GCF
Test Certify Connect

Mobile Device TRENDS

February 2023

An analysis of GCF device certifications in 2022

By combining conformance and interoperability tests undertaken in laboratories with field trials on multiple commercial networks, GCF Certification verifies the quality of the interoperability of mobile phones and other wireless devices with different network elements, vendors' infrastructure and services such as eSIM or oneM2M.

GCF certifies hundreds of different device models each year. The following is an analysis of GCF's certification listings which provides insight into current trends within the mobile device market, and some brief information on likely trends into 2023.

Executive SUMMARY

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

As of January 2023, over 158 device manufacturers across 25 countries were participating in GCF. The GCF suite of certification solutions is also recognised by network operators and service providers with interests in markets all around the world.

This February 2023 review of Mobile Device Trends is based on an analysis of device certifications published by the Global Certification Forum during 2022. The analysis provides insights into the mobile technologies and functionalities being requested by operators and end-users across markets worldwide.

A total of 649 devices from 85 manufacturers were certified by GCF in 2022. The following outlines the key findings:

5G:

- Now in its fourth year, the integration of 5G into devices has continued to grow, but its speed of adoption has slowed. Compared with LTE, the speed of 5G adoption, considering all types of GCF certified devices, seems to be lower at the same stage.
- 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, and has continued its rapid growth, with 91% of 5G devices certified in 2022 supporting SA.
- 5G Connectivity option 4 (NE-DC) was added to the certification in 2022.
- 215 devices (33%, up from 31% in 2021) of all 2022 certified devices included 5G. This came from 42 vendors, very slightly down from 43 in 2021.
- Looking specifically at smartphones, in 2020, a lot of smartphone models came in two variants (LTE and 5G), which were certified separately. However, in 2021, we started to see manufacturers just releasing one variant (5G) of their new smartphones, which contributed to the reduction in the number of total certifications from 2020 to 2021.This trend to one variant has continued in 2022.

Device types

- Smartphone certifications reached 240 in 2022 (down from 259 in 2021).
- Module certifications increased to 238 in 2022 (up from 184 in 2021).

Covid-19

- The processes introduced in 2020 allowing postponement of certain testing due to Covid-19 decreased to being used in 8 device certifications in 2022, compared to being used in 18 in 2021 and 102 in 2020.

LTE

- As in 2021, LTE was the most used wireless communications standard in devices certified by GCF during 2022.
- In 2022, we did not see new features of LTE coming up for certification, which shows that it is a stable, mature technology.
- 89% of all devices (576) supported LTE.
- 100% of the LTE devices supported FDD-LTE. 81% (465) supported TDD-LTE, up from 78% in 2021.
- VoLTE support was certified in 76% of LTE devices (440). This is an increase from 2021, where 68% supported VoLTE.
- An additional 53 devices incorporated the cellular IoT variant, LTE CAT M1.

3G (UMTS/ WCDMA)

- 3G certifications dropped very slightly, with 78% of certified devices implementing the standard in 2022, compared to 79% in 2021. The standard's continued resilience is surprising given a long-term push by operators to replace 3G data capacity and frequency bands with LTE and 5G.

- There were no standalone 3G devices developed and certified by GCF in 2022 (compared to one in 2021).
- The penetration of HSDPA (75%) and HSUPA (69%) was slightly down in 2022 compared to 2021.

GSM

- 64% of 2022 GCF certified devices incorporated GSM. This was the same as in 2021, and represented a flattening off of the steady decline of GSM, down from 72% in 2020.
- Only seven standalone GSM devices were certified in 2022.
- EDGE penetration also dropped to 56% of devices in 2022, down from 60% of devices in 2021 and 56% in 2020.

Cellular IoT

- 2022 saw a decrease in the number of devices incorporating a cellular LPWA (low-power wide area) IoT standard.
- As in 2021 and 2020, two standards dominated these certifications, NB-IoT and LTE CAT M1 (FDD). These were each incorporated in 53 devices respectively.
- Conversely, LTE CAT M1 (TDD) and EC-GSM were included in only two and one devices, respectively, in 2022.

eSIM

- This was the fourth full year that the certification of eSIM (RSP) devices has been possible.
- 124 devices were certified that supported RSP. This compares with 83 RSP devices that were certified in 2021.
- Of these, 33 devices supported removable eUICC and 94 supported non-removable eUICC.

Secure NFC

- 22 devices were certified that supported embedded secure element NFC (eSE-NFC), representing about 9% of all smartphones certified, slightly down from 27 devices in 2021.

oneM2M

- In 2022, one product supporting oneM2M Release 1 was certified (the same as in 2021). Validation of Release 2 test cases was delayed, which reduced the number of oneM2M certifications. oneM2M Release 2 became active within GCF's certification programme in January 2023.

Complexity / multi-mode devices

- 90% of all devices certified in 2022 incorporated more than one radio bearer technology, down slightly from 93% in 2021.
- 69% of devices incorporated three or more technologies, down slightly from 71% in 2021.
- This reflects the continued need to support end-users served by operators whose network infrastructures include more than one generation of mobile technology, or where these new generations are active at different time frames.
- The number of 5G frequency bands supported on average by devices keeps growing, while the number of 3G bands continues its decline, and the number of LTE bands stopped its growth. This aligns with the trend of more operators launching 5G services and more frequency bands (new or refarmed from previous generations) being used for these services.

Number of bands in "average" (mean) GCF-certified device (across all devices)											
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
GSM	3.5	3.5	3.5	3.2	3.1	3.1	3.2	3.7	3.4	3.7	3.6
3G	2.2	2.6	2.7	2.9	3.1	3.2	3.4	6.1	6.0	3.8	3.7
FDD-LTE	0.3	1.2	2.3	3.6	4.6	6.0	7.6	10.0	10.6	11.1	9.3
TDD-LTE	0.0	0.0	0.1	0.3	0.6	1.0	1.3	2.9	2.5	3.5	2.6
5G								0.1	1.7	10.7	12.9

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

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

2022 saw 85 device manufacturers undergoing certification of at least one device with GCF, down slightly (4%) versus 2021, but still higher than any other previous year.

The number of devices certified (649) was 6.6% higher than in 2021. The main area of growth was in the number of modules, so this increase has primarily been driven by the growing demand for modules for different applications (laptops, tablets, vehicles, routers and many other IoT use cases).

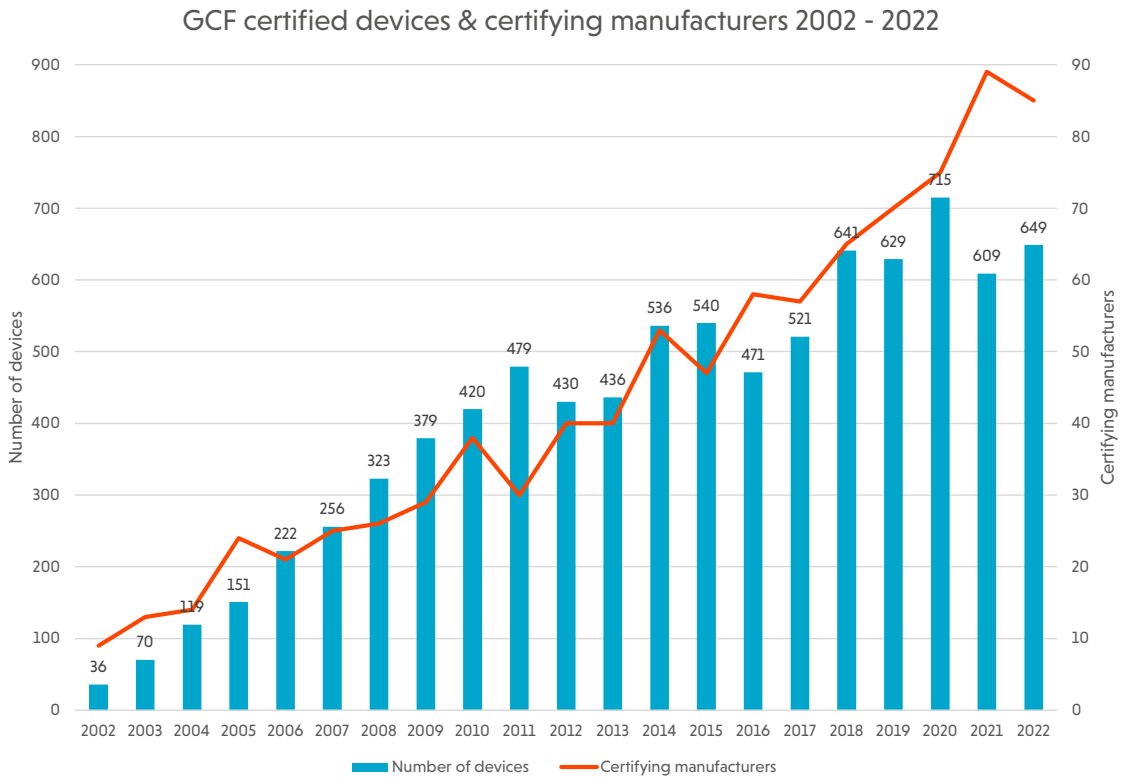

Fig 1

GCF works with device manufacturers of all sizes, and three manufacturers certified 38 devices or more. Conversely, 49 manufacturers certified three devices or fewer. And of the 85 manufacturers certifying devices in 2022, 15 were new members.

Comparing annual certifications against global device sales (source: Gartner) 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 (source: Gartner). All of the world's top-10 smartphone manufacturers are members of GCF and adhere to its principles.

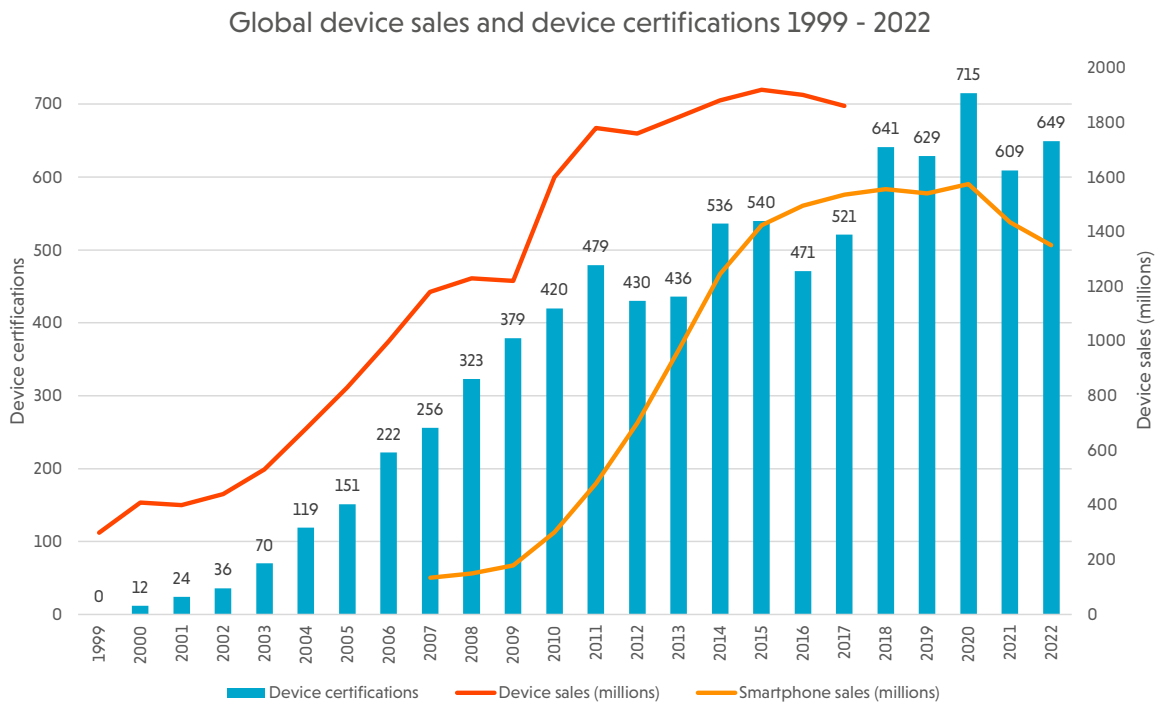

Fig 2: Device sales source: "Gartner Worldwide Manufacturer Sales to End Users of Mobile Terminal Devices / Gartner Global smartphone sales to end users 2007-2021", and estimate from public data for 2022, collated by GCF.

1.2: Certified devices by type

Smartphones continue to be the largest class of devices certified, but in 2022 they make up just 37.0% of the devices certified, down six percentage points on 2021, which in itself was a decline from 2020. This decrease may well be due to changes in approach from manufacturers, with fewer different product models released, rather than any fall in the popularity of smartphones. We have also seen an impact of the global chip shortages on smartphone model numbers.

This decrease in smartphone share is also partly due to continued growth in the number of modules certified, up more than six percentage points on 2021 to 36.7%. There were fewer IoT-specific modules within this number, making up only about one in eight of the total number of modules.

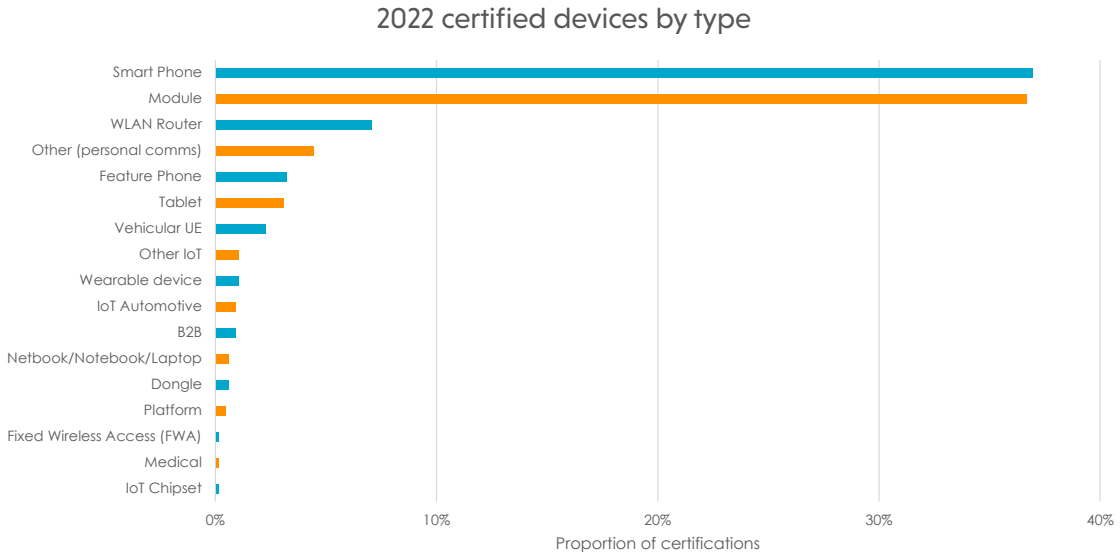

Fig 3a

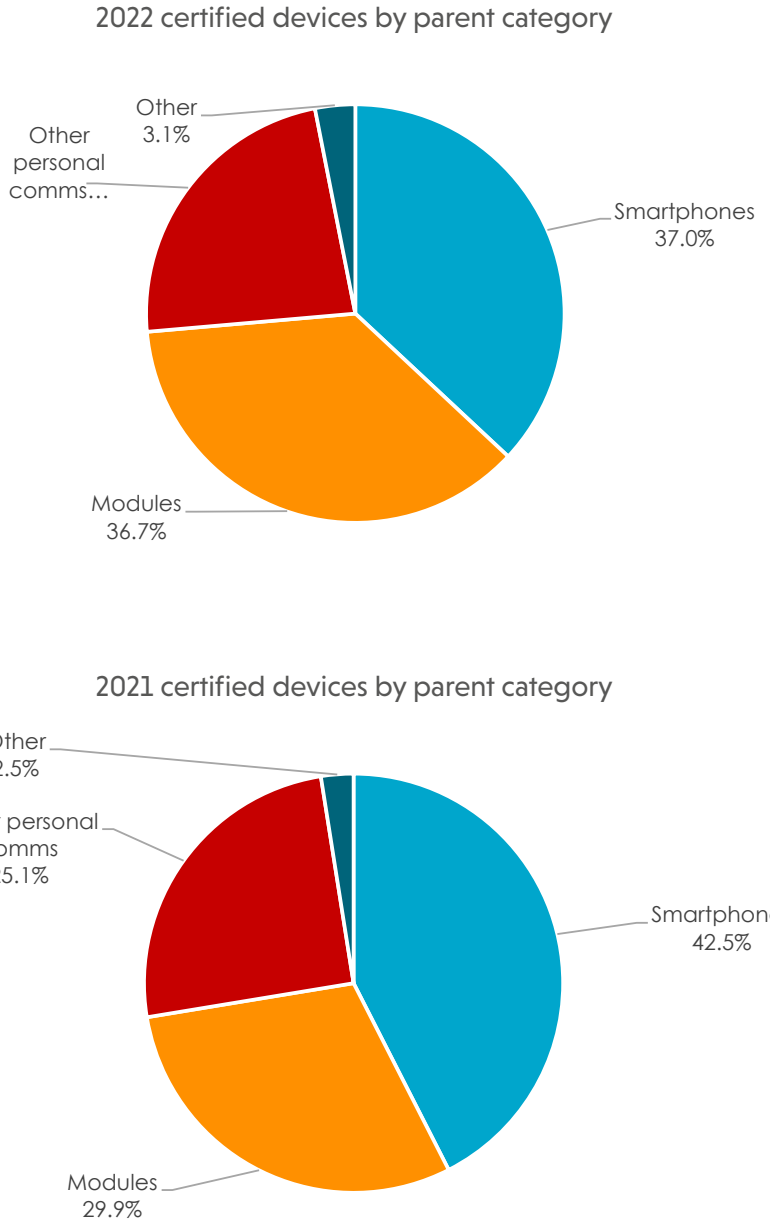

Fig 3b and c

The number of smartphones certified decreased to 240 in 2022, down from 259 in 2021 (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.

13% of certifications were feature phones, tablets, laptops, mobile gateways/ portable hotspots, USB modems and other non-smartphone communication devices, down slightly on 15% in 2021.

This includes:

- Tablets with cellular connectivity, where the proportion of certifications fell from 4.8% in 2021 to 3.1% in 2022 (20 devices).
- Feature phones, where the proportion of certifications fell slightly from 4.1% in 2021 to 3.2% in 2022 (the number of devices certified fell from 25 to 21).

1.3: Certified devices by mobile technology used

As in 2021, LTE has again retained its crown as 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 hardly any devices where 3G or GSM are the highest level of RAN supported (one for 3G, and seven for GSM), typically targeting low-cost devices with limited capabilities..

Proportion of 2022 certified devices incorporating each mobile technology

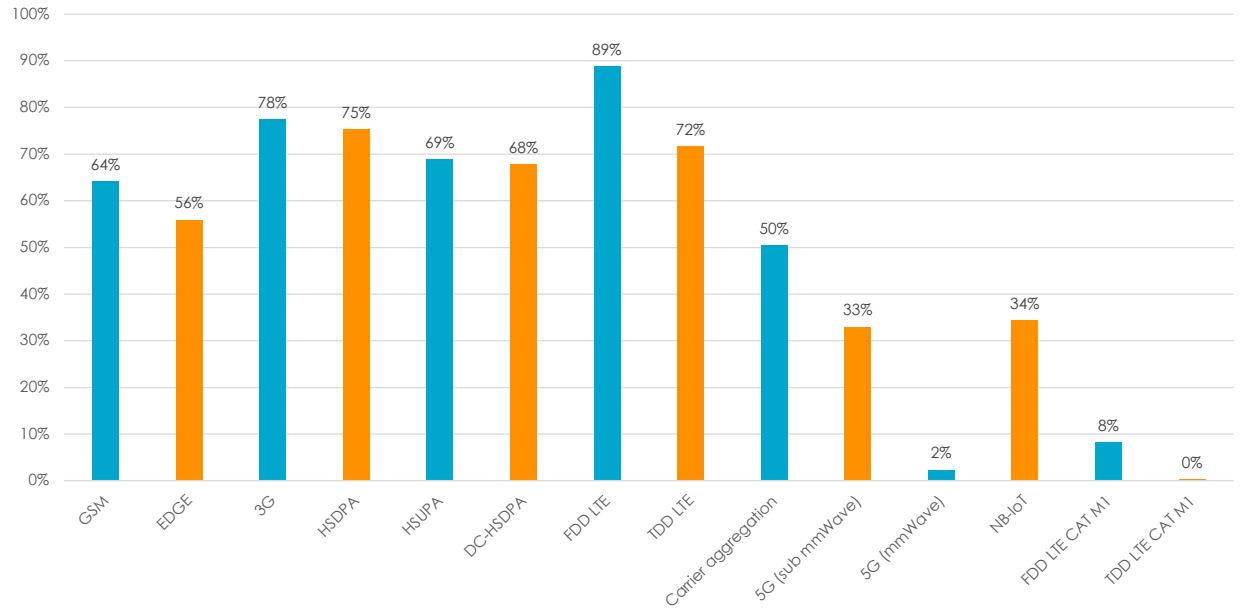

Fig 4

2. 5G

2.1: The rate of 5G incorporation

5G incorporation has continued to increase, although at a slowing rate if we consider the total number of devices, with the standard included in 33% of devices (215) certified, versus 31% in 2021, 21% in 2020, and just 2.5% in 2019.

Additionally, 91% (195) of 5G devices supported standalone 5G; and 7% (16) of 5G devices enabled access to FR2 5G frequencies, also referred to as high or FR2 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.

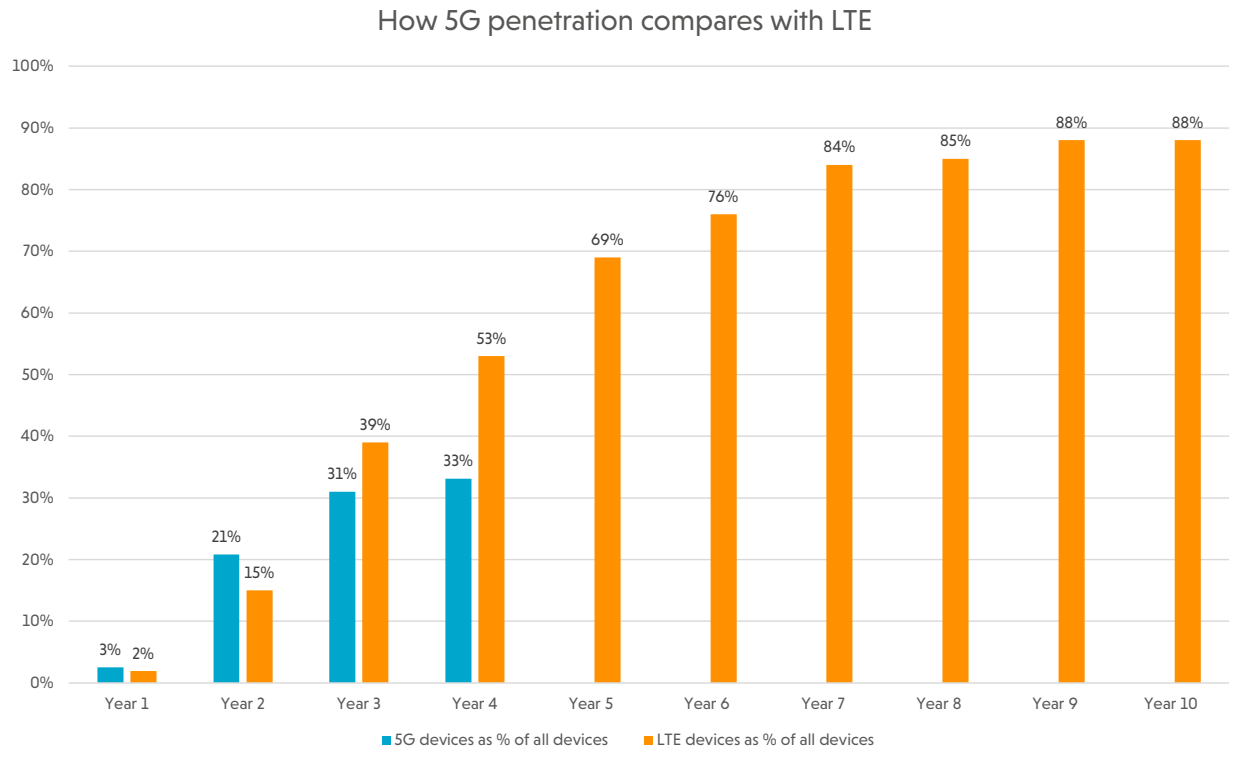

Fig 5

2.2: How this compares with LTE

This is the fourth year in which 5G services have been available to the public.

LTE was launched at the end of 2009, with the first LTE device certifications completed by GCF in Q1 2011. Nine LTE certifications were made that year, representing 1.9% of the total. The following year this increased to 15%, with 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 now lagging behind LTE's progress in years three and four if we consider the total number of certified devices, with 189 5G devices certified in 2021, representing 31% of all devices certified, and 215 5G devices (33%) certified in 2022. While most smartphones support 5G nowadays, the demand is not that high for wireless modules, with many use cases not requiring high bandwidths and being delivered over LTE or LPWA cellular standards.

In the early stages of 5G deployment, there was a high proportion of devices classed as NSA (Non-Standalone), while more recently, in 2022, there has been a shift with many more devices supporting 5G Standalone (SA) – now up to 91% of 5G devices certified. This reflects the rollout of more 5G SA networks by mobile operators, with further launches and service improvements in 2022.

2.3: Number of 5G device manufacturers

In 2021, 43 device manufacturers certified 5G devices with GCF, and 27 submitted at least two. Fifteen manufacturers certified five or more.

In 2022, 42 device manufacturers developed and certified 5G devices with GCF, and over two thirds of these companies (30) submitted at least two. Eighteen manufacturers certified five or more.

2.4: Breakdown of 5G devices by classification

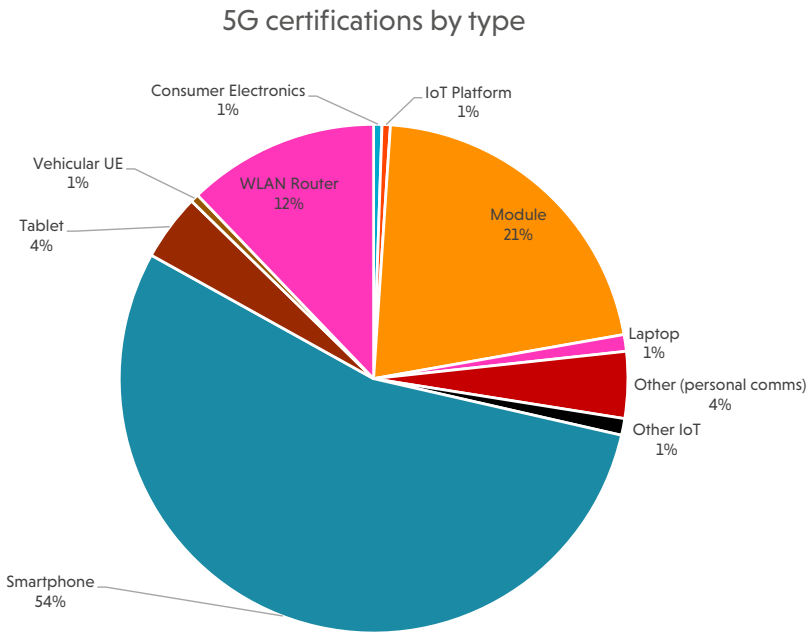

Fig 6

In 2020, most (84%) of 5G certifications were for smartphones (106 of the 149 certified 5G devices, 71%), and modules (twenty devices, 13%).

In 2021, the number of smartphones certified stayed almost the same (103), but the growth in 5G certifications overall meant that it was only 54% of the total. Modules grew their share to 21% (40 devices), and WLAN routers represented 12% (23 devices), significantly up from 4.7% in 2020.

In 2022, the percentage share of each kind of device stayed almost identical to 2021, with smartphones (117 devices) still being the largest group.

2.5: 5G NR bands certified

Incorporating multiple bands expands the potential market for a given device. With certification actively underway for 79 of the 87 5G NR bands (all 17 standalone bands are active for certification, as well as 62 out of 70 of the non-standalone bands), 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), as well as for standalone and non-standalone usage.

Bands of particular note include:

- n79 (3500 MHz), which was in 204 devices (95%), was the most commonly incorporated band.
- n1 (2100 MHz) was the second most commonly incorporated band, featuring in 181 certified devices (84% of 5G devices).
- n3 (1800 MHz) was the next most commonly incorporated band, featuring in 176 certified devices (82% of 5G devices).
- In the FR2 spectrum, the Ka band n261 (28 GHz) was incorporated in all 16 of the FR2 devices, while the band n260 (39 GHz) was incorporated in 15 of the FR2 devices.

During 2022, GCF has started tracking of 5G NR bands supported (not included in the certification) and certified:

- 26 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.

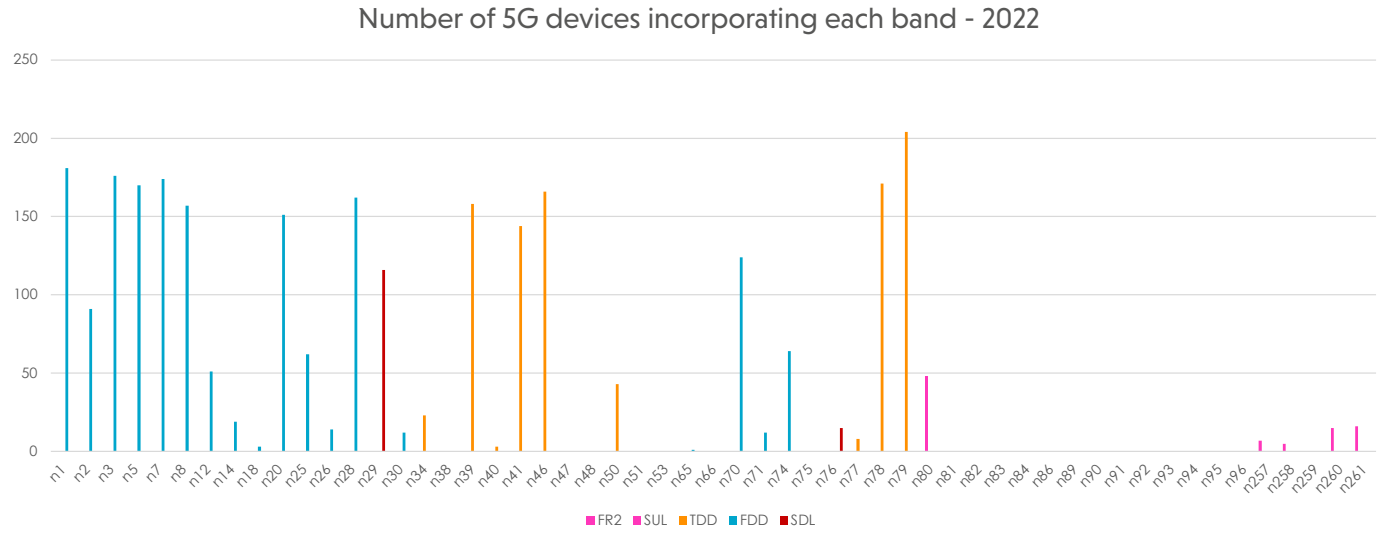

Fig 7

2.6: 5G device complexity

All of the 215 certified 5G devices supported E-UTRA-NR dual connectivity (Non-Standalone NSA EN-DC) with 195 devices supporting 5G Standalone (SA 5G NR only). Certification of 5G Non-Standalone connectivity option 4 (NE-DC) was introduced in 2022 but no devices were certified.

Looking at 5G SA devices that were certified, we can see that the mean number of 5G bands per 5G SA device was 13.0, up from 10.9 in 2021, with 113 devices supporting 12 or more 5G bands, up substantially from 30 devices in 2021.

16 devices were able to use the FR2 frequency bands.

The average complexity of FR2 capable devices decreased slightly, with these 16 devices allowing the use of 11.2 bands on average, down from 12.7 in 2021.

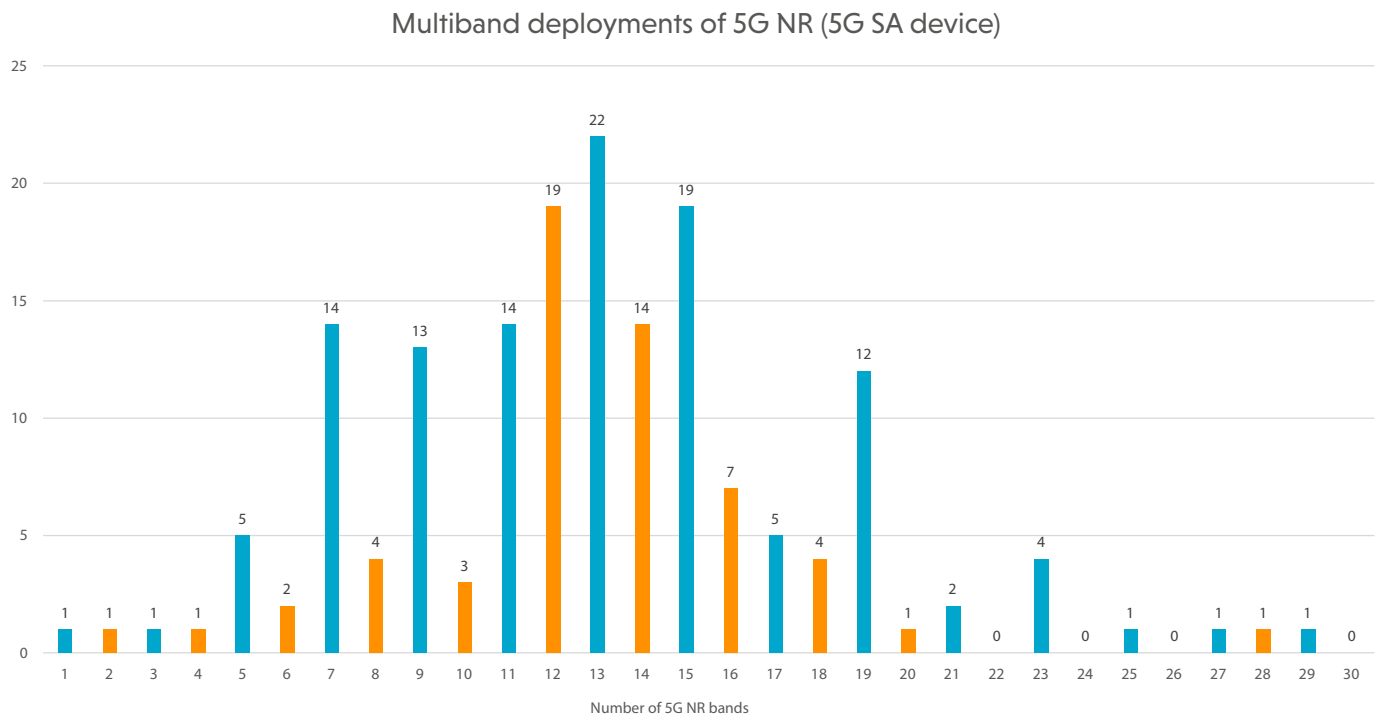

Fig 8

3. LTE

3.1: LTE appears to have plateaued

The penetration of LTE in certified devices has continued to plateau in 2022, with the standard being integrated into 89% of all certified devices (almost identical for the figures for 2019-21), and LTE retaining its position as the most integrated standard.

While it is holding steady for now, it will be interesting to see if this share falls as 5G continues its growth and begins to replace LTE for data communications, or if it stays at this level for the short-to-midterm future as a backup technology.

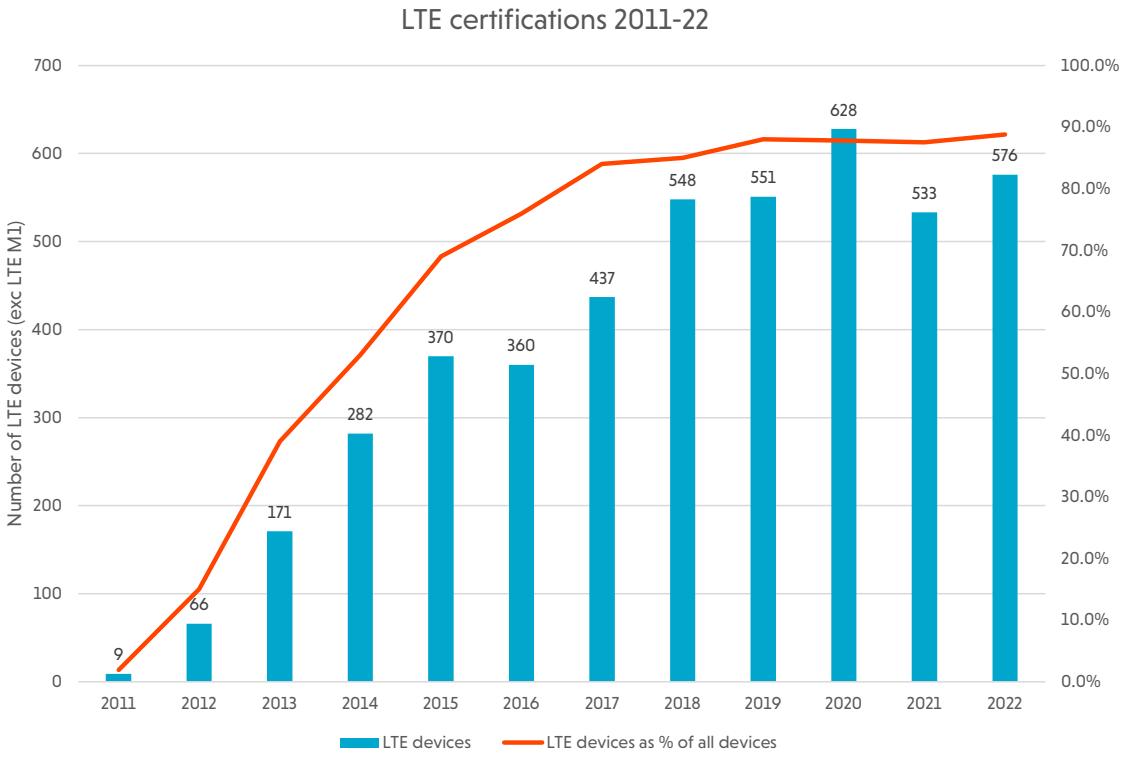

Fig 9

In 2022, 576 certified devices supported LTE. An additional 53 devices incorporated the cellular IoT variant, LTE CAT M1.

As in 2020 and 2021, FDD-LTE was supported in all these devices. TDD-LTE was incorporated into 81% of them (465 devices), up from 78% in 2021, 70% in 2020 and 66% in 2019. And while all TDD-LTE capable devices also incorporated FDD-LTE, the proportion of LTE devices supporting simultaneous FDD/TDD operation is 62% (357 devices). This is up from 55% in 2021.

There was also an increase in certifications supporting Gigabit LTE, with 99 Category 16 / Category 18 devices certified, up from 70 in 2021 and slightly down from 125 in 2020, but still up from 50 in 2019 and just six in 2017.

VoLTE operation was certified in 76% of LTE devices (440), which is an increase from 2021 when 68% of devices supported it.

3.2: LTE bands used

The GCF scheme enables the certification of devices designed to operate in 25 FDD-LTE and sub bands and nine TDD-LTE bands.

During 2022, all bands covered by the GCF scheme had devices certified. Bands of note include:

- Band 7 (2600 MHz) moved up one place to become the most certified LTE band, incorporated in 507 devices (88% of LTE devices and 78% of all devices).
- Band 3 (1800 MHz) dropped down to become the second most certified LTE band. It features in 485 LTE devices (84% of LTE devices and 75% of all devices).
- Band 1 (2100 MHz) retained its position as the third most incorporated band. It featured in 481 devices (84% of LTE devices and 74% 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 403 devices (70% of LTE devices and 62% of all devices), slightly down on 2021 (which saw 71% of LTE devices able to utilise the band).

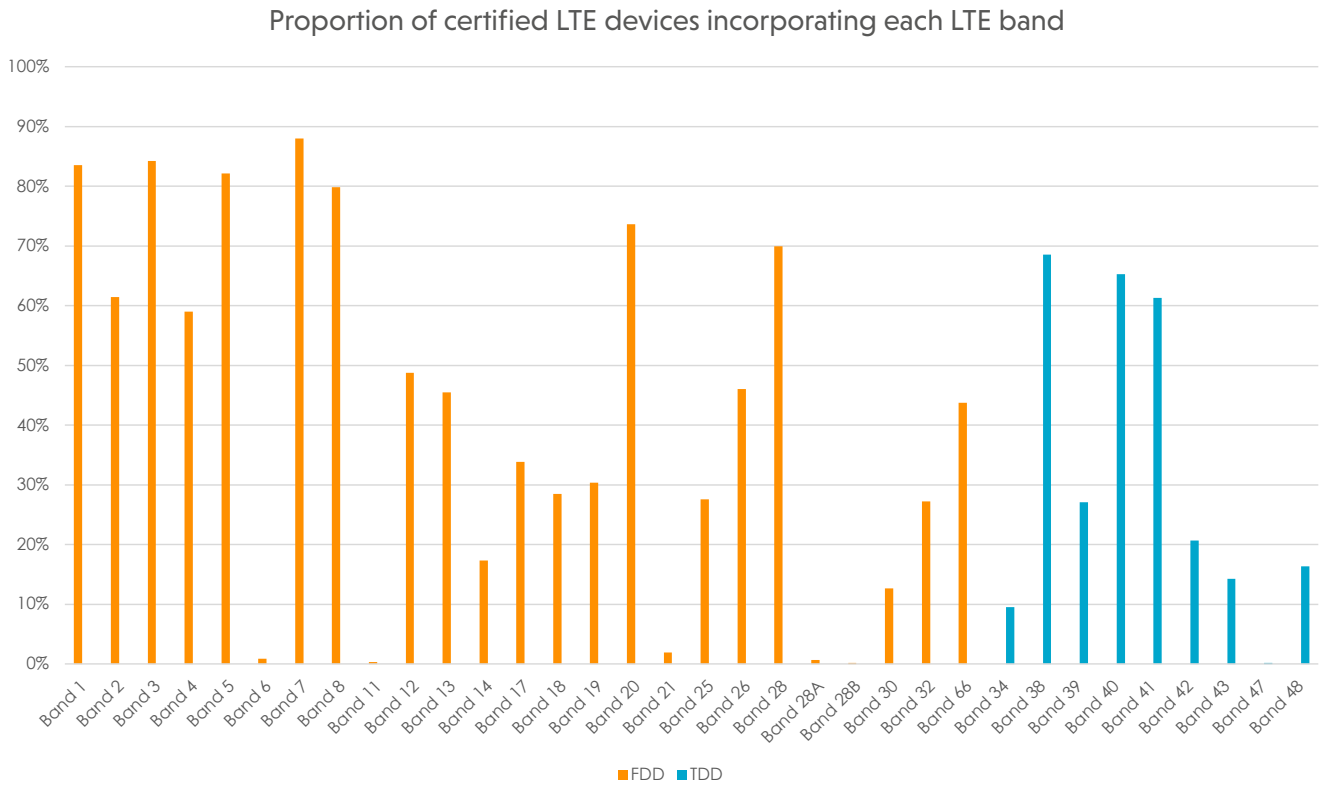

Fig 10

3.3: LTE device complexity

In general, the number of supported bands in LTE devices continued to increase during 2022.

Of the 576 devices incorporating LTE, 570 (99% of LTE devices – the same percentage as in 2021 and 2020) incorporated three or more LTE bands, while 98% incorporated five or more bands (same as 2021 and 2020), and (slightly over) half of LTE devices incorporated 12 or more bands (versus 13 bands in 2021 incorporated in half of the LTE devices, and 11 bands in 2020) .

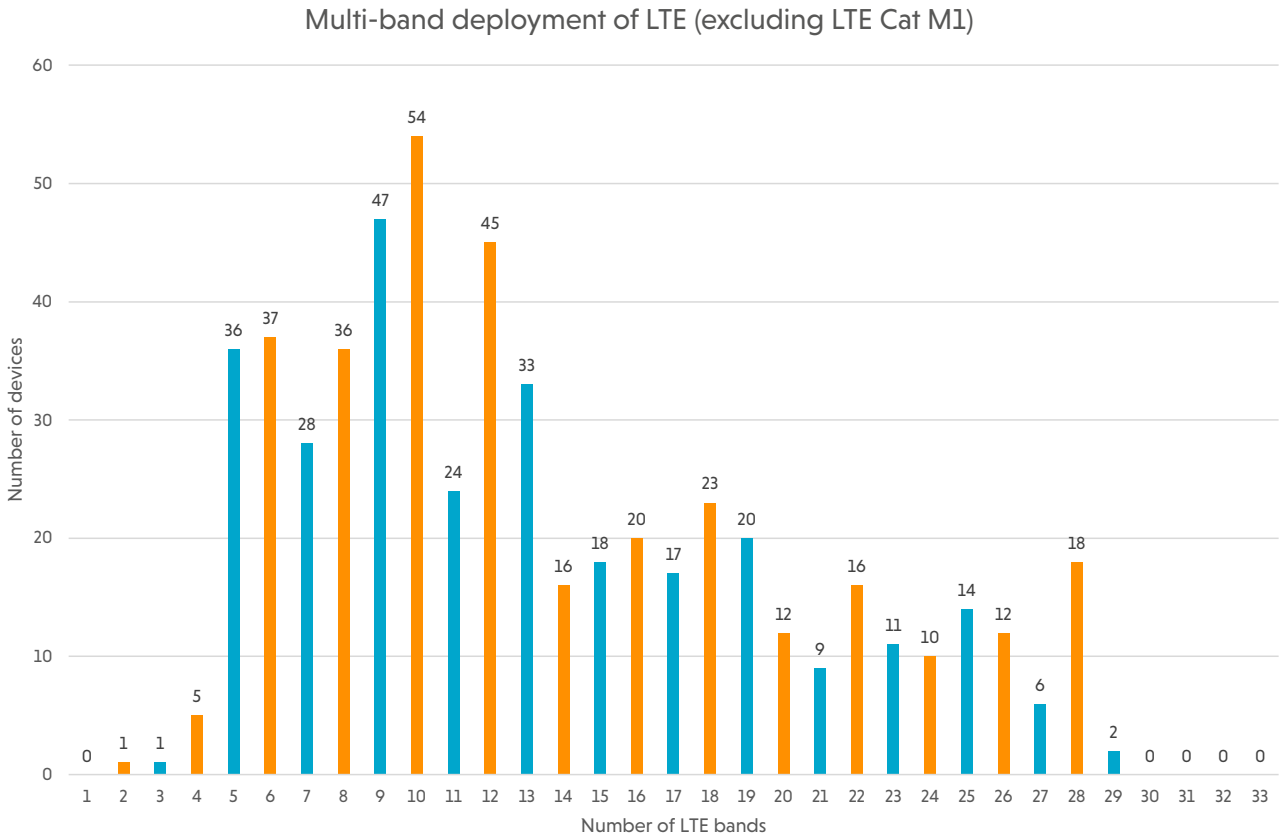

Fig 11

The modal number of LTE (excluding LTE Cat M1) bands is ten (the same as in 2021), and a slightly bimodal distribution is occurring, with 89 devices deploying 22+ bands (the same number as in 2021). 276 (48% of LTE devices) incorporated 10 or more FDD-LTE bands; down from 69% in 2021. 134 (23% of LTE devices) supported 15 or more FDD-LTE bands; down from 214 in 2021.

In 2021, the average (mean) LTE device incorporated 13.3 LTE bands, down slightly from 13.8 in 2021.

With such a wide diversity of bands, the number of potential inter- 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 Carrier Aggregation decreased in the past year with 337 devices certified (59% of LTE device certifications), down slightly from 61% (383 devices) deploying Carrier Aggregation in 2021.

4. 3G and GSM

Due to the decreasing interest in 3G and GSM, we have reduced the amount of detailed analysis in this report compared to previous editions.

4.1: Support of 3G

Manufacturers are still embracing 3G, despite operators prioritising LTE and 5G for data delivery. Certifications for 3G (UMTS/ WCDMA) stood at 78% (503 devices) in 2022, slightly down on 79% in 2021.

3G is usually included as a fallback technology for LTE devices, with just one standalone 3G device being certified during 2022 (the same as in 2021).

Certification of HSDPA and HSUPA were down slightly versus 2021, with 75% (489 devices) and 69% (447 devices) incorporating each respectively. This represents 97% and 89% of 3G devices. The penetration of dual-cell HSDPA remained about the same, at 68% of all devices.

4.2: GSM decline stabilised

The penetration of GSM declined steadily from 2008 and 2009 (when 100% of devices included the standard) to 2021 (when just 64% of devices did).

2022 saw the decline stabilise, with 64% of devices again including the standard, the same as 2021. However, there were only seven GSM standalone devices certified.

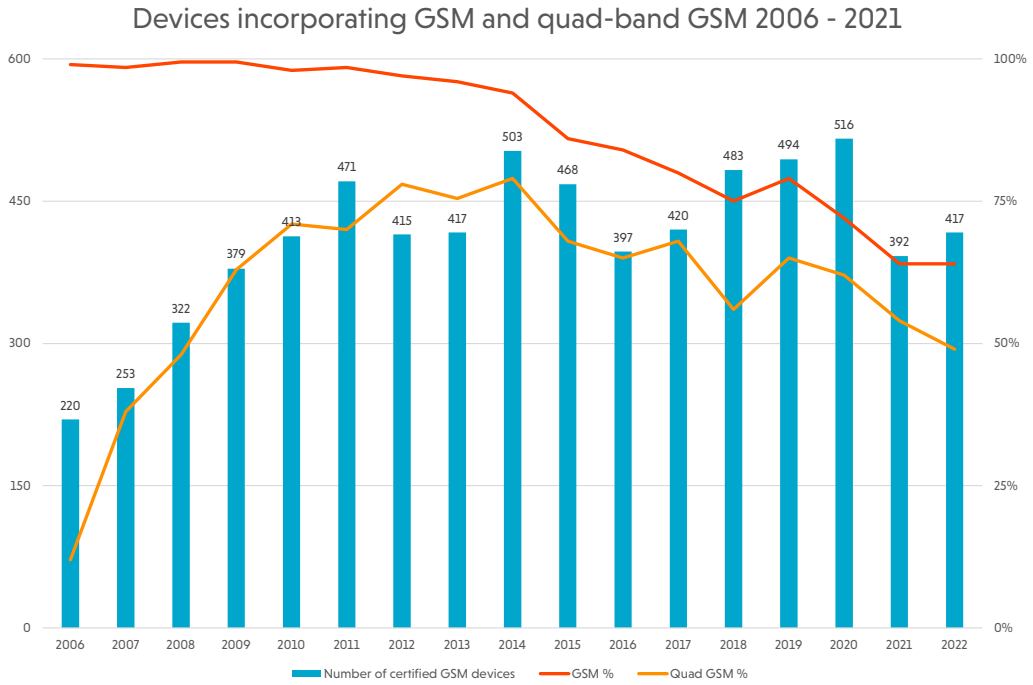

Fig 12

4.3: EDGE/ Quad-band GSM

EDGE was certified in 363 devices (56% of all devices, down from 60% in 2021, and 67% in 2020).

Certifications for Quad-band GSM devices saw a decrease, with 318 certifications (49% of all devices, versus 54% in 2021, 62% in 2020 and 65% in 2019).

5. Cellular IoT

5.1: The adoption of cellular IoT standards pauses

Cellular IoT has been widely adopted globally, and those devices based on 2G, 3G and 4G technologies are set to be enhanced further with the growth of 5G networks: improving not just in terms of speed, but in latency and reliability.

This is the 6th year that GCF has certified the cellular LPWA IoT standards: LTE CAT M1 (FDD), LTE CAT M1 (TDD), NB-IoT and EC-GSM. In this time the number of devices has increased significantly, with NB-IoT certifications increasing more than 10-fold, and LTE CAT M1 (FDD) increasing more than 20-fold.

However, both of these figures decreased in 2022:

- NB-IoT was featured in 53 devices certified this year (down from 65 in 2021)
- LTE CAT M1 (FDD) featured in 53 devices (down from 64 in 2021)

But, these two standards dominate. LTE CAT M1 (TDD) was not included in any devices certified in 2021 (there was just one in 2020); and EC-GSM was also not in any devices (there were three in 2020).

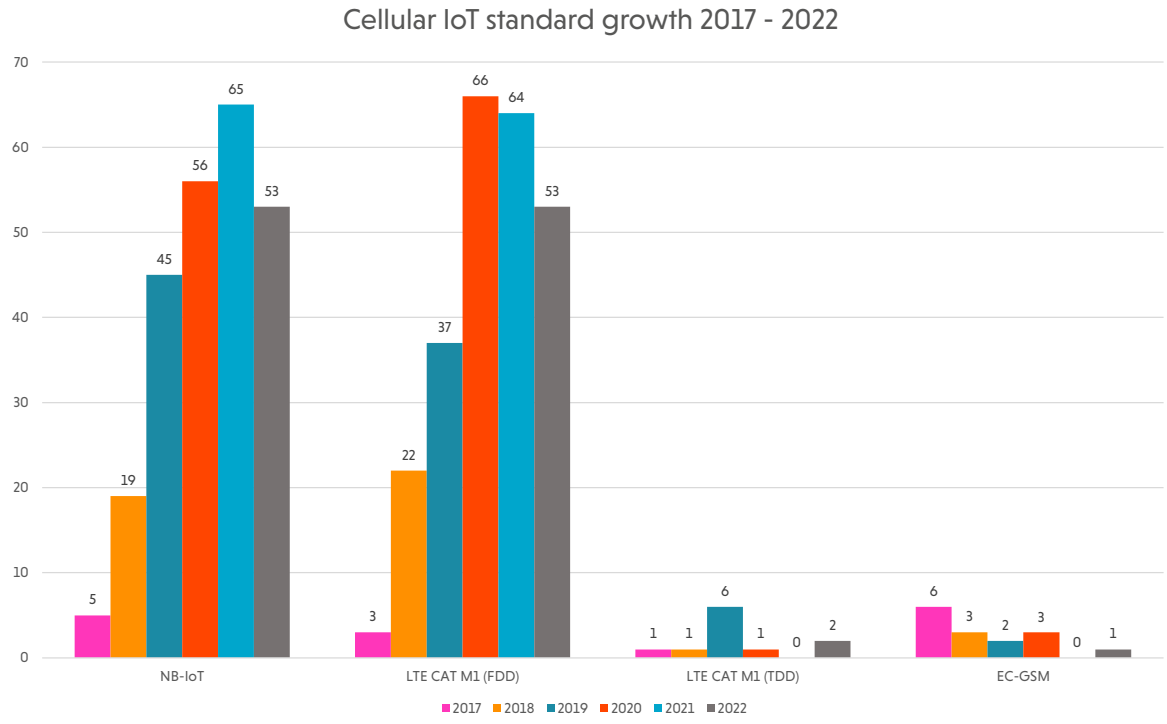

Fig 13

6. Device complexity

6.1: A further rise in overall complexity

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

2022 continued this trend overall, and the proportion of certifications for devices supporting four or more bearer technologies rose to 22%, from 18% in 2021.

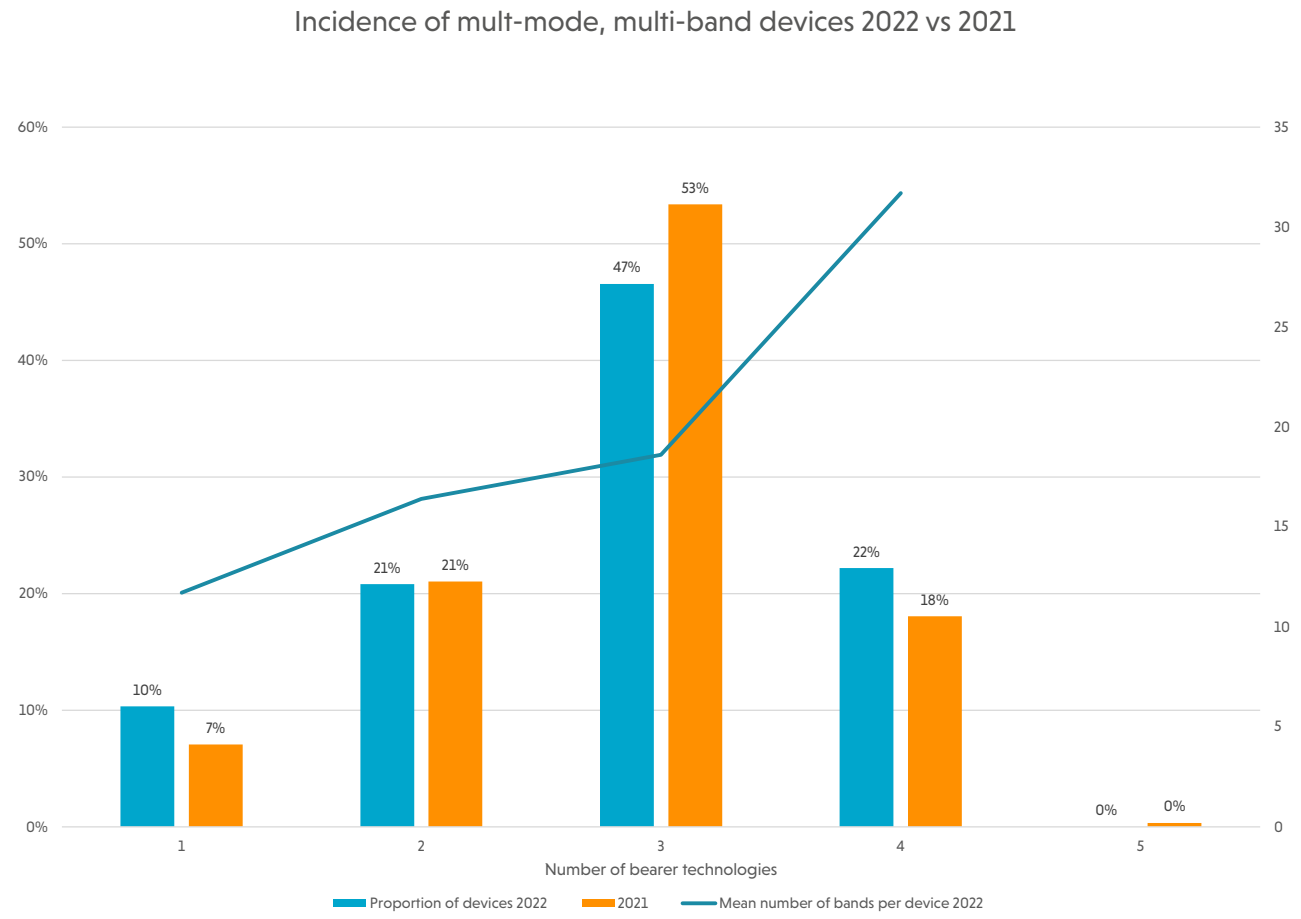

Fig 14 – Bearer technologies have been classified as 2G (GSM/ EDGE), 3G (WCDMA/ UTRA/ HSDPA/ HSUPA), 4G (LTE FDD/ LTE TDD), 5G, CDMA2000, NB-IoT, LTE M1 (TDD/ FDD), EC-GSM

6.2: Single-mode devices

The proportion of single mode devices (just one radio bearer supported) rose slightly in 2022, up to 10% compared to 7% of devices in 2021, although still down from 12% of devices in 2020. These single-mode devices are predominantly Cellular IoT (8 devices), and LTE systems (45 devices).

There was only one standalone 3G device (that only supports 3G and no other modes), down from four in 2021. There were no 5G-only devices in 2022, the same as in 2021.

The complexity of single mode devices increased substantially, with the mean number of bands in 2022 being 11.7, up from 5.8 in 2021.

6.3: Multi-mode devices

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

As in 2021, 2020, 2019 and 2018, 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 doubled in the last few years, from 8.5% in 2019 to 22% in 2022.

The number of implemented bands used in the average device is down slightly. Certified devices now have a mean of 20.3 frequency bands, compared to 21.8 in 2021, and 19.8 in 2020.

This figure increases to 31.7 bands for devices supporting four radio bearer technologies (down from 37.7 in 2021).

The highest number of implemented bands in one device in 2022 was 60, down slightly from 68 in 2021.

7. Smartphones

7.1: Smartphone growth

Smartphones have consistently represented the largest category of devices certified by GCF. 2022 continued this trend, with the category representing 37% of all certifications, although this was down from 2021's figure of 42.5%.

A total of 240 smartphones were certified in 2022, down from 259 in 2021.

These 240 devices came from 29 manufacturers. 40% of the certified smartphones were developed by just two manufacturers, although this is down from 45% in 2021. And 63% of smartphones certified were made by just five manufacturers, down from 70% in 2021.

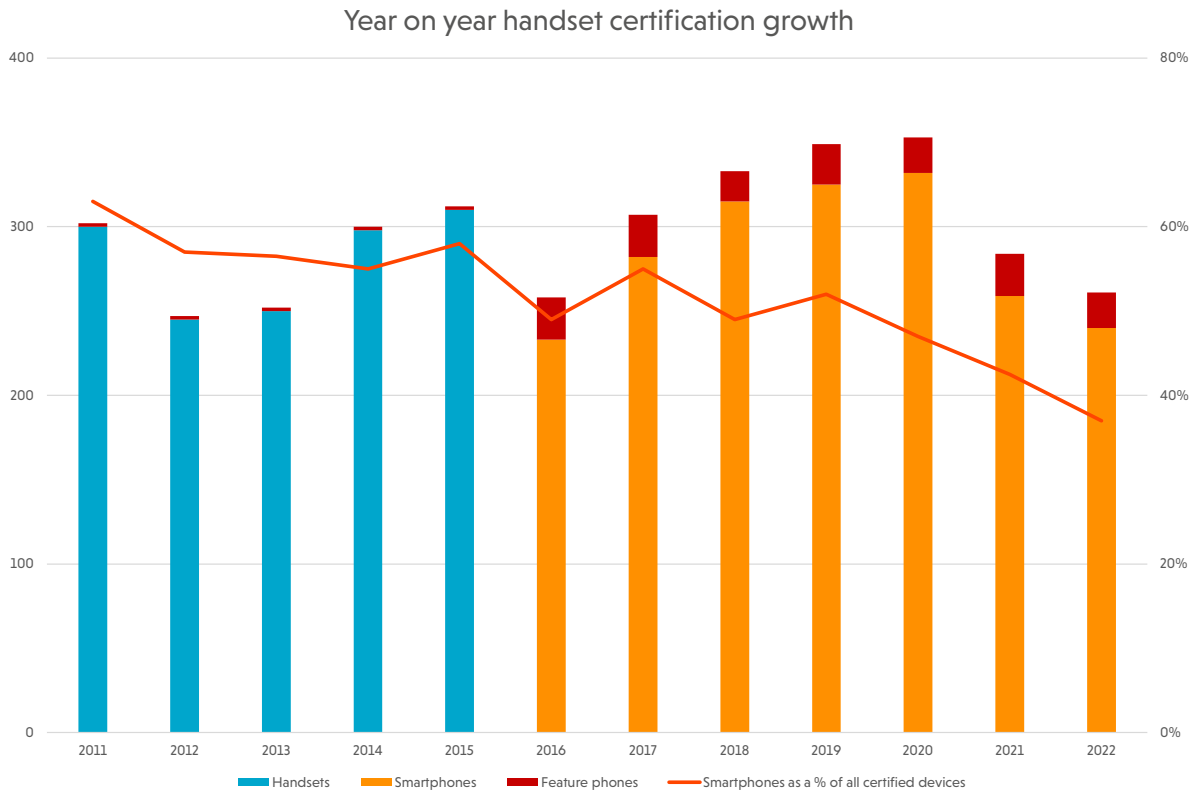

Fig 15

7.2: Smartphone complexity

Smartphones are also significantly more complex than the average device, with 95% of smartphones (the same as in 2021) integrating three or more radio bearer technologies, versus 53% for non-smartphone devices (up from 41% in 2021).

However, the number of bands per device is lower for smartphones, continuing the pattern established in 2021, while in previous years it was higher than for non-smartphone devices. Smartphones with three bearer technologies used spectrum across an average of 15.8 bands; for non-smartphone devices this figure is 20.2. This appears to be due to the high number of modules being certified that support a large number of bands.

Due to the very small number of non-smartphone devices that support four or more radio bearer technologies, it is not possible to compare without being affected by skews.

Complexity of smartphones vs other devices - 2022

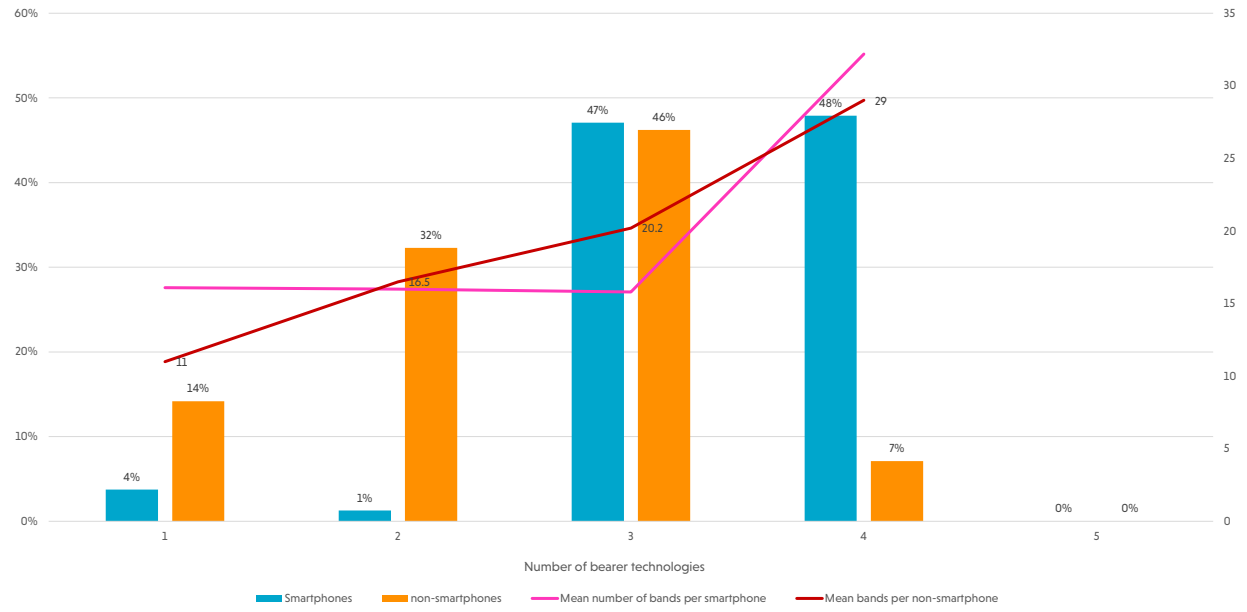

Fig 16

7.3: Mobile technologies incorporated

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. Additionally, 117 smartphone designs support 5G.

Proportion of 2022 certified devices incorporating each mobile technology - smartphone vs non-smartphone

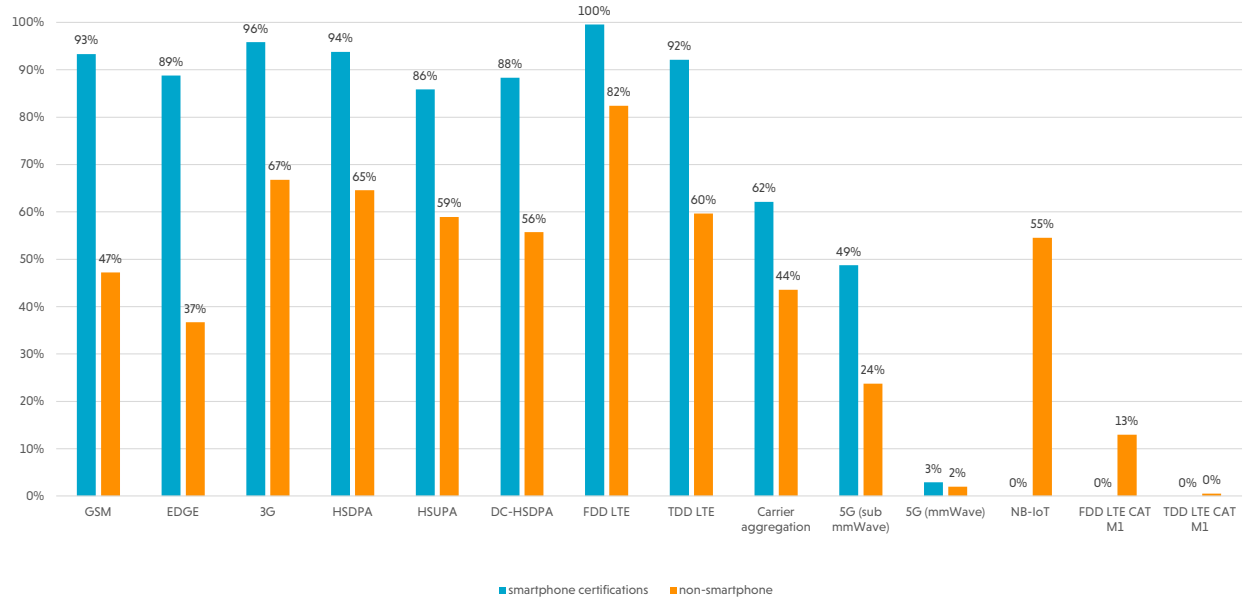

Fig 17

8. Wireless modules

8.1: Wireless module growth

Since 2020, GCF has included IoT-oriented modules among the more general module category. In total, there were 238 modules certified in 2022; representing just under 37% of the total, almost identical to the figure in 2021.

In 2022, 66% of module certifications came from just four companies (down slightly from 71% in 2021). Additionally, the top four module manufacturers were among GCF's top 10 manufacturers by number of certifications.

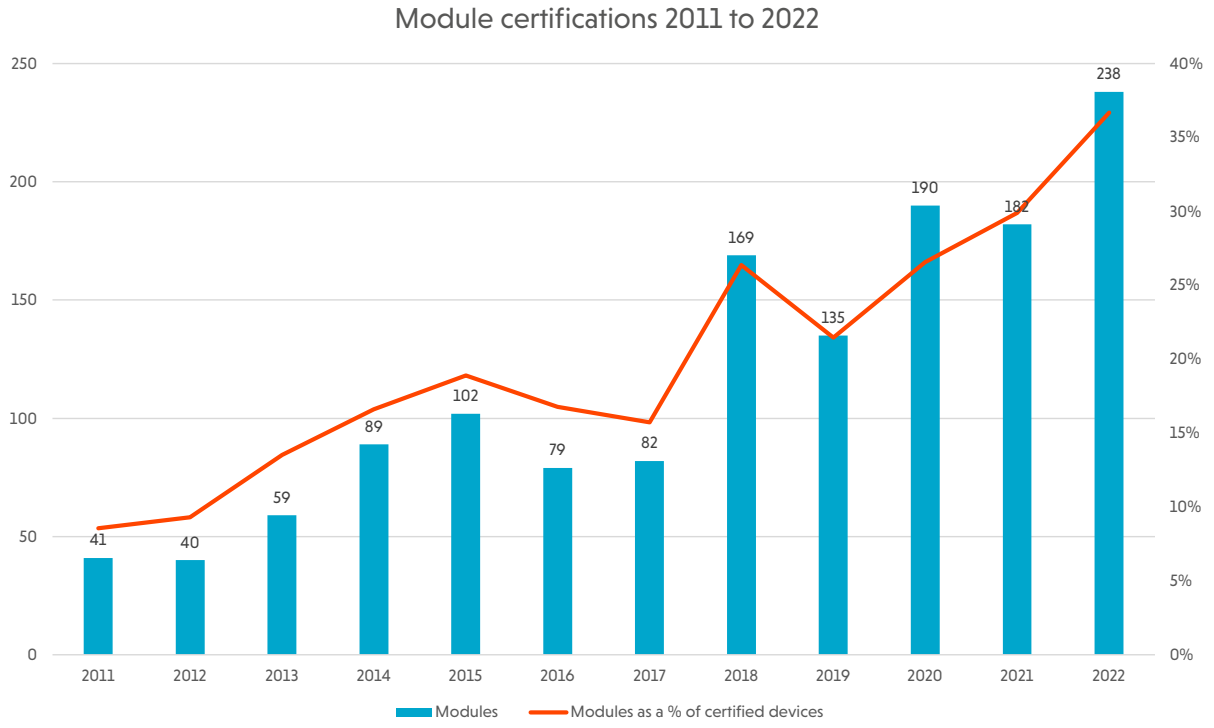

Fig 18

8.2: Module complexity

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

38 of the 238 certified modules (16%) were single-mode, up slightly on 14% in 2021. 35% in 2022 incorporated two radio bearer technologies (up slightly on 32% in 2021) and 46% in 2022 included three (down slightly on 51% in 2021). There were also 8 modules incorporating four radio bearer technologies, compared to none in 2021.

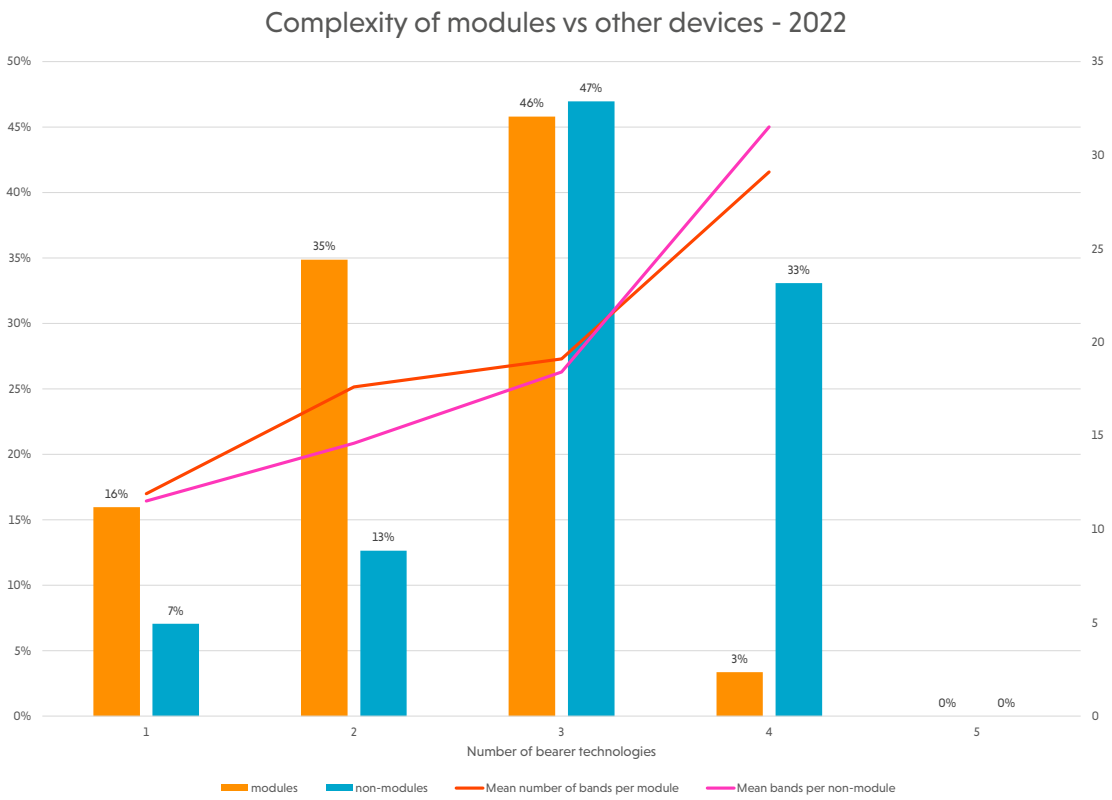

Fig 19

The mean number of frequency bands per module certified has risen slightly, now standing at 17.7 per module (up from 17.6 in 2021). The maximum number of frequency bands for a module was 60.

8.3: 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 2021, FDD LTE is the most commonly certified bearer technology in modules, with 76% of modules incorporating it in 2022, compared to 64% in 2021. In 2022, 62% of modules incorporated 3G (UTRA) versus 53% in 2021, and in 2022, 26% incorporated GSM, versus 38% in 2021.

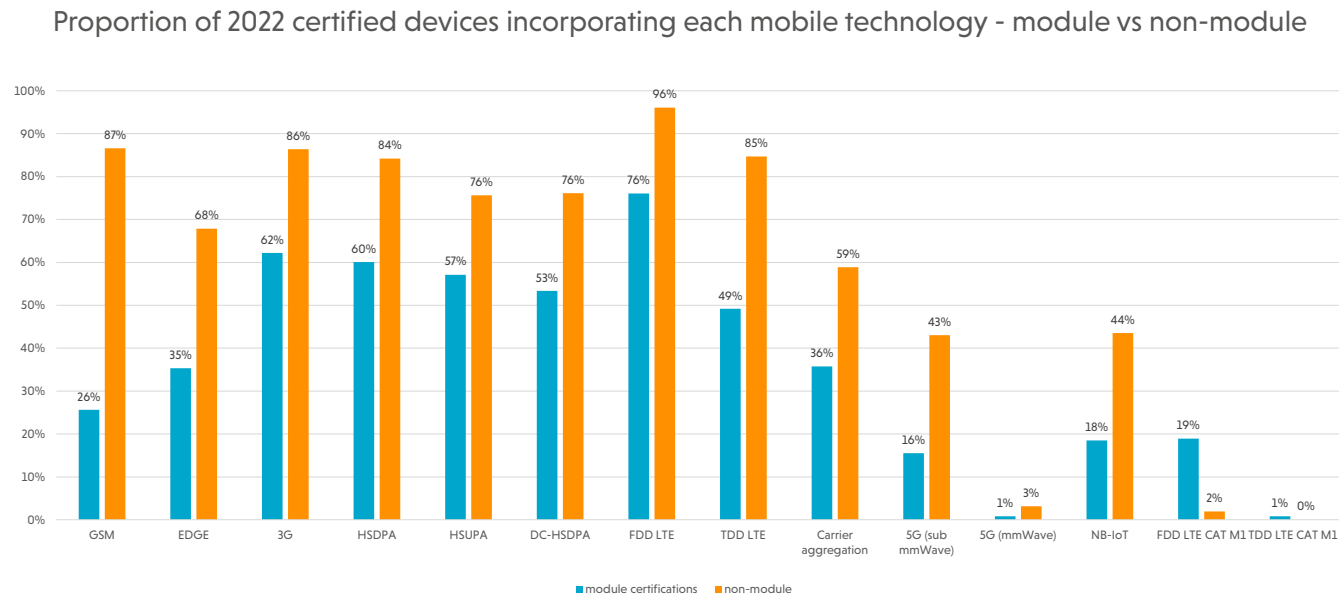

Fig 20

9. 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.

While the number of smartphone certifications went down in 2022 compared with the previous year, module certification was increasing reflecting the growth of, and need for, multiple applications, including an increasing range of IoT solutions.

In 2022, the average GCF-certified device incorporated 2.8 radio bearer technologies (the same as in 2021) and operated across 20.3 frequency bands (this was 21.8 in 2021).

Demonstrating the conformance and interoperability of today's sophisticated multi-mode, multi-band smartphones, modules and vehicles to the satisfaction of the world's mobile operators and governments is therefore essential. And this GCF Device Analysis shows that its solutions remain relevant to the pre-launch testing of devices.

With 2023 set to see a significant rise in the number and market penetration of 5G devices, coupled with its use in vehicle-to-vehicle and vehicle-to-infrastructure systems, the need to demonstrate this conformance and interoperability remains paramount.

10. Looking ahead

As we look ahead to 2023, we can see that the implementation of 5G is continuing to grow, not just in number of devices supporting it, but also in the support for more operation modes, frequency bands and frequency bands combination (carrier aggregation), to support the increasing bands being activated for 5G services by operators and service providers. 5G Reduced Capability (5G NR Light or 5G RedCap), 5G features from 3GPP releases 17 and 18, and satellite connectivity for IoT are expected to be incorporated in the GCF certification in 2023.

GCF expects to see more interest in certification of C-V2X (cellular vehicle-to-everything) devices, which are fundamental to the growth and adoption of next-generation automotive systems. In 2022, we saw two products certified by GCF for C-V2X, and more will come in 2023 with the scope of certification being extended from vehicle-to-vehicle (V-V) to include vehicle-to-network (V-N) and 5G.

In cooperation with TCCA, GCF will also launch certification for mission-critical services within 2023.

For other technologies, GCF announced the activation of oneM2M Release 2 within GCF's certification programme in January 2023, extending the scope of the oneM2M standard to meet the growing needs of the global IoT market. Certification of oneM2M Release 3 is also on the way and is expected by the end of 2023.

11. How GCF ensures compliance and interoperability

11.1: 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, OMA, NFC Forum, oneM2M and TCCA. 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.

11.2: Who GCF works with

As of February 2023, over 150 device manufacturers are participating in GCF. The GCF suite of certification solutions is also recognised by operators with interests in global markets.

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.

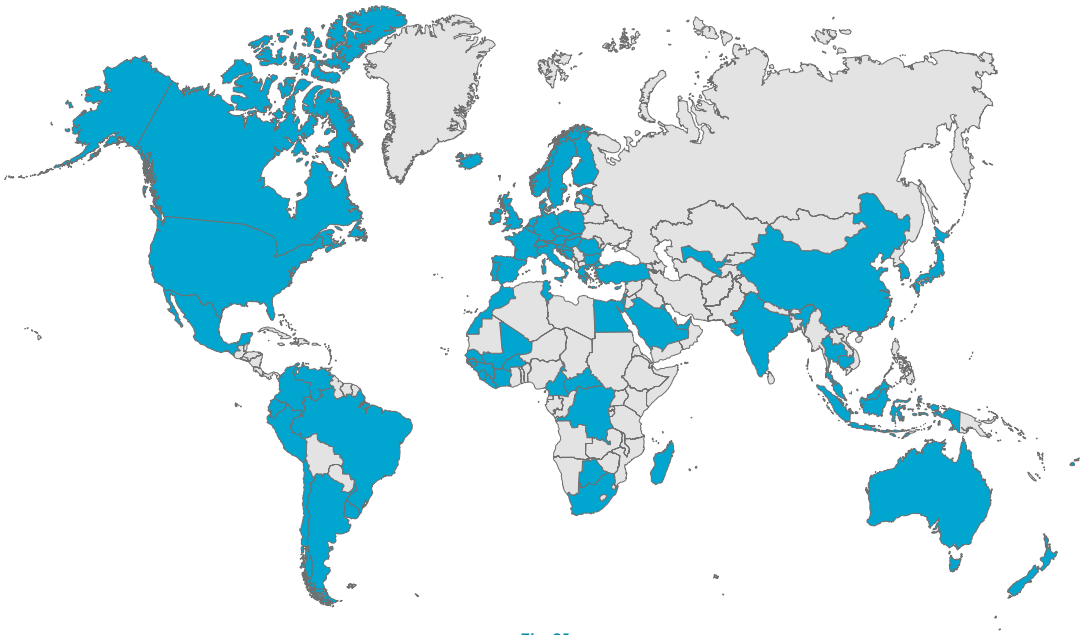

Fig 21

11.3: 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.

11.4: 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 cover newer technologies as they were adopted: GPRS, EDGE, 3G UMTS (WCDMA), HSPA, 4G LTE, LTE-Advanced, LTE-Advanced Pro, NB-IoT, eSIM and 5G (FR1 and FR2 bands).

More recently, GCF has added Cellular Vehicle-to-Everything (C-V2X) compliance testing, and also will soon launch MC-LTE and cellular satellite-based (non-terrestrial networks) device certification capabilities. GCF can also 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/ to networks is assisted by the GCF initiative, which provides an effective method for verifying the correct operation of Carrier Aggregation currently up to 5 simultaneous frequency bands (5CA).

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

12. Key GCF milestones:

Date	Event
January 2023	oneM2M Release 2 certification launched
November 2022	First C-V2X module certified
June 2021	C-V2X Automotive programme launched
March 2020	First IoT chipset certified
July 2019	First 5G device capable of accessing FR2 bands certified
April 2019	First 5G device certified
February 2018	RSP eSIM certification for consumer devices introduced
December 2017	GCF starts development of 5G device certification
September 2017	First LTE-M device certified
March 2017	First NB-IoT device certified
February 2017	Platform Certification introduced
December 2014	First CDMA2000 devices certified.
March 2011	First LTE device certified
Feb 2006	First 3G device certified
May 2000	Certification of first device – GSM
1999	GCF Founded

Fig 25

13. GCF Device Certifications

Certified devices are listed on the GCF website at:
https://www.globalcertificationforum.org/services/3gpp-certifications/all-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/services/3gpp-certifications/modules-and-iot-chipsets.html

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