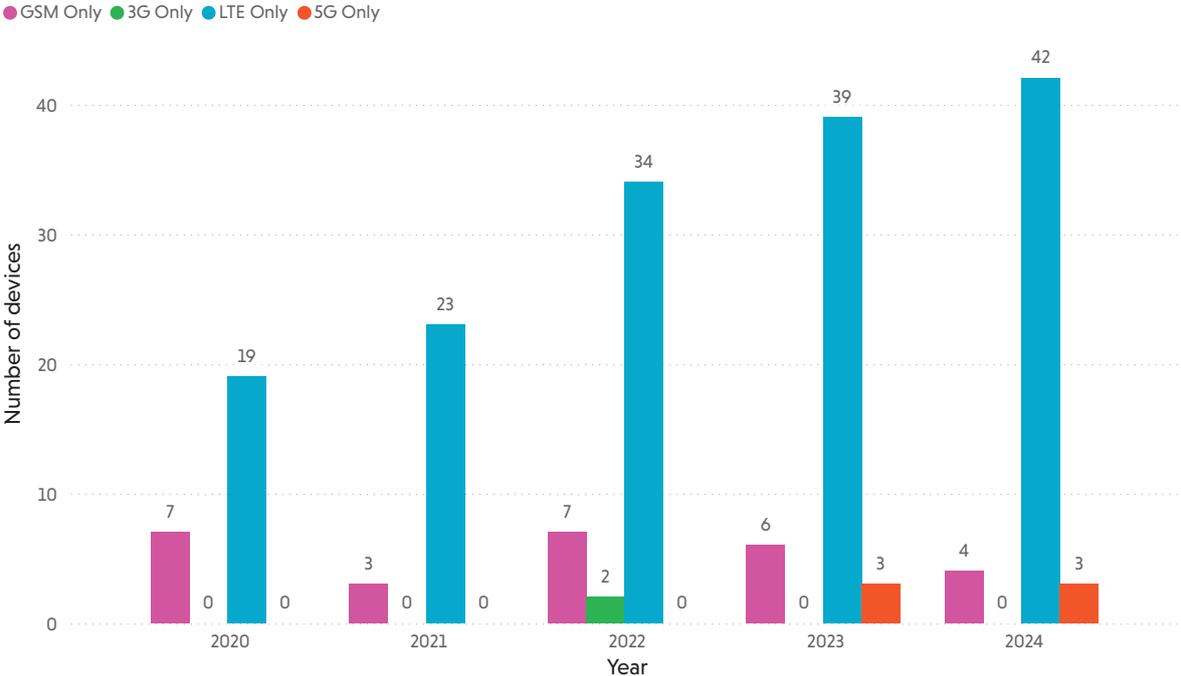


Fig 20: Devices incorporating only one Radio Access Technology 2020-2024

The number of 5G devices remained at 3 (two modules and one IoT device, all 5G SA), in accordance with most of the 5G networks being complementary, and not a replacement, of existing LTE ones.

There is also a clear decline of 2G and 3G standalone devices, as the number of standalone 2G devices lowers to 4 (all very basic feature phones), and, for the second year in a row, there were no standalone 3G devices (and only two have been certified in the last five years).

7.3. Multi-mode devices

The complexity of devices, in terms of the number of radio bearer technologies, is once again rising.

As in all years since 2020, the modal number of radio bearer technologies per device was three, however the proportion of systems employing four or more bearer technologies has more than tripled in the last few years, from 8.5% in 2019 to 32.1% in 2024. In 2024, 69% of devices incorporated three or more technologies, up slightly from 66% in 2023 but down from 73% in 2022, and quite likely related with the sunset of 3G and 2G technologies, which are now on a declining phase.

The number of implemented bands used in the average device keeps growing. Certified devices in 2024 supported a median of 16 LTE or 5G frequency bands, compared to 13 in 2023 and 12 in 2022. When we consider LTE only devices, the median number of supported LTE bands remains at 10, same as in 2023. However, considering 5G devices – also including LTE – this figure remains at 30, evolving to 35 for smartphones (up from 33 in 2023).

The maximum number of 5G bands implemented on a single device has risen to 32, and the total number of 5G and LTE bands rises to 60, evolving from 29 and 57 respectively in 2023. The average number of 5G bands has also increased from 5.4 to 7.2, and, including LTE bands, from 18 to 20.

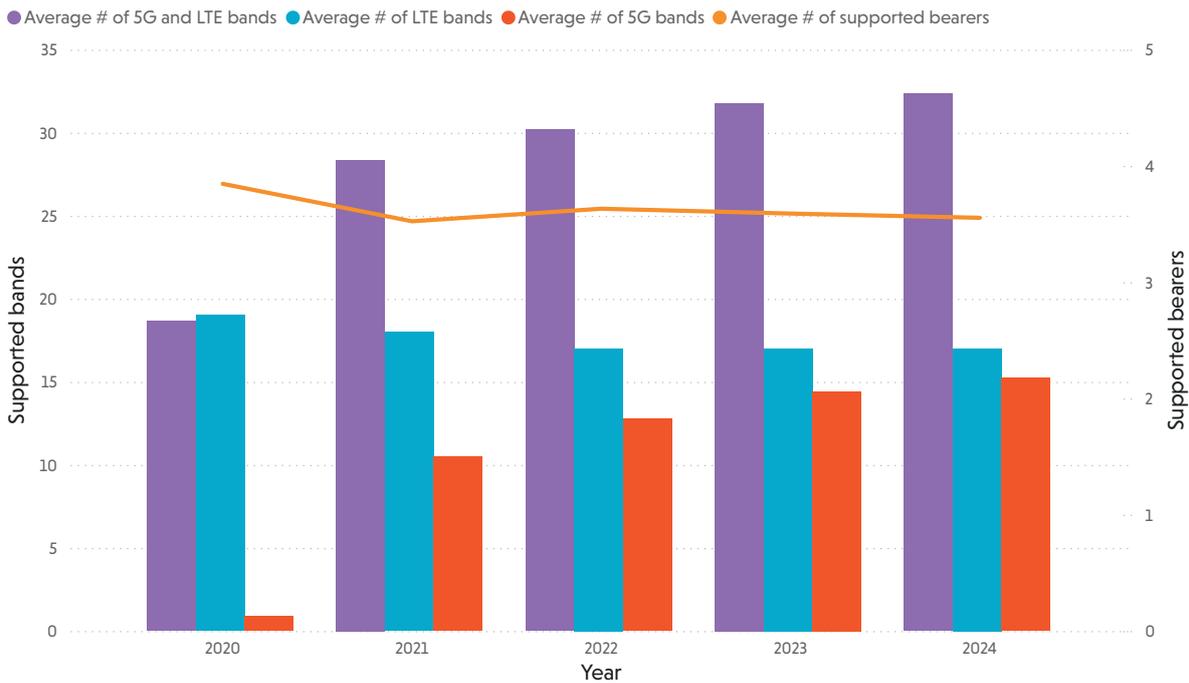


Fig 21: Complexity of 5G Devices 2020-2024

We can also see that the complexity of smartphones continues to grow, while modules are becoming more tailored to specific applications, and not experiencing a similar increase in complexity.

8. Smartphones

8.1. Smartphone growth

Smartphones had consistently represented the largest category of devices certified by GCF, but in 2023, for the first time, smartphones were overtaken by modules as the largest category.

In 2024, modules were again ahead of smartphones, with smartphones representing 36% of all certifications, up slightly from 34% in 2023, but down from 38% in 2022, and 43% in 2021.

A total of 207 smartphones were certified in 2024, up from 184 in 2023, but still down significantly from 263 in 2022. The number of smartphone vendors certifying devices reached a record number of 32, up from 29 in 2023. 11 of these vendors were certifying a device for the first time. This includes not only consumer-oriented manufacturers (the 10 largest smartphone vendors worldwide are GCF members), but also professional, mission critical, and B2B oriented smartphones. Regarding distribution, 33% of the certified smartphones were developed by just two manufacturers, comparable to 32% in 2023, although this is down from 40% in 2022, and 45% in 2021.

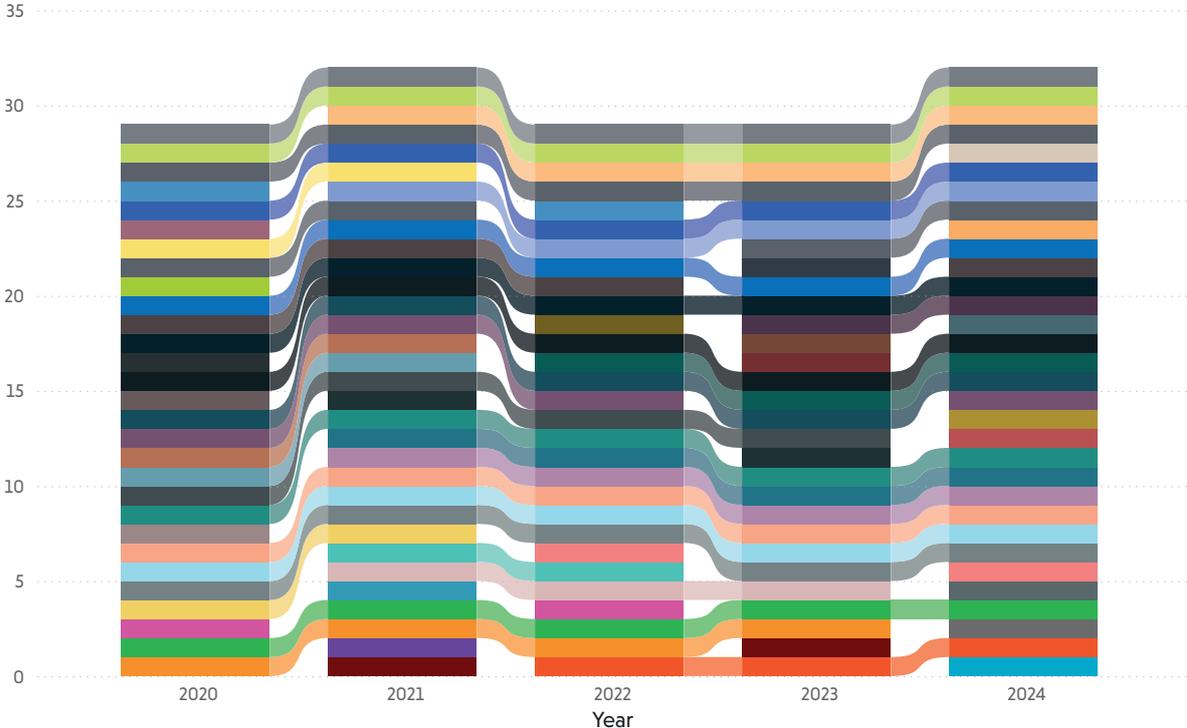


Fig 22: Companies certifying smartphones – vendor evolution 2020-2024.

Each colour represents a specific smartphone manufacturer.

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And 56% of smartphones certified were made by just five manufacturers, down from 63% in both 2023 and in 2022, and down from 70% in 2021.

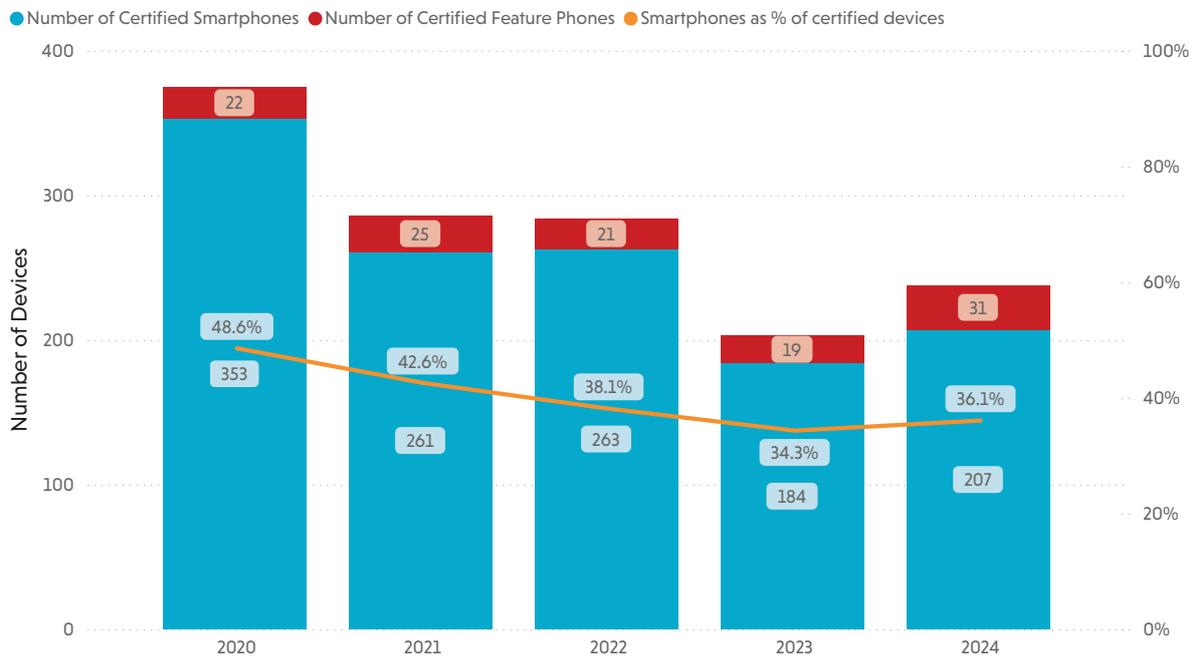


Fig 23: Smartphone and feature phone certifications 2020-2024



8.2. Smartphone complexity

Smartphones are also significantly more complex than the average device, with 93% of smartphones integrating three or more radio bearer technologies, versus 53% for non-smartphone devices (down slightly from 54% in 2023). This figure for smartphones is comparable to previous years: 91% in 2023 and 95% in 2022.

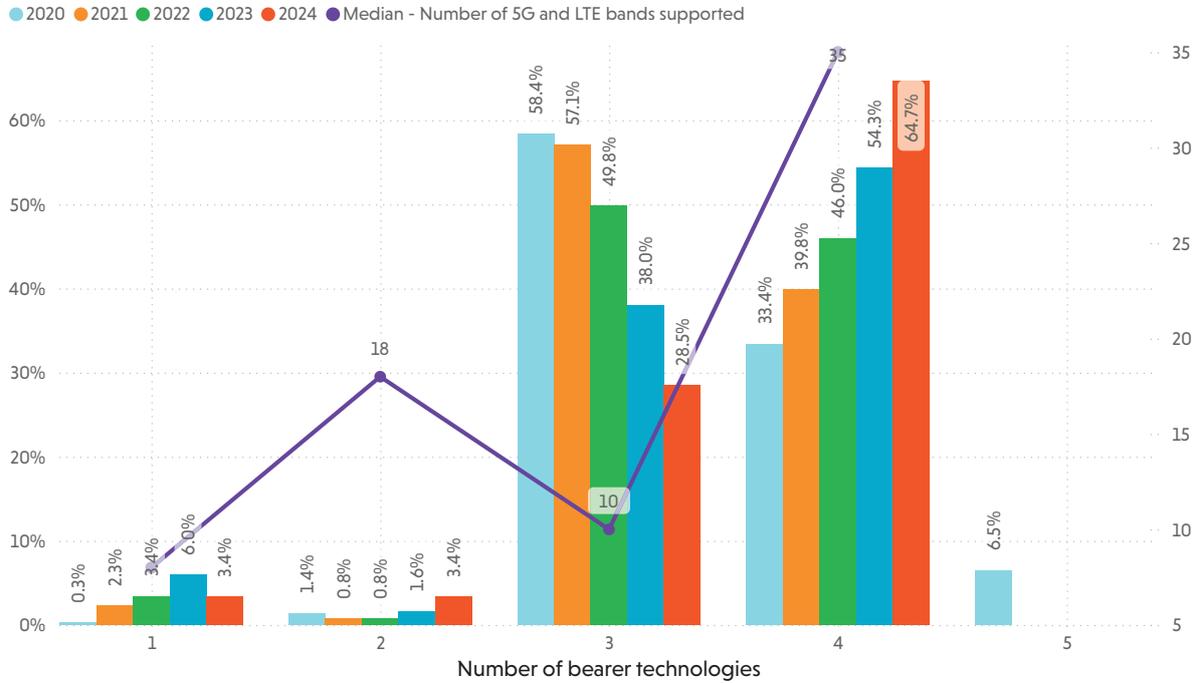


Fig 24: Complexity of smartphones – incidence of multi-mode, multi-band devices

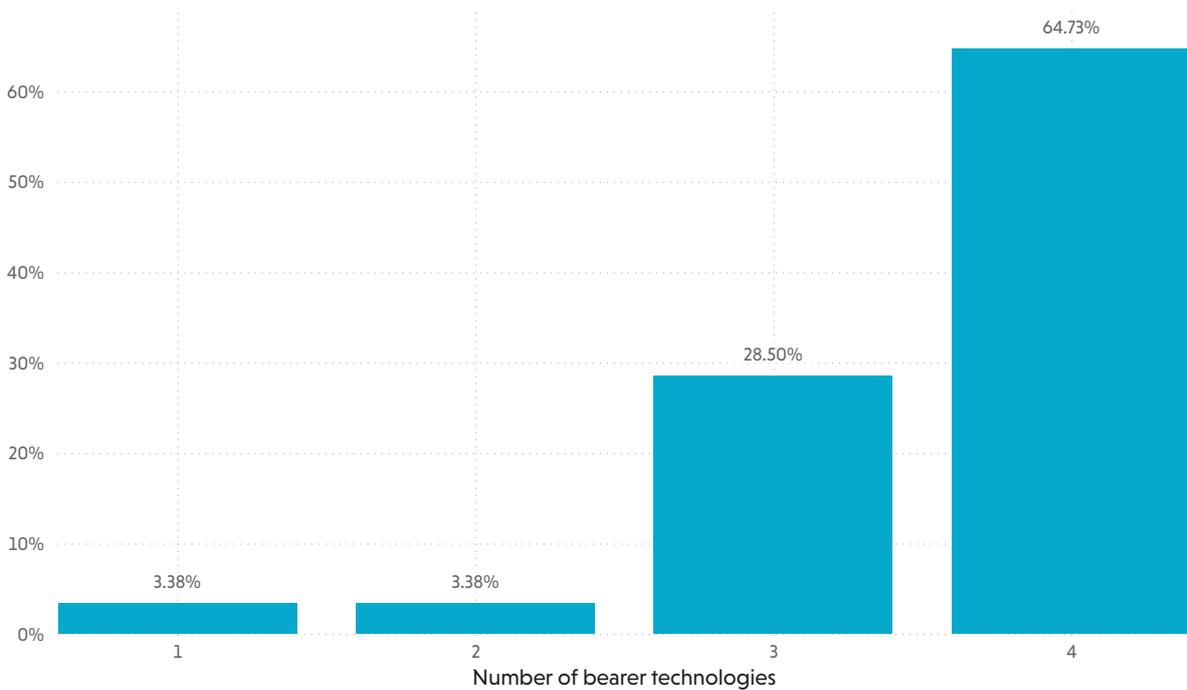


Fig 25: Complexity of smartphones – multi-mode, multi-band devices by bearer technology

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The increased level of complexity of smartphones can also be highlighted by examining the proportion of devices using each mobile technology, and comparing it against non-smartphone devices.

FDD LTE is again the dominant mobile technology, supported by 184 (89%) of certified smartphones. Additionally, 140 smartphone devices (68%) support 5G, up from 60% in 2023 and 47% in 2022. The gap between 5G non standalone and 5G standalone (5G SA Option 2) has narrowed in the last two years to less than 3% -compared to 16.8 in 2021 and 21.8 in 2020.

Support for legacy technologies (2G and 3G) remains strong (above 85%) to guarantee interoperability in all geographies.

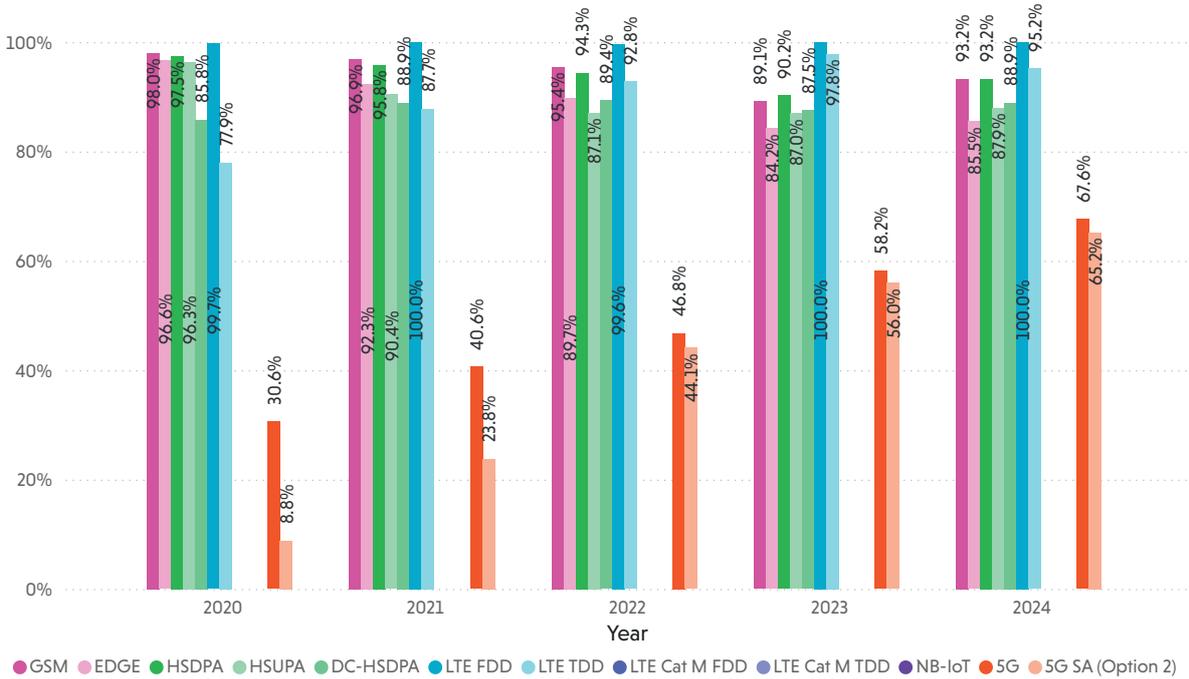


Fig 26: Smartphones – proportion of certified devices by technology 2020-2024

9. Wireless modules

9.1. Wireless module growth

In total, there were 209 modules certified in 2024, representing 36% of the total number of devices, almost identical to the figure in 2023 and in 2022. This includes modules supporting any cellular wireless technology (from 2G to 5G, including IoT oriented modules with only LTE-M or NB-IoT and NTN modules, certified in 2024 for the first time).

In 2024, the number of manufactures certifying wireless modules was 24, down two from the previous year, and 6 from 2022. 68% of certifications came from five companies who certified 15 or more modules, and the top two companies certifying modules accounted for 44% of all certifications.

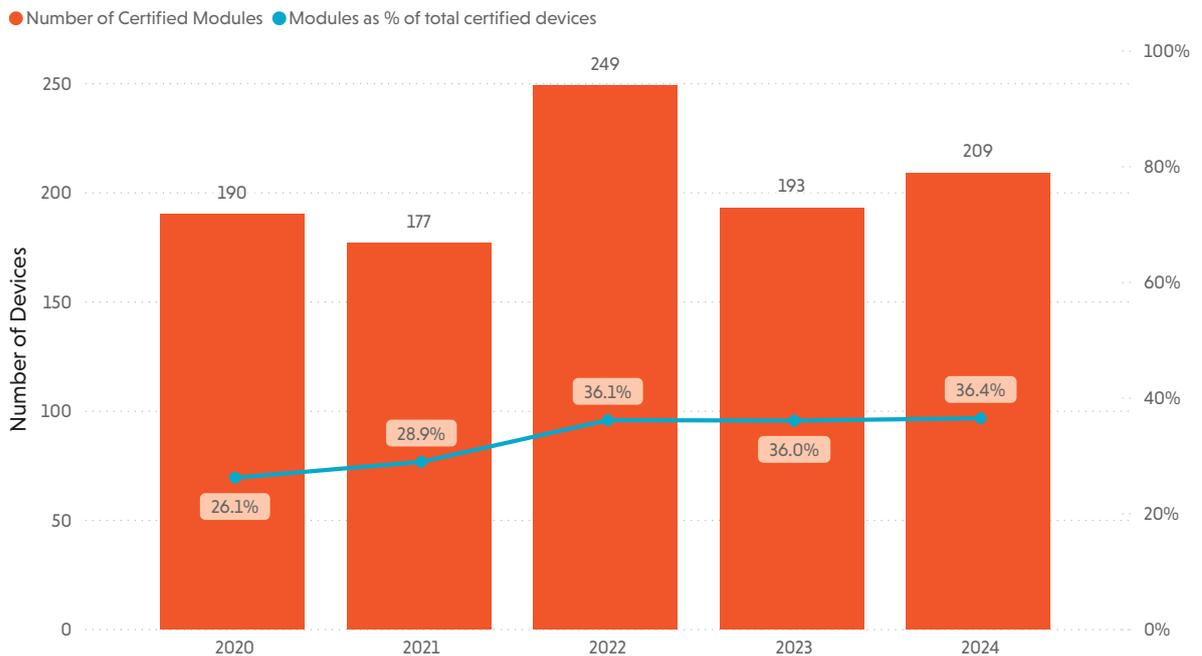


Fig 27: Wireless modules certifications 2020-2024

Device Technology Trends Report 2025

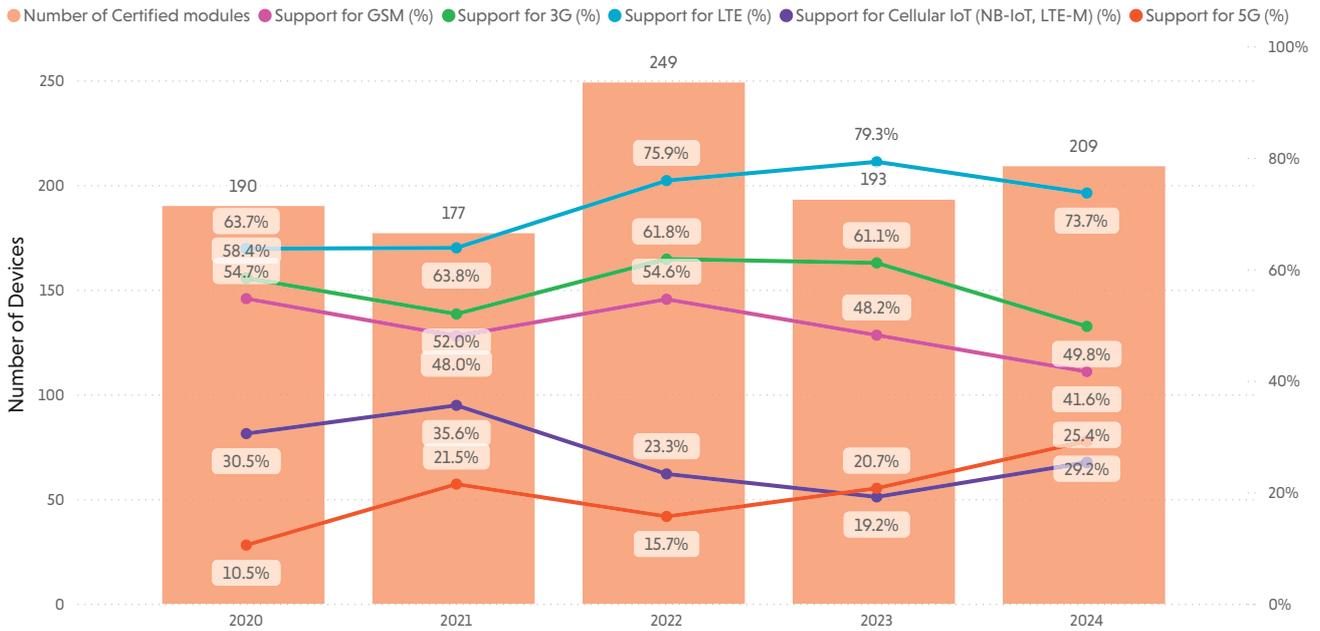


Fig 28: Wireless modules certifications by bearer technology 2020-2024

9.2. Module complexity

As with certified devices generally, a variety of multi-mode, multi-band modules are currently being offered to the market.

49 of the 208 certified modules (24%) were single-mode, up from 16% in 2023. 29% in 2024 incorporated two radio bearer technologies (down slightly on 32% in 2023 and 35% in 2022) and 35% in 2024 included three (down on 42% in 2023 and 46% in 2022). There were also 23 modules incorporating four radio bearer technologies, compared to 17 in 2023, 8 in 2022 and none in 2021.

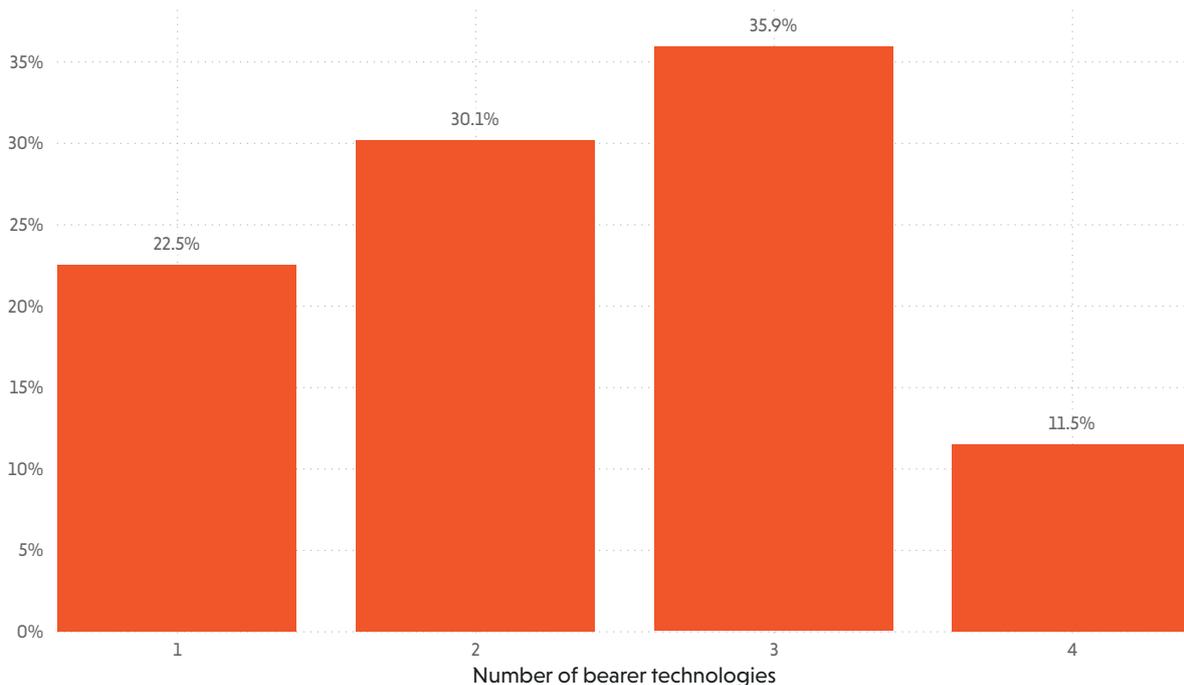


Fig 29: Complexity of modules – incidence of multi-mode, multi-band devices

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The median number of LTE and 5G frequency bands per module certified has declined slightly, now standing at 10 per module (down from 11 in 2023). The maximum number of frequency bands for a module was 53, up from 50 in 2023.

9.3. Mobile technologies incorporated

The average module is significantly less complex than the average device, and this can also be observed in the proportion of devices supporting each mobile technology.

As in 2023, FDD LTE is the most commonly certified bearer technology in modules, with 74% of modules incorporating it in 2024, compared to 79% in 2023. In 2024, 50% of modules incorporated 3G (UTRA) versus 61% in 2023, and in 2024, 42% incorporated GSM, versus 48% in 2023, showing a significant decline in the use of legacy 2G and 3G in the wireless module space, being replaced by LPWA, LTE and 5G technologies, now present in almost 30% of all certified modules.

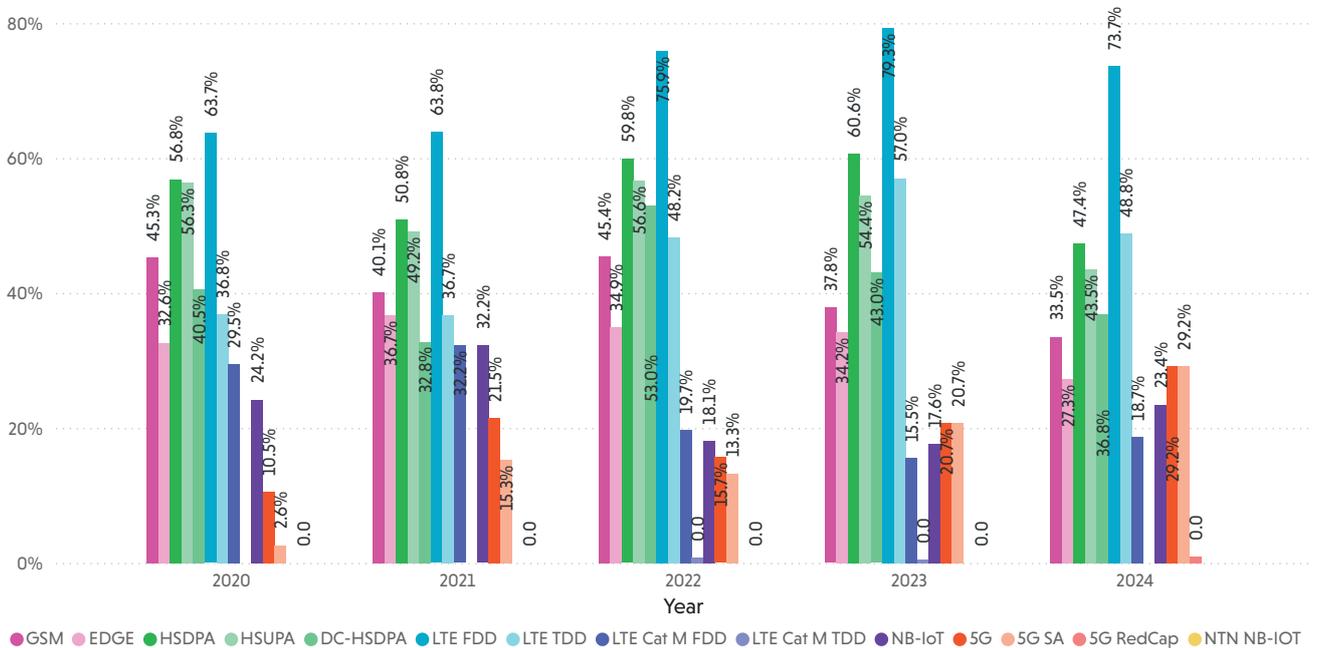


Fig 30: Modules – proportions of certified devices incorporation each mobile technology, 2020-2024

10. Conclusion

In a global mobile ecosystem that now embraces multiple distinct radio bearer technologies deployed across numerous frequency bands, GCF certification provides a practical and industry-recognised means of ensuring devices will interoperate correctly with networks and meet the performance expectations of end-users.

In 2024 several major trends impacted the certification activity at GCF:

- **Number of devices up:** the number of devices certified at GCF increased to 574, up from 536 in 2023 (an increase of nearly 7%), mainly due to an increase in the number of certified smartphones (up 23).
- **Module growth:** modules represented 36.4% of total certifications in 2024, retaining their slight lead from last year over smartphones (35.9% in 2024) as the most certified product category, with a slight consolidation in the number of module manufacturers certifying devices.
- **Smartphone certification broadens:** 207 smartphones were certified in 2024, up from 184 in 2023, but still down from 263 in 2022. The number of smartphone vendors certifying devices reached a record number of 32, up from 29 in 2023, and 11 of these vendors were certifying a device for the first time. This includes not only consumer-oriented manufacturers (the 10 largest smartphone vendors worldwide are GCF members), but also professional, mission critical, and B2B oriented smartphones.
- **5G growth:** 5G is now present in more than four out of every ten certified devices – including more than six of every ten certified smartphones, and three of every ten modules. Almost all 5G devices support the standalone modes, and the number of supported bands and frequency band combinations continues to grow at a very healthy pace.
- **LTE ubiquity:** LTE is present in all certified smartphones and reached over seven of every ten certified modules, with the average number of supported LTE bands growing to 12.6, and the total number of possible LTE bands for LTE certifications reaching 57, with 34 of them in use for certifications during 2024. Seven of these bands are present in nearly 400 of the total number of certified devices (over 70%), representing a truly global LTE ecosystem.
- **eSIM growth:** Certification of Remote SIM provisioning for consumer eSIM is reaching 85,7% of all certified wearables, and more than half of all smartphones, growing more than 50% year-on-year.
- **NTN:** Still at a very early stage, with the certification program already launched for NTN NB-IoT in GSO (Geo-Stationary Orbit), but just one product (and IoT chipset) certified.
- **MCS:** While only one product has been certified following launch of mission critical services certification program (MC-PTT), the number of mission critical oriented manufacturers and operators (MCCOs) has grown significantly, paving the way for a future growth following the activation of mission critical broadband networks in many countries expected for the following years.
- **2G and 3G sunset:** legacy 2G and 3G wireless technologies maintained their decline overall, but maintained their presence in the smartphone space, for global roaming. More than 30% of all devices do not incorporate any of these technologies. Due to declining relevance, we have chosen not to include dedicated sections for 2G (GSM) and 3G (WCDMA) in this report.

In 2024, a GCF-certified device incorporated an average 2.90 radio bearer technologies (compared to 2.82 in 2023) and operated across 19.82 5G and LTE frequency bands (this was 17.78 in 2023).

Demonstrating the conformance and interoperability of today's sophisticated multi-mode, multi-band smartphones, modules and IoT devices to the satisfaction of the world's mobile operators and consumers is therefore essential. And this GCF analysis of mobile device trends shows that its certification programs remain relevant to the pre-launch testing of devices.

11. Looking ahead

11.1. There are several significant technology evolutions expected for 2025:

- Smartphone plateau: several tendencies are expected to impact the growth of smartphones:
 - Longer lifecycle of devices, due increased average price of devices and a limited innovation in the industry leading to a longer customer tenure.
 - A regulatory push in certain countries to maintain smartphones active for a longer time with extended support and updates from manufacturers.
 - Larger number of frequency bands, and therefore target markets, with single variants of the same devices.

In this scenario, growth expected in the smartphone market is low for 2025, leading to a consolidation in the portfolios of key manufacturers, and a stable number of GCF certifications.

- Consolidation of 5G, including 5G SA, as mature technology, reaching most networks worldwide, over 75% of all certified smartphones and more than 40% of all certified modules. Alongside with 5G SA, Certification of 5G Network Slicing capabilities will see initial certifications being achieved during 2025.
- Growth of 5G RedCap modules: while the certification was introduced in mid 2023, very few networks have deployed the technology. It is expected that more operators and vendors will incorporate the functionality during 2025 leading to certification of low end 5G modules supporting the technology.
- Activation of Non-Terrestrial Networks NB-IoT connectivity in GCF certification for LEO (Lower Earth Orbits), also defined as NGSO (Non Geostationary orbits), and growth on the certification of modules and smartphones supporting basic messaging and emergency capabilities over satellite networks. Besides this, D2D (Direct-to-device) LTE connectivity will continue to rise in the standards-based satellite connectivity, with more satellite operators activating services in this area.
- Growth of GCF certification for mission critical services, evolving to further releases of 3GPP MC-PTT client certification, and activation of certification for MC-Video clients. More players, mainly Operators and Safety Agencies, are expected to join GCF ahead of MCX networks being activated, mainly in Europe, over the next few years.
- Further sunset of 2G and 3G radio access technologies, that remain present in smartphones for global coverage, but strongly being eliminated from other form factors as networks are being sunset all around the world and spectrum properties being transferred to more efficient technologies, such as LTE, 5G or LPWA.
- Consolidation of Remote SIM Provisioning for Consumer devices, becoming present in most consumer oriented devices (smartphones and wearables).
- Incorporation of Remote SIM Provisioning for IoT devices in GCF certification, following the new specification released by GSMA during 2024.
- Growing interest in cybersecurity related topics, targeting both smartphones and IoT devices, pushing the ecosystem towards global certification practices.

12. How GCF ensures compliance and interoperability

12.1. About GCF

Founded in 1999, the Global Certification Forum (GCF) is the globally-recognised quality mark for the interoperability of mobile phones and other devices that incorporate mobile connectivity.

GCF Certification is based on test cases defined by recognised standards organisations such as 3GPP, GSMA, oneM2M, and NFC Forum. GCF operator and manufacturer members identify and agree a selection of available test cases for each technology and functionality to be brought within the scope of the scheme to deliver a robust but pragmatic testing regime that meets market needs.

GCF Certification comprises lab-based conformance and interoperability testing complemented by field trial testing on live commercial networks.

12.2. Who GCF works with

As of January 2025, over 350 member companies are participating in GCF. The GCF suite of certification solutions is also recognised by operators with interests in global markets.

Over the years, a number of GCF operator members have undertaken studies to evaluate device performance on their networks. These studies have shown that GCF certified devices perform significantly better, for the metrics measured, than non-certified devices.

GCF members are spread across the globe.

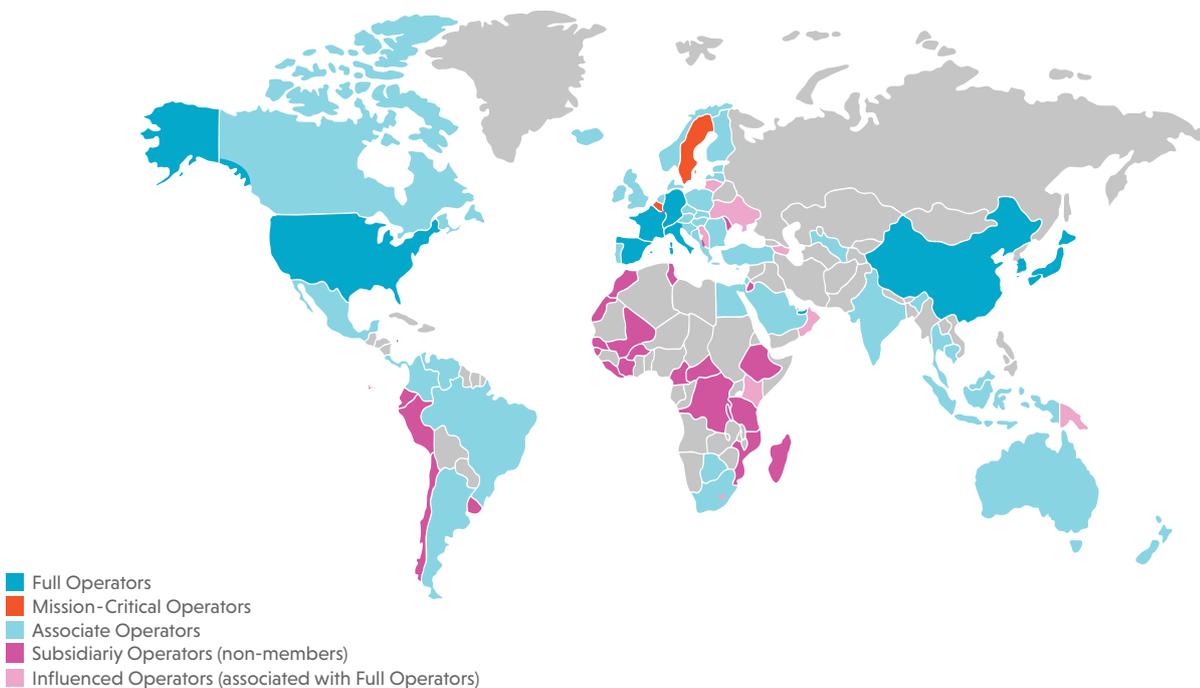


Fig 31: GCF Operator members worldwide by country

12.3. The GCF process

Common, rigorous and trusted certification criteria promote harmonisation of operator acceptance testing schemes. By minimising duplication, GCF Certification reduces acceptance testing costs and contributes to improved economies of scale for device manufacturers.

The initiative provides a consistent, optimised, flexible, scalable framework for certifying any mobile device: from a simple single-mode low-cost handset to sophisticated multi-mode and multi-band smartphones, tablets, wireless routers, IoT modules and other IoT products.

12.4. The benefit of GCF Certification

By adopting GCF Certification into its quality management system, a manufacturer can be marketed to the customers of multiple network operators worldwide. In markets where operators are not directly involved in the marketing of devices, distributors can reduce their after-sales service overheads by prioritising products that have been shown to meet GCF's globally recognised benchmark of conformance and interoperability.

Originally developed for GSM, GCF certification broadened to support newer technologies as they were adopted and now covers most LTE and 5G Technologies and bands, including FR1, FR2 frequencies and 5G NR Light (RedCap), as well as NB-IoT for terrestrial and NTN bands and legacy wireless technologies (2G and 3G). GCF also certifies capabilities such as Remote SIM Provisioning for Consumer eSIM (mainly for smartphones and wearables) and IMS Services (VoLTE, VoNR).

GCF has also added Cellular Vehicle-to-Everything (C-V2X) compliance testing, and has released, in cooperation with TCCA, a certification program for mission-critical services. GCF has also introduced support for Non-Terrestrial Networks (NTN), and can certify standards-based client applications such as RCS and NFC.

The effective use of frequency bands, and the handling of the growing number of band combinations available in devices and networks is assisted by the GCF initiative, which provides an effective method for verifying the correct operation of Carrier Aggregation currently up to five simultaneous frequency bands (5CA).

The quality of interoperability assured by the programme facilitates successful international and national roaming for end users.

13. Key GCF milestones

Date	Event
January 2025	Announcement of the GCF IMC Joint Task Force on IoT Security
September 2024	GCF Steering Group #100 and 25-years celebration in London
September 2024	First 5G RedCap device certified
July 2024	First NTN NB-IoT device certified
June 2024	Launch of MCS certification (MC-PTT)
February 2024	GCF introduces NB-IoT support for Non-Terrestrial Networks (NTN)
March 2020	First IoT chipset certified
April 2019	First 5G device certified
February 2018	RSP eSIM certification for consumer devices introduced
September 2017	First LTE-M device certified
March 2017	First NB-IoT device certified
March 2011	First LTE device certified
February 2006	First 3G device certified
May 2000	Certification of first device – GSM
1999	GCF founded

14. GCF device certifications

Certified devices are listed on the GCF website at:

<https://www.globalcertificationforum.org/gcf-certified-products/3gpp-certifications.html>

A list of certified modules suitable for adding mobile connectivity to other products and qualifying for GCF's optimised certification scheme can be found at:

<https://www.globalcertificationforum.org/gcf-certified-products/module-certifications.html>

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