GCF
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Mobile Device TRENDS

An analysis of GCF device certifications in 2020

By combining conformance and interoperability tests undertaken in laboratories with field trials on multiple commercial networks, GCF Certification verifies the quality of the interoperability between mobile phones, wireless or IoT devices across different network elements and vendors' infrastructure.

Hundreds and hundreds of different devices are certified each year. The following is an analysis of GCF's certification listings which provides insight into current trends within the mobile device market.

March 2021

Executive SUMMARY and 2021 anticipated trends

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 2021, over 130 device manufacturers across 23 countries are participating in GCF. The scheme is also recognised by operators with interests in global markets (Fig 25).

This annual review of Mobile Device Trends is based on an analysis of device certifications published by the Global Certification Forum during 2020. The analysis provides insights into the mobile technologies and functionalities being requested by operators and end-users across markets worldwide. It also takes into account the effect of Covid-19 on the sector and certifications.

A total of 715 devices from 75 manufacturers were certified by GCF in 2020. The following outlines the key findings:

5G:

- Now in its second year, the integration of 5G into devices has continued rapidly, and the incorporation of the technology is significantly outpacing 4G in its first years.
- 149 devices (21%, up from 2.5% in 2019) of all 2020 certificated devices integrated 5G. This came from 28 vendors.
- 32 of these devices were also able to use the mmWave spectrum, with 30 using the Ka band (both 28 GHz and 39 GHz), five used the 26 GHz K band, and four using the 28 GHz LMDS band.
- A third (34%) of 5G devices supported standalone operation.
- This compares with just 15% of devices (66) able to access LTE spectrum in the 4G standard's second year of operation.
- In 2019, two companies were responsible for 69% of all 5G certifications. While there is still a significant market leader, contributing over three times as many certifications as its next rival, this domination was markedly reduced.
- The complexity of 5G systems is high. One device supported up to 19 5G bands. The average (mean) 5G device supported 8.8 5G bands, with 65 devices (44%) deploying 10+ bands, and nine deploying 15+.

Covid-19

- The overall number of device certifications was relatively unaffected by the Covid-19 pandemic, with only a very slight dip in certifications during Q2 2020. As a result of travel restrictions due to Covid-19 a temporary process under strict quality surveillance was introduced in March to allow manufacturers to postpone testing blocked by travel restrictions to a later time. More than 90% of these were closed in 2020.
- However, when breaking down certifications by bearer technology, a significant drop in certifications could be seen for non-5G devices in Q2 (see fig 23/24), with a recovery later in the year, and certifications of 5G devices continued relatively unaffected. We believe this is probably due to a shift in market focus, rather than being caused by Covid-19 (and the move to home working).

LTE

- As in 2019, LTE was the most used wireless communications standard in devices certified by GCF.
- 88% of all devices (628) supported LTE. 100% of which supported FDD-LTE. 70% (439) supported TDD-LTE, 61% (383) supported carrier aggregation. This is a similar proportion as in 2019, albeit a significantly increased absolute number of certifications.
- VoLTE support was certified in 69% of LTE devices (430). This is comparable with 2019, where 70% supported VoLTE.

3G (UMTS/ WCDMA)

- 3G certifications remained constant, with 83% of certified devices implementing the standard. This had fallen in 2019, and the standard's resilience is surprising given a long-term push by operators to replace 3G data capacity with LTE and, now, 5G.
- There were no standalone 3G devices developed and certified by GCF in 2020 (down from five in 2019).
- The penetration of HSDPA (81%), HSUPA (80%) and dual-cell HSDPA (65%) remained approximately the same as 2019 (which had 81%, 79% and 64% respectively). The share of both HSDPA and HSUPA are down vs 2018.

cdma2000

- While cdma2000 remains a legacy technology, the number of devices certified in 2020 remains stable at 57.

GSM

- 72% of 2020 GCF certified devices (516) incorporated GSM, 1.4% of which (seven devices) were standalone GSM devices.
- This is a noteworthy fall vs 2019, where 79% of devices incorporated GSM and 39 standalone GSM devices were certified.
- EDGE penetration also dropped 4 percentage points compared with 2019, from 71% of devices to 67%.

Cellular IoT

- 2020 saw a significant increase in the number of devices incorporating a cellular IoT standard vs both 2018 and 2019.
- As in 2019, two standards dominated these certifications, NB-IoT and LTE CAT M1 (FDD). These were incorporated in 56 and 66 devices respectively.
- Conversely, LTE CAT M1 (TDD) was included in just one; and EC-GSM in just three.

eSIM

- This was the second full year that the certification of eSIM (RSP) devices has been possible.
- 69 devices were certified that supported RSP. This compares with 14 RSP devices that were certified in 2019.
- Additionally, 26 devices supported removable eUICC and 95 supported non-removable eUICC.

Secure NFC

- 177 smartphones (53% of all smartphones) were certified that supported SIM-based (UICC) Secure NFC services according to GSMA NFC specifications.
- Additionally, 63 smartphones (18.7% of all smartphones) were certified that supported embedded secure element NFC (eSE-NFC).

oneM2M

- In addition to Cellular IoT technologies, GCF also launched a certification program for oneM2M technology in 2019
- In 2020, 8 products supporting oneM2M Release 1 were certified
- It is projected that oneM2M product certifications will increase with upcoming Release 2 and Release 3 feature support in 2021

Complexity / multi-mode devices

- 93% of all devices certified in 2020 incorporated more than one bearer technology.
- 73% of devices incorporated three or more technologies.
- This reflects the need to support end-users served by operators whose network infrastructures include more than one generation of mobile technology.

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

Expectations for 2021

5G

The integration of 5G into devices has continued rapidly, and the incorporation of the technology is significantly outpacing 4G in its first years. Based on current trends, we expect to see that 5G will be supported in 40% of all devices certified during 2021, and that over 75% of these will support standalone 5G functionality. There will also be an increase in devices capable of using the higher bandwidth mmWave (FR2) 5G frequencies.

Growth for the 5G device sector will focus on, but not be limited to, smartphones and modules. And we anticipate seeing a significant increase in the number of bands and validated test cases in the certification scheme.

LTE certification

We also anticipate the start of LTE certification for C-V2X products that support the Mode 4 Sidelink PC5 interface for vehicular communication; for the 450 MHz band; and for mission-critical services.

Increased complexity

As new technologies are introduced and GCF certification matures, the total number of technologies and bands in the "average" certified device tends to increase, even as the oldest technologies start to decline.

An upside of such complexity is that certified multi-mode, multi-band devices can be marketed in multiple territories, thereby improving economies of scale for manufacturers.

Pre-launch testing is required to demonstrate that each individual bearer technology is performing correctly and that the incorporated technologies interwork with each other to deliver seamless operation to end-users when moving between areas covered by different technologies. GCF's widely recognised certification framework is the most cost-effective way of robustly testing these core but complex communications capabilities.

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

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1. General device trends

1.1: Year on year growth

Despite the pandemic, 2020 saw a record number of devices certified (715) and a record number of device manufacturers undergoing certification with GCF (75).

Growth continued in 2020, with a 7.1% increase in the number of manufacturers certifying at least one device versus 2019, and a 13% rise in the number of devices certified.

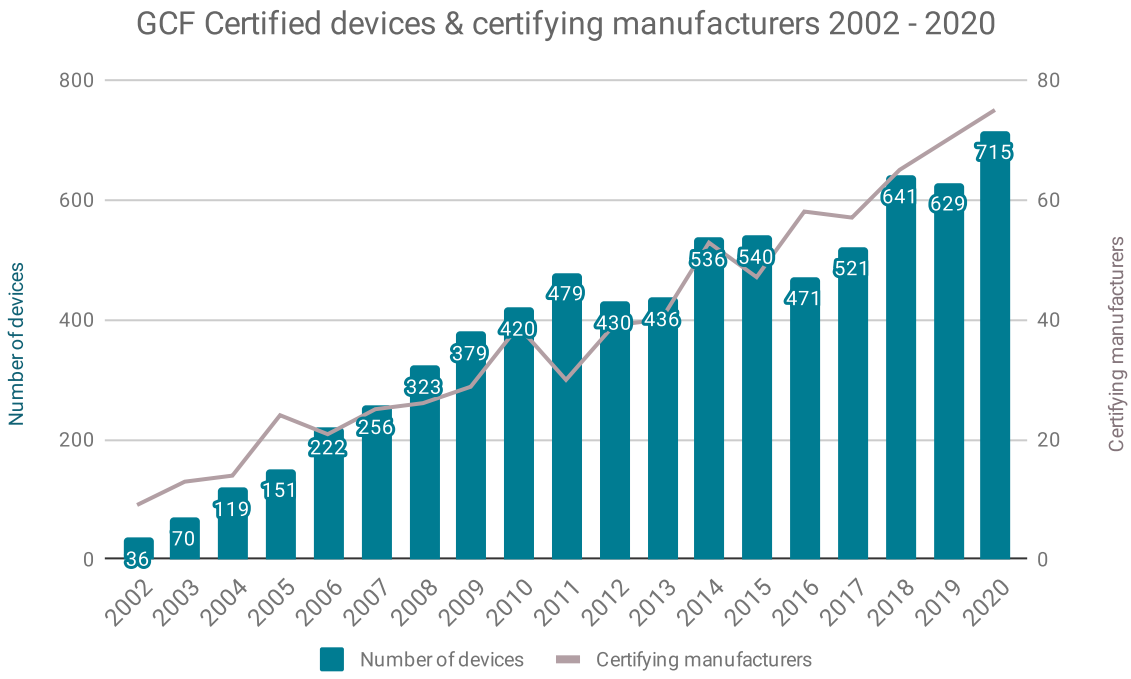


Fig 1

GCF works with device manufacturers of all sizes, and four manufacturers certified 40 devices or more. Conversely, 37 manufacturers certified three devices or fewer. And of the 75 manufacturers certifying devices in 2020, 8 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. For the first time, 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 (source: Straits Research) are certified by GCF and included in the below graph's data.

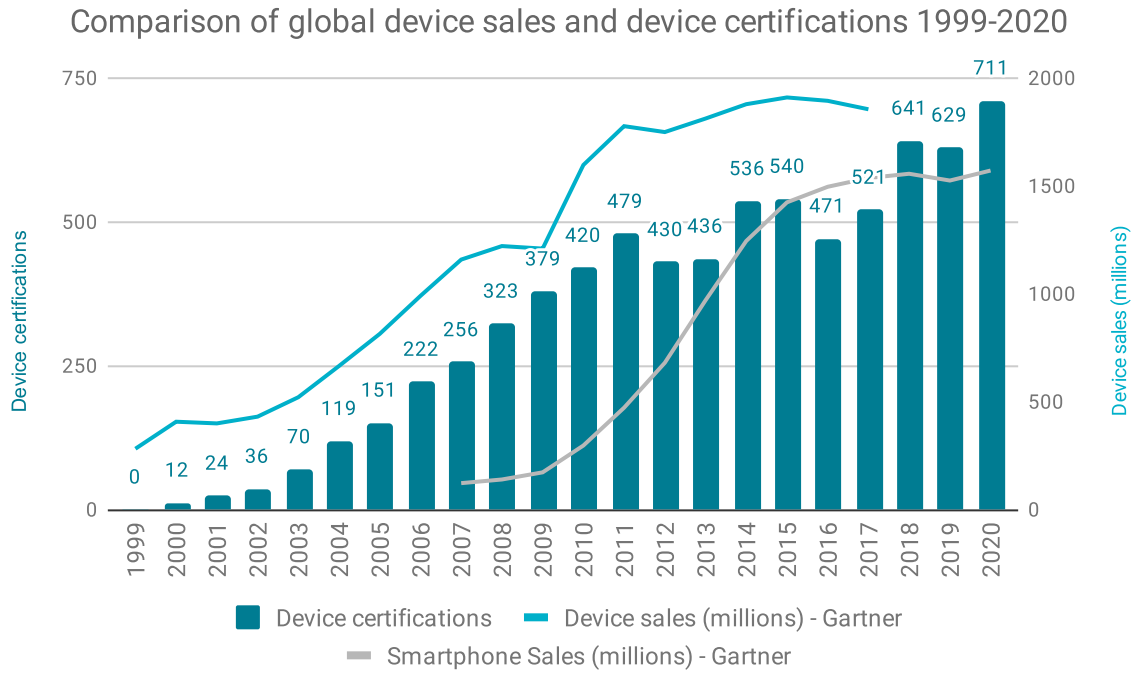
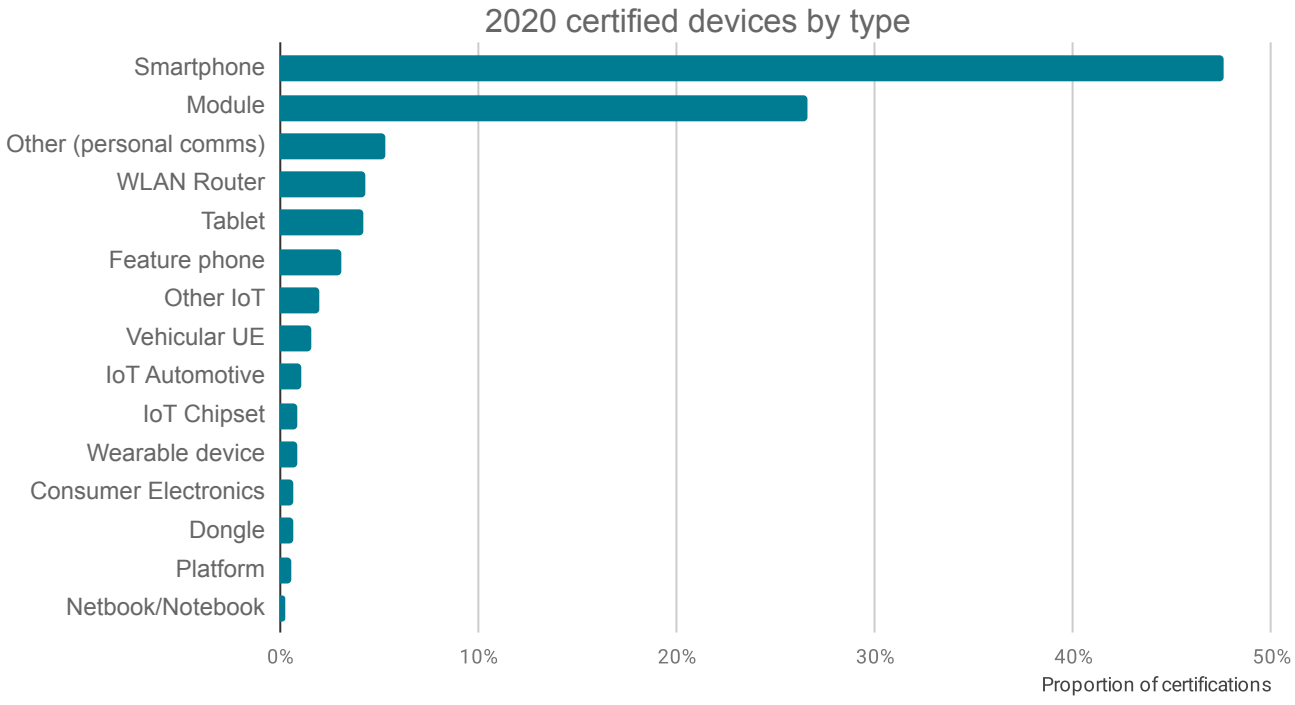


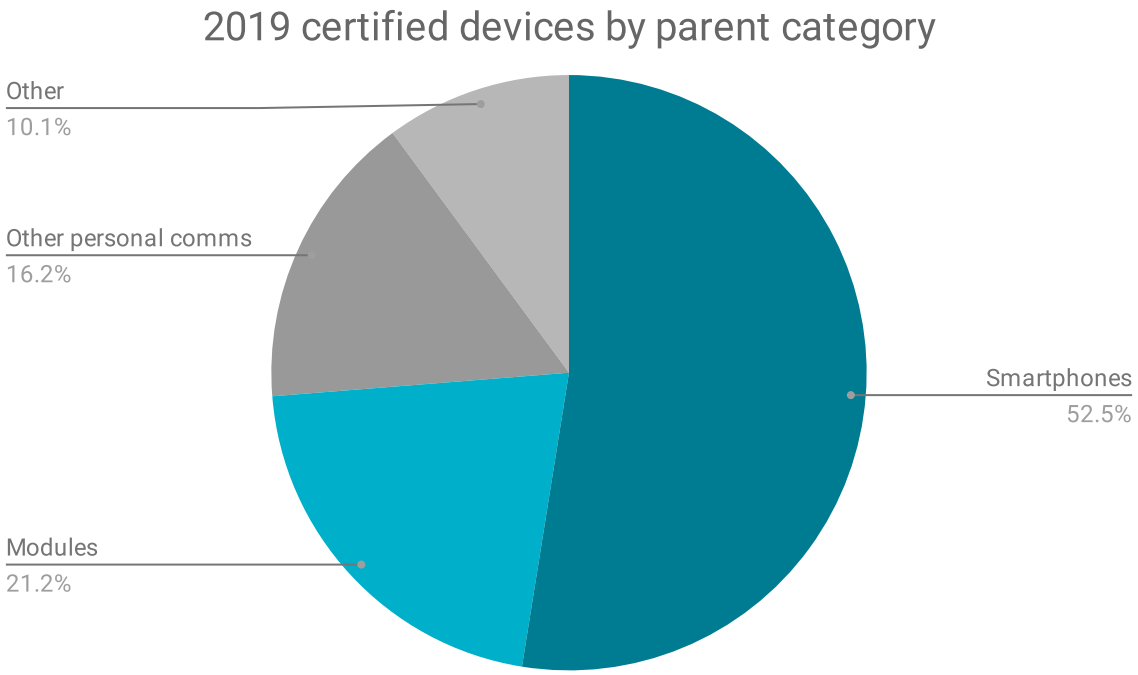
Fig 2: Device sales source: "Gartner Worldwide Manufacturer Sales to End Users of Mobile Terminal Devices / Gartner Global smartphone sales to end users 2007-2021", collated by GCF. Gartner attributed the pause in the growth of sales in 2008/ 2009 to the collapse in consumer confidence in the wake of the September 2008 international banking crisis.

1.2: 2020 certified devices by type

While smartphones still represent the largest class of devices certified, and while the sector has again seen growth in 2020, the rapid growth of other sectors has meant smartphones now make up less than half of certifications (48%, down 4 percentage points versus 2019).

Modules again contributed to just over a quarter of devices, making these once again the second largest device class, up from 6th in 2017.





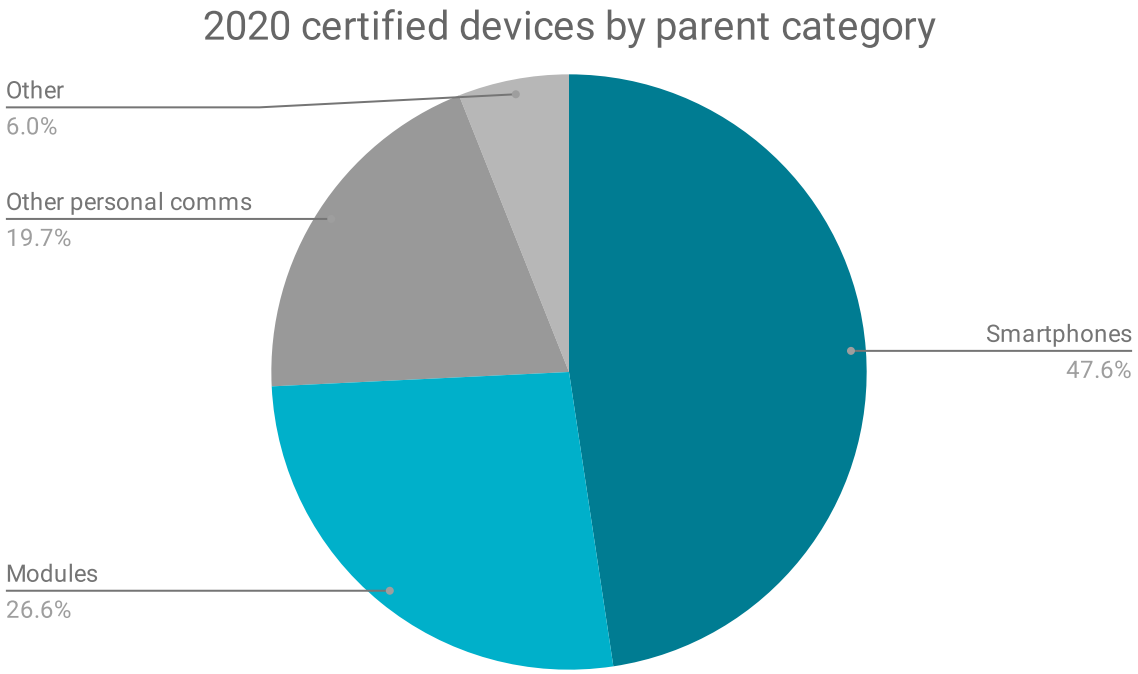


Fig 3a, b and c

Despite the fall in share, the number of smartphones certified increased slightly, from 329 in 2019 to 340 in 2020.

20% of certifications were feature phones, tablets, notebooks, mobile gateways/ portable hotspots, USB modems and other non-smartphone communication devices, an increase from 16% in 2019.

This includes:

- Tablets, where the proportion of certifications remained roughly constant, rising only very slightly to 4.2%
- Feature phones, where the proportion of certifications fell (from 4.1% in 2019 to 3.1% in 2020).

Automotive systems accounted for 2.7% of certified devices.

1.3: 2020 certified devices by mobile technology used

LTE has retained its crown as the most commonly integrated standard - see section 3.

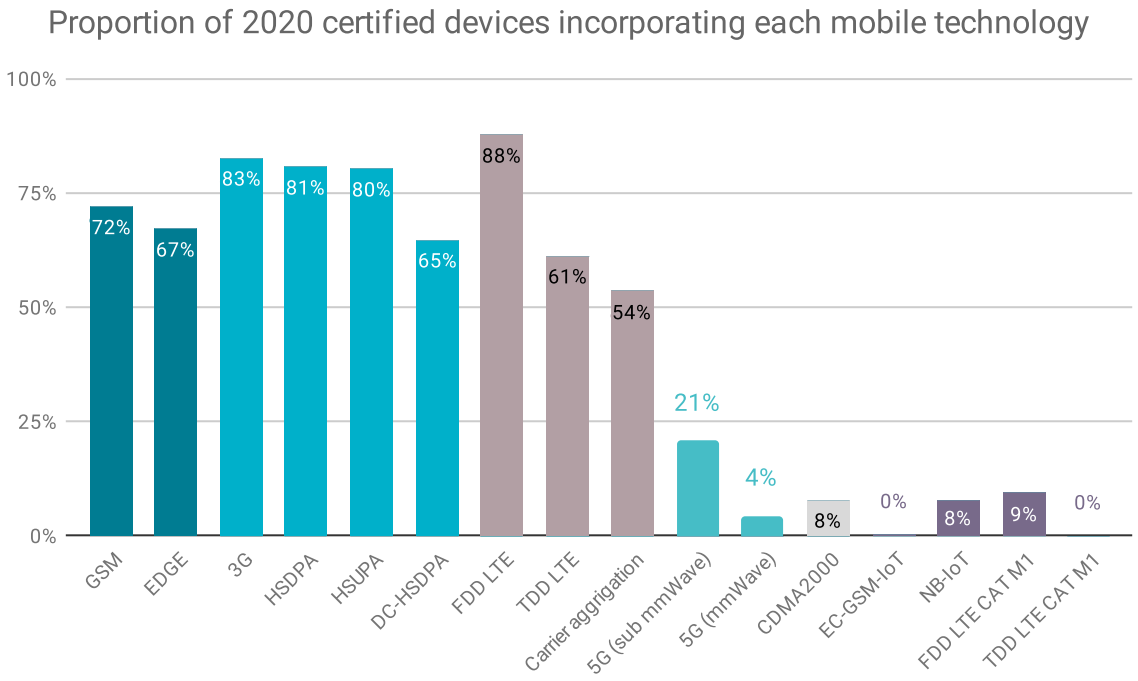


Fig 4

2. 5G

2.1: The rate of 5G incorporation

The rate of 5G incorporation has accelerated versus 2019, with the standard included in more than 21% of devices (149) certified, versus 2.5% in 2019.

Additionally, 34% (50) of 5G devices support standalone 5G; and 21% of 5G devices enabled access to mmWave 5G frequencies, typically in the Ka band.

GCF offers certification for ENDC1-5, NRDC1, SANRFR1-2 and the many inter-band configurations (see ETSI) related to these.

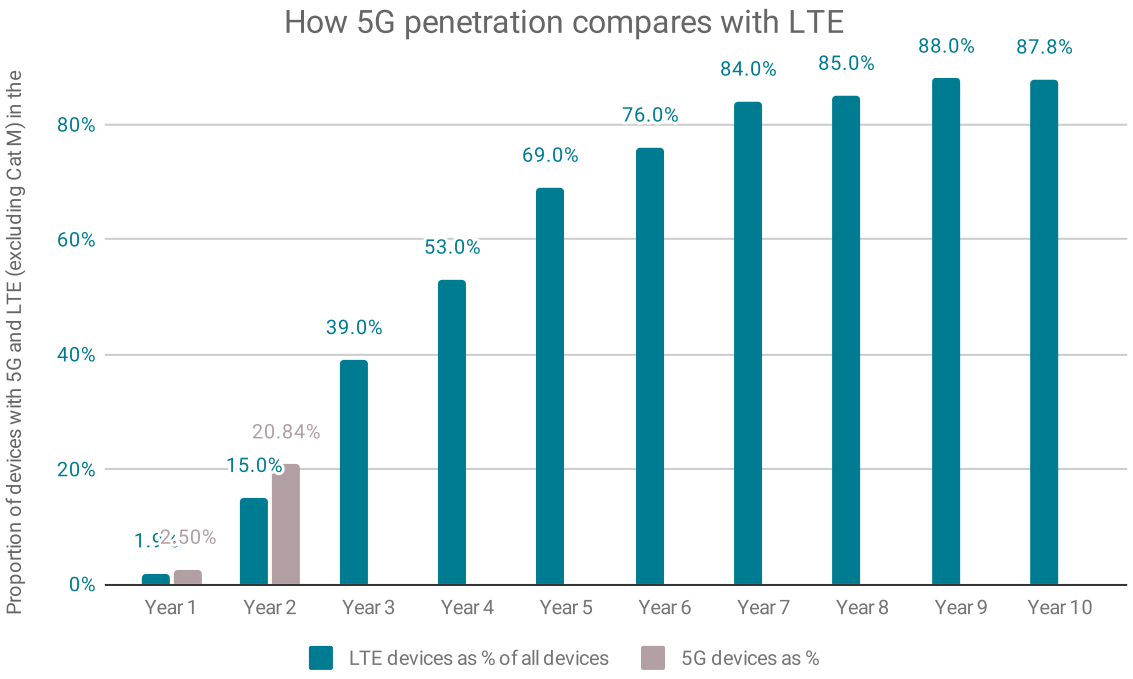


Fig 5

2.2: How this compares with LTE

This is the second year in which 5G services have been available to the public and this allows the first direct full-year comparison to be made in order to give a meaningful reference to the technology's growth rate.

LTE was launched in the dying weeks 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 our 2019 report we postulated if this initial faster growth was a skew caused by small numbers, and if this adoption rate would continue to outstrip LTE's. It (probably) wasn't a skew. And it has continued to outpace the rise of LTE.

The adoption of 5G is happening significantly faster than for LTE, with 149 5G devices certified in 2020, representing 21% of all devices certified.

2.3: Increasing numbers of 5G device manufacturers

In 2019 seven device manufacturers developed and certified 5G devices with GCF, with 69% of these devices (11) coming from just two manufacturers, with the other five manufacturers having just one 5G device certified.

In 2020 28 device manufacturers certified 5G devices with GCF, and over two thirds (21) submitted at least two. Nine manufacturers certified five or more.

2.4: Breakdown of 5G devices by classification

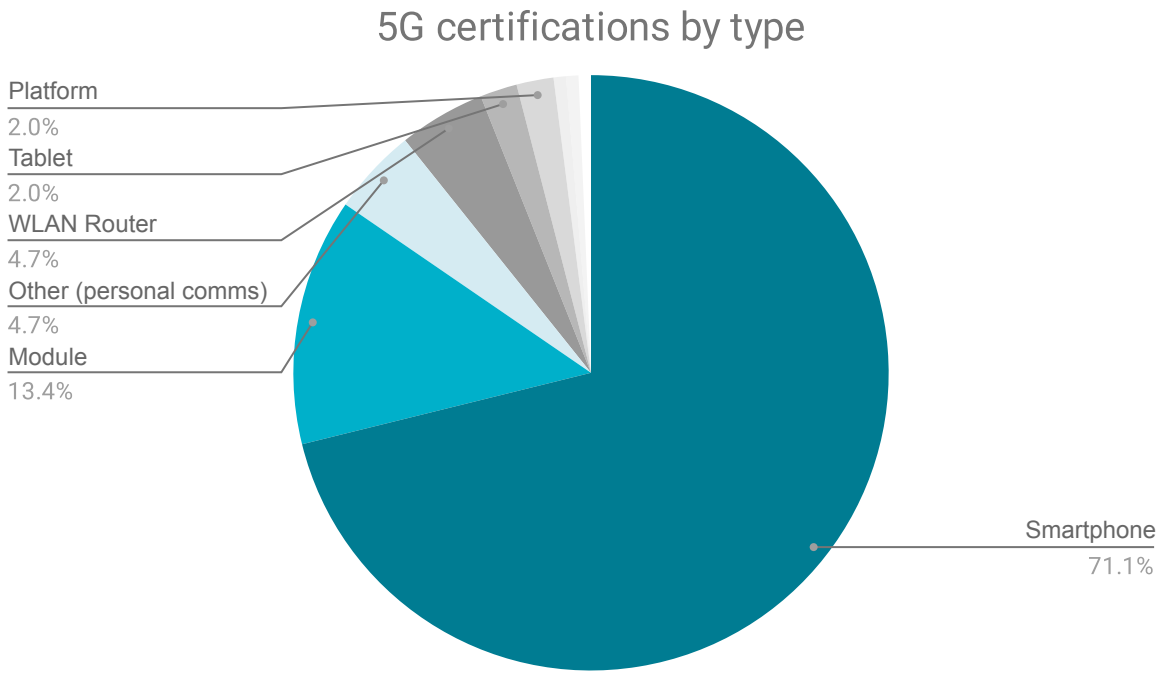


Fig 6

In 2019 94% of 5G certifications were predominantly for either smartphones (63%, 10 devices) or mobile gateways and hotspots (31%, five devices).

In 2020 106 of the 149 certified 5G devices were smartphones (71%). Just eight (5.4%) were mobile gateway devices. And the range of devices has increased significantly, with 20 modules (13%), 12 tablets, notebooks or other personal communication / consumer electronic devices (8.1%) and three platforms (2.0%).

2.5: 5G NR bands certified

Incorporating multiple bands expands the potential market for a given device and with certification possible for 13 of the 55 5G NR bands, GCF is being used to certify devices destined for use in all the leading mobile markets worldwide.

The GCF scheme enables the certification of devices designed to operate in both sub-mmWave and mmWave bands, as well as for standalone and non-standalone usage.

During 2020, devices using 21 of the sub-mmWave and four of the mmWave bands were certified. Bands of particular note include:

- n7 (2600 MHz) was the most commonly incorporated band, featuring in 136 certified devices (91% of 5G devices).
- n2 (1900 MHz) was the second most certified 5G band and was incorporated in 131 5G devices (89%), followed by n78 (3500 MHz), which was in 110 devices (74%).
- In the mmWave spectrum, the Ka bands n260 (39 GHz) and n261 (28 GHz) were incorporated in 30 of the 32 mmWave devices.
- Certified devices used 13 frequency division duplex (FDD) bands and six sub-mmWave time division duplex (TDD) bands. Additionally, two SUL bands were adopted in certified devices and (as stated) four mmWave bands were too.

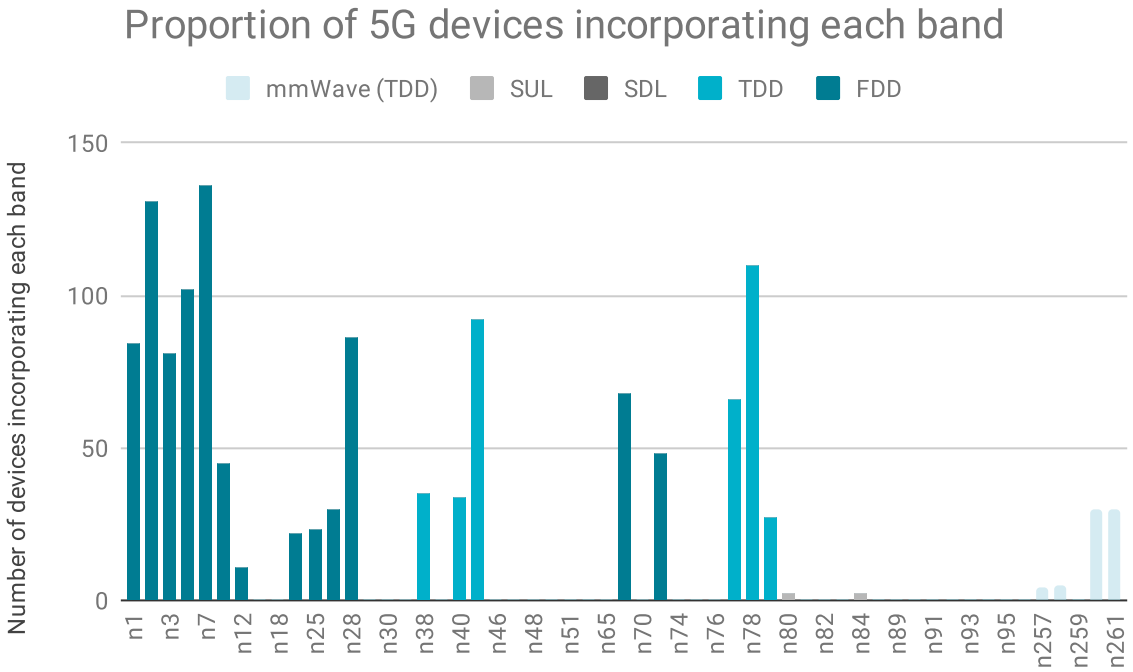


Fig 7

2.6: 5G device complexity

All 149 certified 5G devices supported 5G NR dual connectivity (EN-DC).

The mean number of 5G bands per 5G device was 8.3, with 35 devices supporting 12 or more 5G bands. 32 devices were able to use the mmWave frequency bands and 30 of these were able to access the n260 Ka band (all supporting use on both the 28 and 39 GHz bands).

The average complexity of mmWave capable devices increased, with these 32 devices allowing the use of 9.3 bands on average.

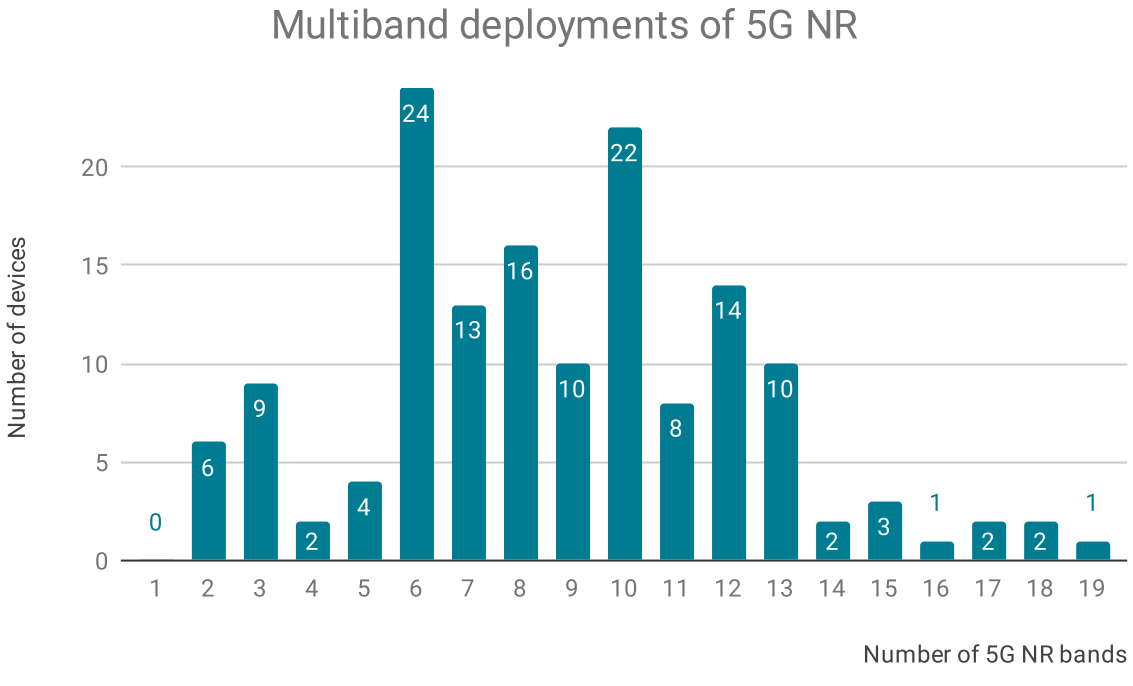


Fig 8

3. LTE

3.1: Has LTE growth plateaued?

The penetration of LTE in certified devices finally plateaued in 2020, with the standard being integrated into 88% of all certified devices, and LTE retaining its position as the most integrated standard.

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.

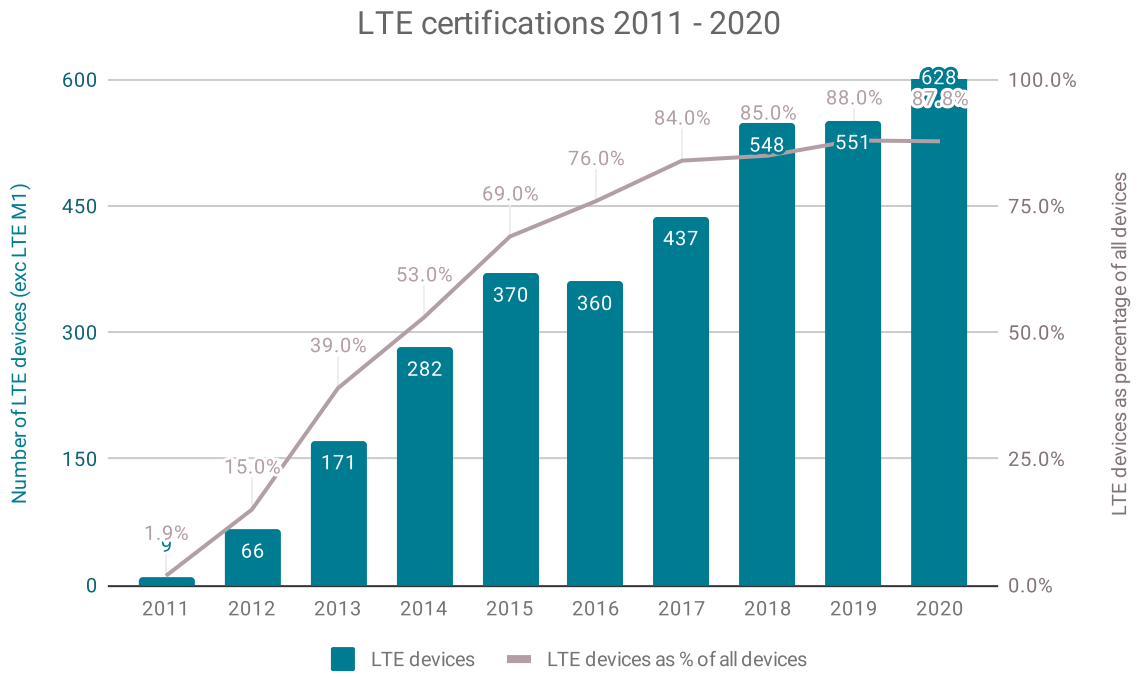


Fig 9

In 2020, 628 certified devices supported LTE. An additional 67 devices incorporated the cellular IoT variant, LTE CAT M1.

As in 2018 and 2019, FDD-LTE was supported in all of these devices. TDD-LTE was incorporated into 70% of them (436 devices), up from 66% in 2018 and 62% in 2018. And while all TDD-LTE capable devices also incorporated FDD-LTE, the proportion supporting simultaneous FDD/ TDD operation is 49%. This is significantly down on both 2019 and 2018 when 52% and 75% respectively supported it. Unlike in 2019, there was no overlap in the devices supporting LTE and LTE CAT M1.

There was also a significant rise in certifications supporting Gigabit LTE, with 125 Category 16 / Category 18 devices certified, up from 50 in 2019 and just six in 2017.

VoLTE operation was certified in 69% of LTE devices (430), which is comparable with 2019 when 70% 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 2020, all bands covered by the GCF scheme had devices certified. Bands of particular note include:

- Band 7 (2600 MHz) became the most certified LTE band, incorporated in 559 devices (89% 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 540 LTE devices (86% of LTE).
- Band 5 (850 MHz) became the third most incorporated band, overtaking Band 1. Band 5 featured in 532 devices (85% of LTE devices).
- Band 28, the APT 700 MHz band, which has been allocated in major markets in Latin America and Asia Pacific including Brazil, Argentina, Japan, Korea, India, the Philippines, Australia and New Zealand was certified in (66% of LTE devices and 57% of all devices), a marked increase on 2019 (which saw 50% of devices able to utilise the band), and on 2018 (37%).

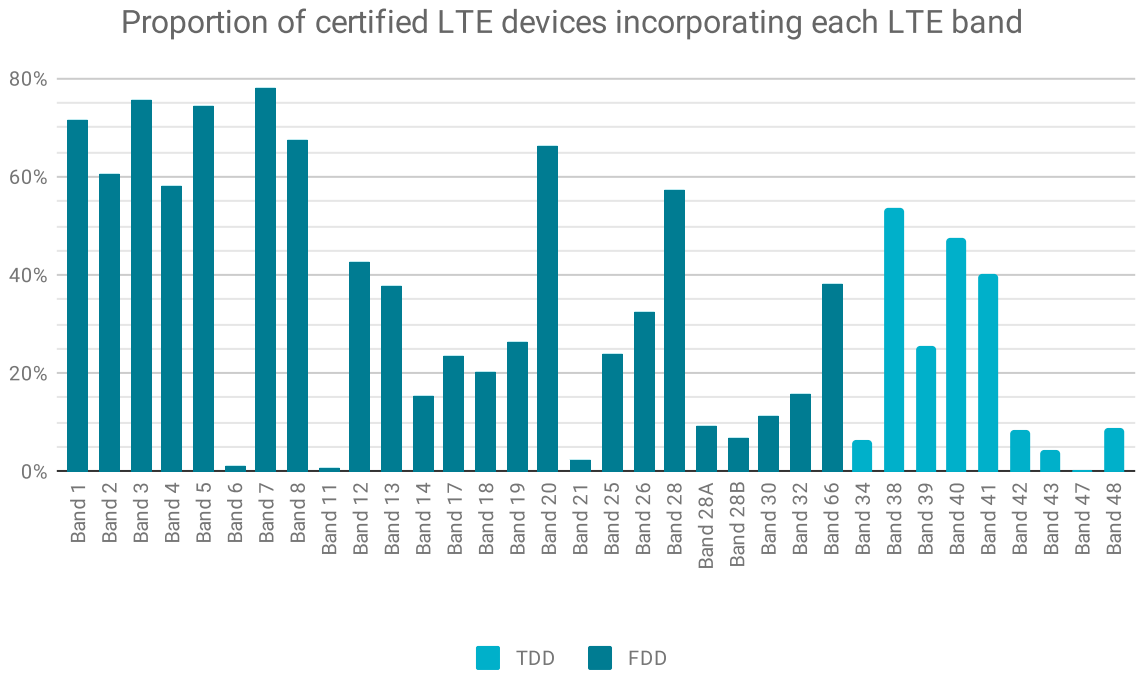


Fig 10

3.3: LTE device complexity

It's particularly noteworthy that the number of certified bands in LTE devices continued to increase during 2020.

Of the 628 devices incorporating LTE, 623 (99% of LTE devices - versus 97% in 2019) incorporated three or more LTE bands, while 98% incorporated five or more bands (versus 93% in 2019), and (over) half of LTE devices incorporated 11 or more (versus nine bands in 2019).

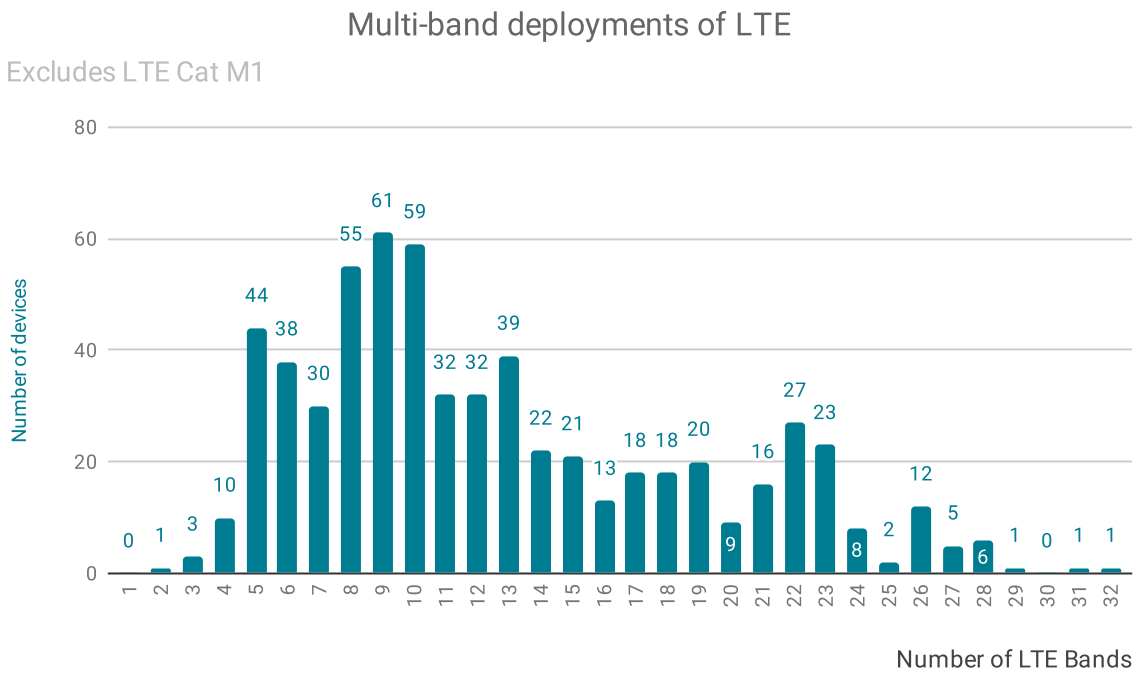


Fig 11

The modal number of LTE (excluding LTE Cat M1) bands is nine (up from six in 2019), and a slightly bimodal distribution is occurring, with 86 devices deploying 22+ bands. 385 (61% of LTE devices) incorporated 10 or more FDD-LTE bands; up from 274 (51%) in 2019. 201 devices supported 15 or more FDD-LTE bands; up from 115 in 2019.

In 2020, the average (mean) LTE device incorporated 12.7 LTE bands, up from 11.4 in 2019.

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 increased in the past year with 383 devices certified (61% of LTE device certifications), an increase on 2019, which had 58% (319 devices) deploying Carrier Aggregation.

4. 3G

4.1: Penetration of 3G

Manufacturers are still embracing 3G, this is despite operators prioritising LTE (and now 5G) for data delivery. As per 2019, certifications for 3G (UMTS/ WCDMA) stood at 83% (592 devices) in 2020.

3G is typically included as a voice-call fallback for VoLTE devices when roaming, with no standalone 3G devices being certified during 2020. This is the first year this has happened, albeit 2019 saw just one standalone 3G device.

Certification of HSDPA and HSUPA remained static versus 2019, with 81% (578 devices) and 80% (575 devices) incorporating each respectively. This represents (98% and 97% of 3G devices). The penetration of Dual Carrier HSPA remained static at 65% of all devices, within 1 percentage point of 2019.

4.2: 3G bands used

Bands of note include:

- Band 1 (2100 MHz) featured in 548 certified 3G devices (77% of all devices and 93% of 3G-capable devices). The same share as in 2019.
- Band 8 (900 MHz) again remained the second most frequently certified 3G band – in 539 devices (75% of all devices and 91% of all 3G devices). The same share as in 2019.
- Band 5 (850 MHz) was again the most commonly certified US 3G band, this is used in 521 (73% of devices certified in 2020), up two points vs 2019.

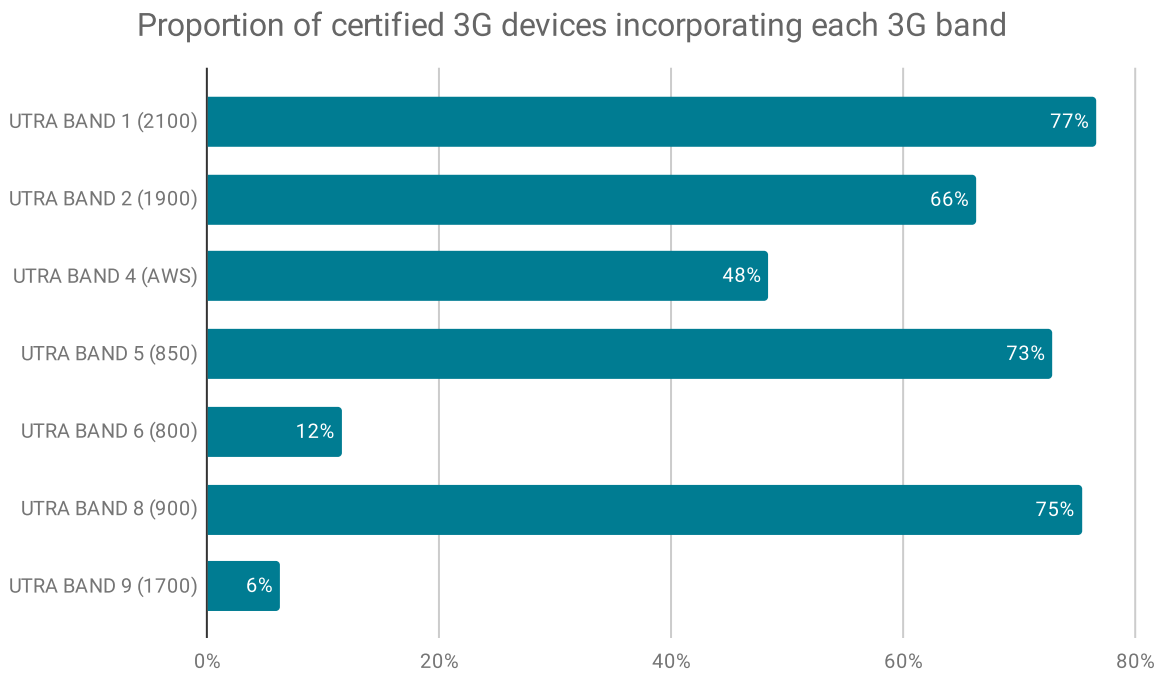


Fig 12

4.3: 3G device complexity

Two or more 3G bands were certified in all bar one device deploying 3G.

As in 2019, the modal number of bands is seven, and 581 devices (98% of 3G devices) were certified with four or more 3G bands.

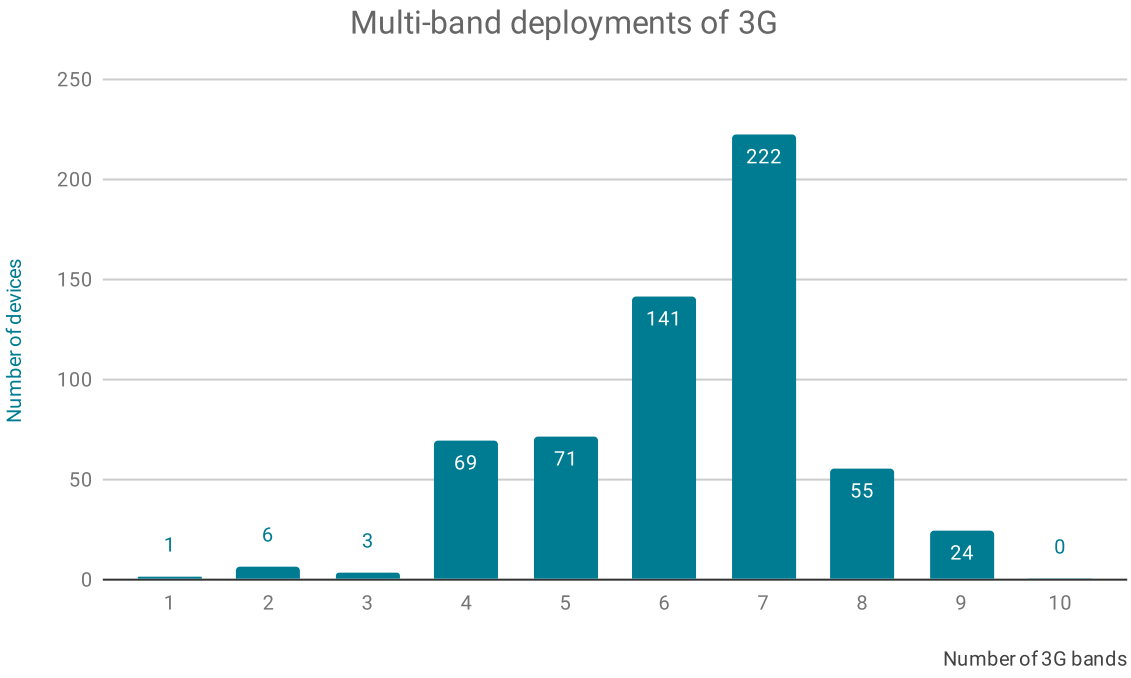


Fig 13

5. GSM

5.1: GSM resumed its decline

The penetration of GSM has declined steadily from 2008/ 2009 (when 100% of devices included the standard) to 2018 (when just 75% of devices did). 2019 unexpectedly saw a small but noteworthy reverse, with a 4 percentage point increase in GSM penetration: increasing to 79% of devices (including 39 standalone devices) that incorporated the technology.

However, 2020 saw the decline resume, with 72% of devices including the standard, and only seven GSM standalone devices certified.

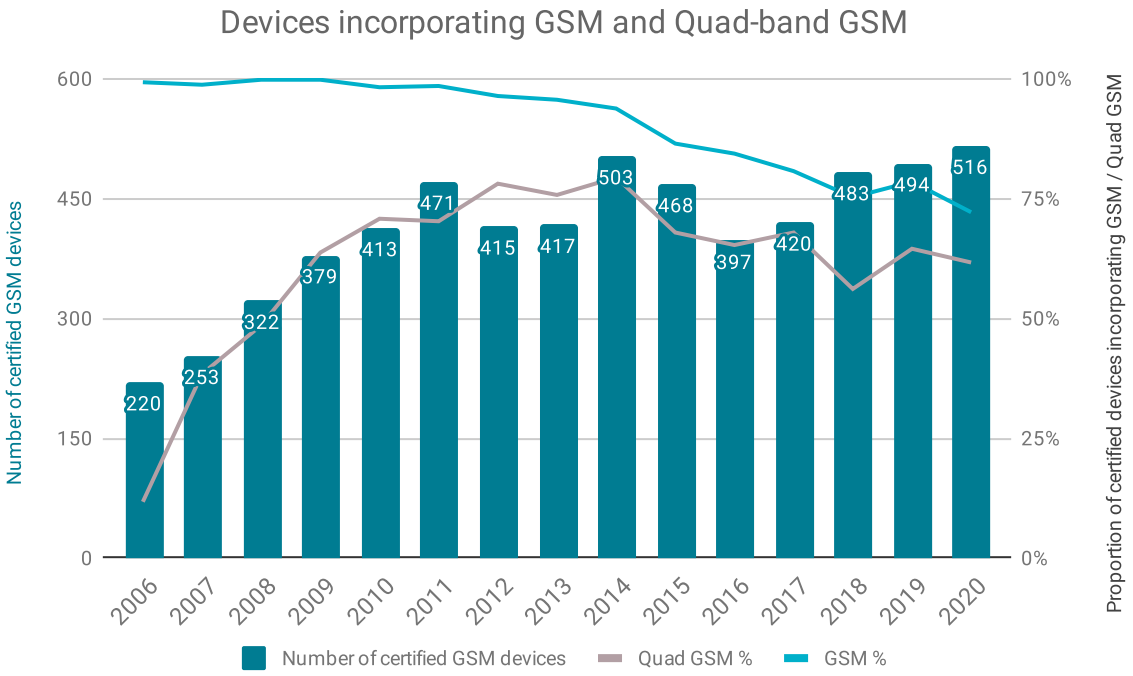


Fig 14

5.2: EDGE/ Quad-band GSM

EDGE was certified in 481 devices (67% of all devices, down from 71% in 2019).

Certifications for Quad-band GSM devices saw an increase, with 441 certifications (62% of all devices, versus 65% in 2019 and 56% in 2018).

6. Cellular IoT

6.1: The adoption of cellular IoT standards continues at a great pace

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

The number of devices connected by Massive IoT and other emerging cellular technologies is forecast to reach 4.1 billion by 2024 and the growth in certified devices reflects this - Source Ericsson.

This is the fourth year that GCF has certified the cellular 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 10-fold, and LTE CAT M1 (FDD) increasing more than 20-fold:

- NB-IoT was featured in 56 devices certified this year (up from 45 in 2019 and five in 2017)
- LTE CAT M1 (FDD) featured in 66 (up from 37 in 2019 and three in 2017)

But, these two standards dominate. LTE CAT M1 (TDD) was included in just one device certified in 2020 (there were just six in 2019); and EC-GSM was in just three (there were two in 2019).

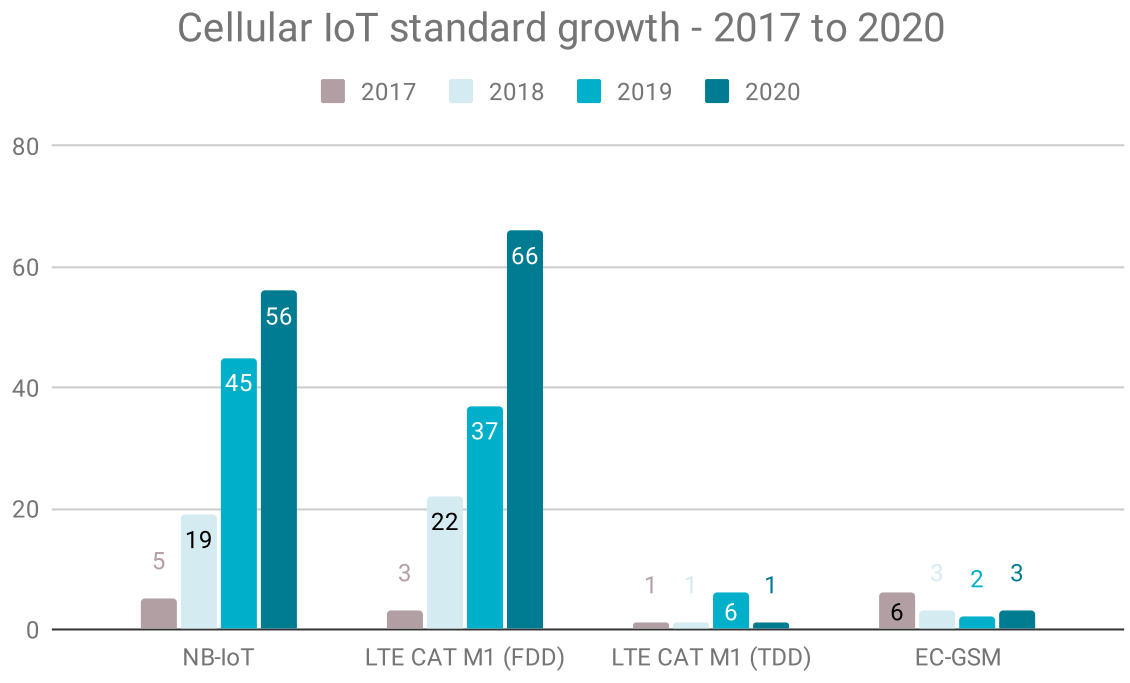


Fig 15

7. Device complexity

7.1: A further rise in overall complexity

Despite a rising proportion of single mode devices being seen, devices on average have continued to increase in complexity for several years.

2020 did not buck this trend, with the proportion of certifications for four+ devices doubling to 16%. Additionally, 3.4% of devices supported five bearer technologies (vs 0.3% in 2019, and no devices in 2018).

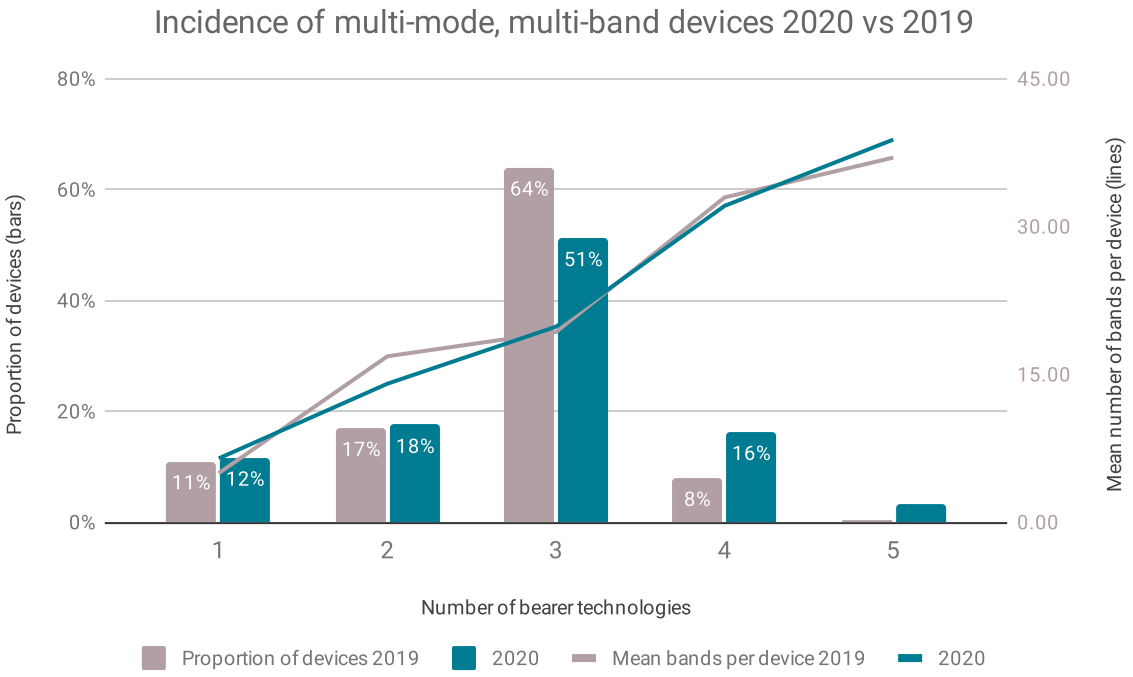


Fig 16 - Bearer technologies have been classified as 2G (GSM/ EDGE), 3G (WCDMA/ UTRA/ HSDPA/ HSUPA), 4G (LTE FDD/ LTE TDD), CDMA2000, NB-IoT, LTE M1 (TDD/ FDD), EC-GSM

7.2: Single-mode devices

The proportion of single mode devices increased slightly in 2019, up one point to 12% of devices. This is, however, still below 2017 levels, which saw single mode devices account for 16% of all certifications. These single-mode devices are predominantly Cellular IoT (44 devices), and LTE systems (30 devices).

There were no standalone 3G devices. And no standalone 5G devices.

The complexity of single mode devices has also increased, with the mean number of bands increasing year on year: from 3.1 in 2017 to 3.7 in 2018 and from 5.0 in 2019 to 6.5 in 2020.

7.3: Multi-mode devices

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

As in 2019/ 2018, the modal number of bearer technologies per device was three, however the proportion of systems employing four or more bearer technologies has more than doubled, from 8.5% in 2019 to 20% this year.

The number of implemented bands used in the average device is also up considerably. Certified devices now have a mean of 19.8 frequency bands.

This figure increases to 32.1 bands for devices supporting four bearer technologies, and 38.8 bands for devices supporting five.

The highest number of implemented bands in 2020 was 52.

8. Smartphones

8.1: Smartphone growth

Smartphones have consistently represented the largest category of devices certified by GCF. 2020 has been no exception to this rule, with the category representing just under half (48%) of all certifications.

A total of 340 smartphones were certified in 2020, a record by absolute number, albeit not by proportion of devices.

These 340 devices came from 28 manufacturers. Almost half (46%) of the certified smartphones were developed by just two manufacturers. And 70% of smartphones certified were made by just five manufacturers.

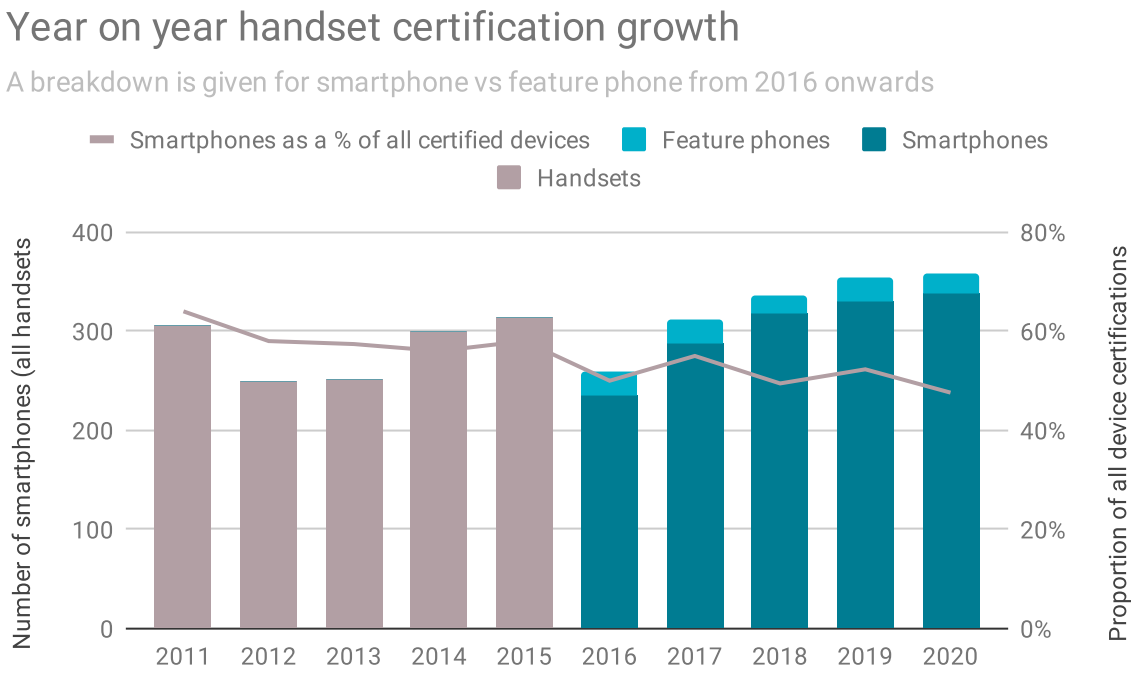


Fig 17

8.2: Smartphone complexity

Smartphones are also significantly more complex than the average device, with 98% of smartphones integrating three or more bearer technologies, vs 72% for non-smartphone devices. Similarly, 23 certified smartphones integrated five bearer technologies. No non-smartphone devices did.

However, the number of bands per device is no longer significantly higher for smartphones. Smartphones with three bearer technologies used spectrum across an average of 20.0 bands; for non-smartphone devices this figure is 19.7.

Due to the very small number (four) of non-smartphone devices with four+ bearer technologies, it is not possible to compare without being affected by skews.

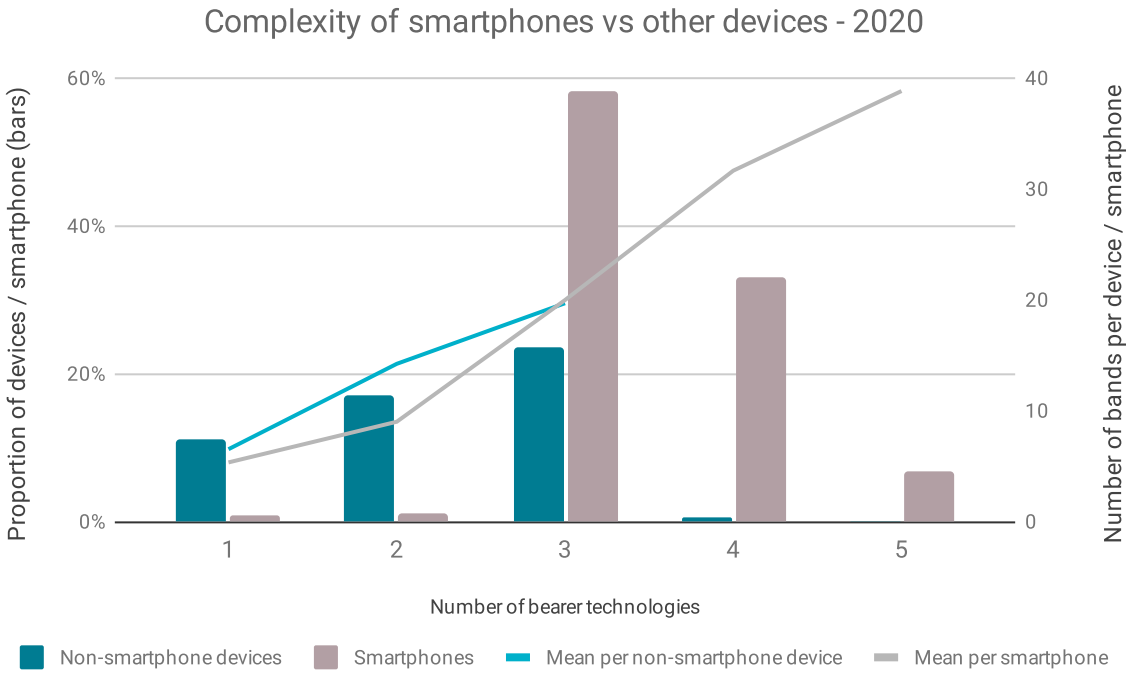


Fig 18

8.3: 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, 106 smartphone designs support 5G.

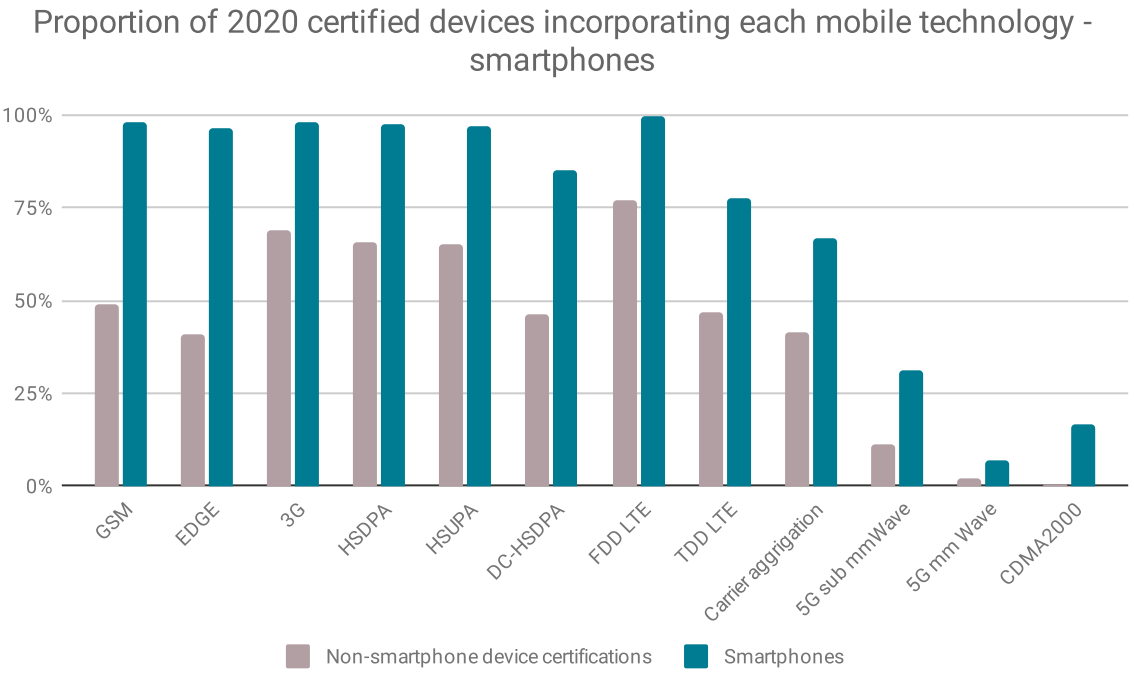


Fig 19

9. Wireless modules

9.1: Wireless module growth

During 2020, GCF began including IoT modules among the general module category. In total, there were 190 modules certified; representing 27% of the total, versus 21% in 2019.

27 OEMs certified modules in 2020, this is up from 20 in 2019.

Despite the increase, 84% of module certifications came from just four companies (versus 70% from the top four manufacturers in 2019). Additionally, the top four module manufacturers, three of which exclusively develop modules, were among GCF's top 10 manufacturers by number of certifications.

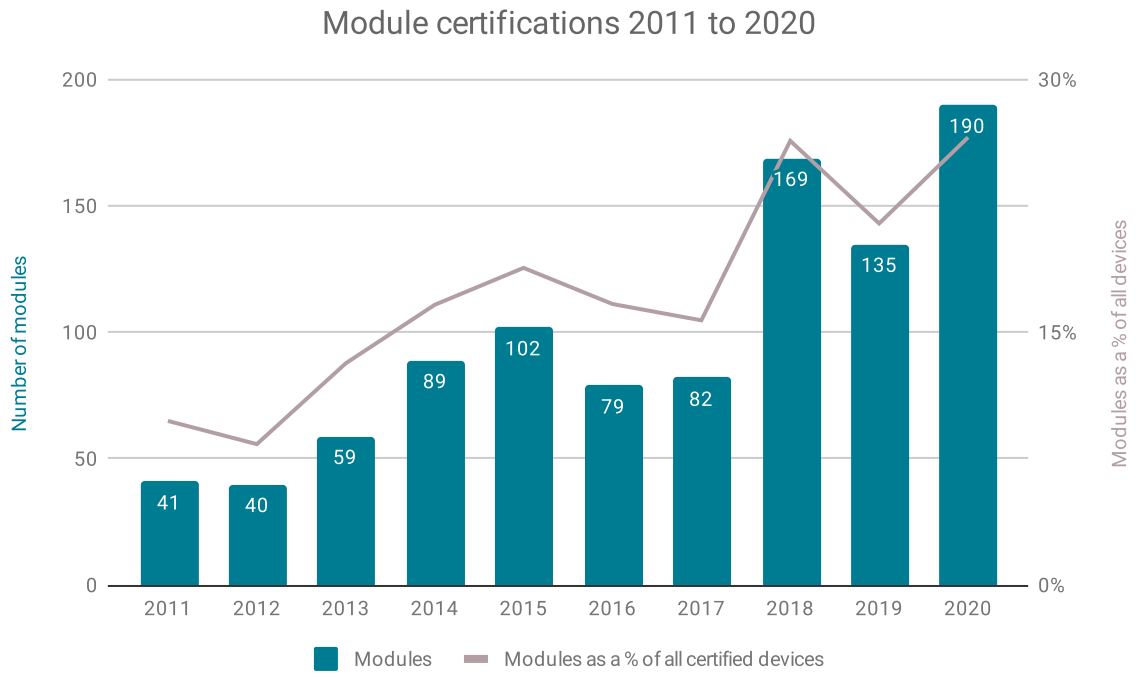


Fig 20

9.2: Module complexity

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

60 of the 190 certified modules (32%) were single-mode. 31% incorporated two bearer technologies and 37% three. The merger of the non-exclusively-IoT-module, and the more-simple IoT-module categories makes it impossible to undertake a year-on-year comparison

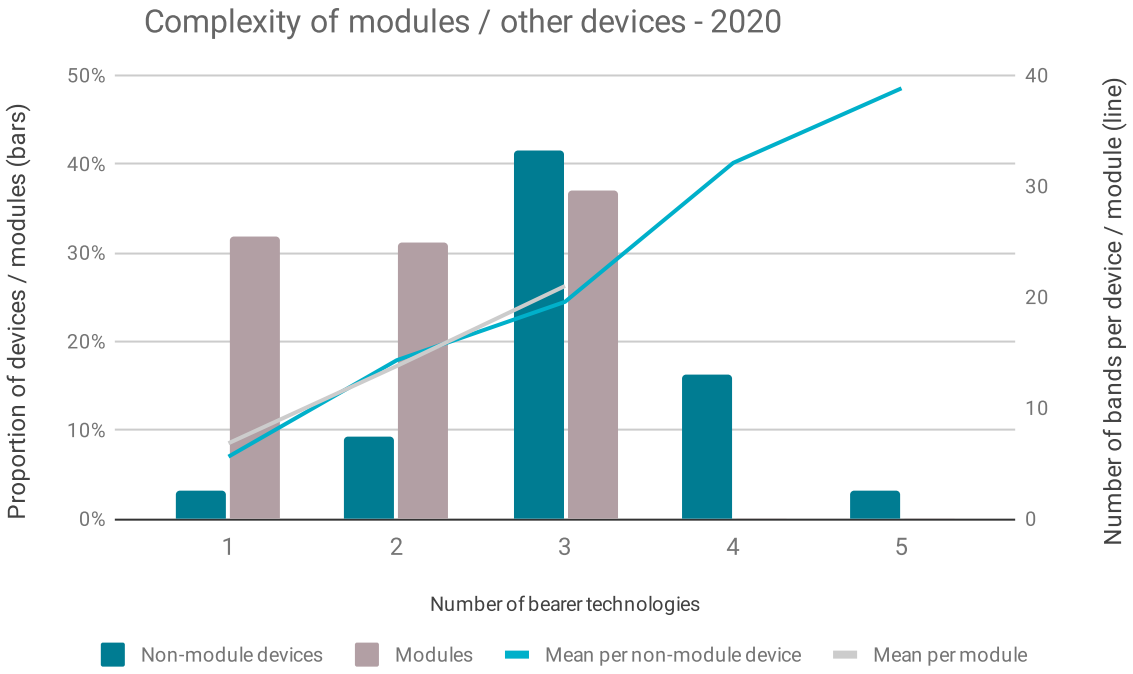


Fig 21

The number of frequency bands per module certified has risen compared with recent years, now standing at 14.2 per module. The maximum number of frequency bands for a module was 49.

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 per 2019, FDD LTE is the most commonly certified bearer technology in modules, with 63% of modules incorporating it, versus 57% incorporating 3G (UTRA), and 44% incorporating GSM.

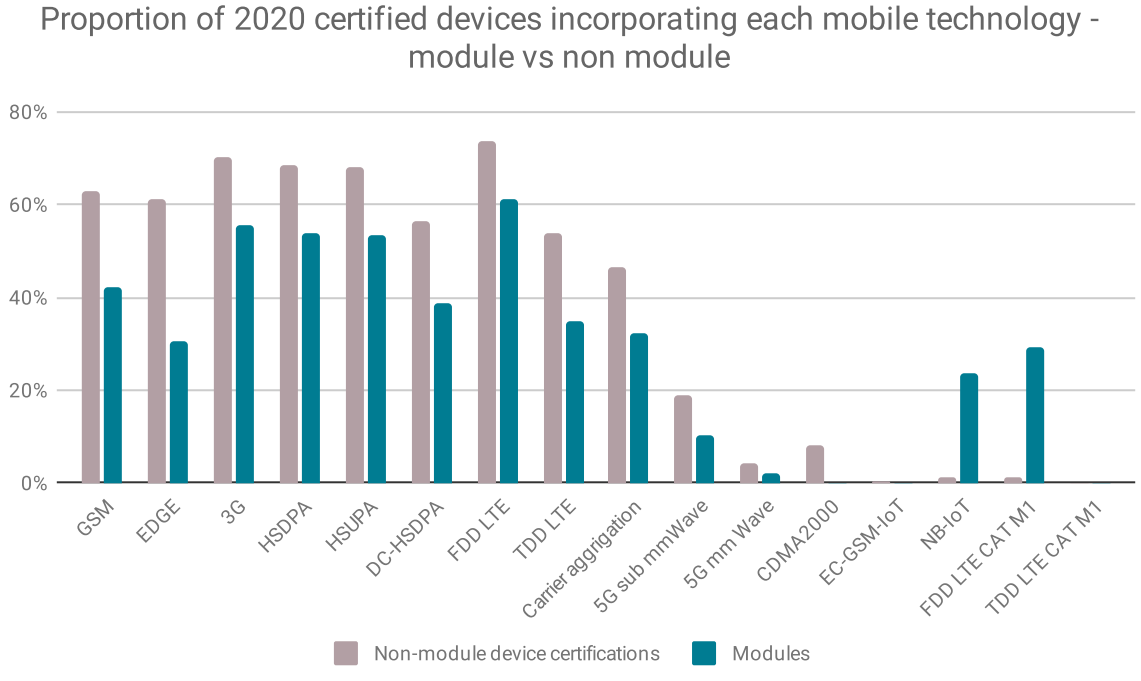


Fig 22

10. The effect of Covid-19 on device certifications

10.1: All technologies

2020 was a record year for CGF certifications, with 715 devices certified by 75 manufacturers.

The number of certifications continued to grow at a relatively steady rate when examined month by month and quarter by quarter.

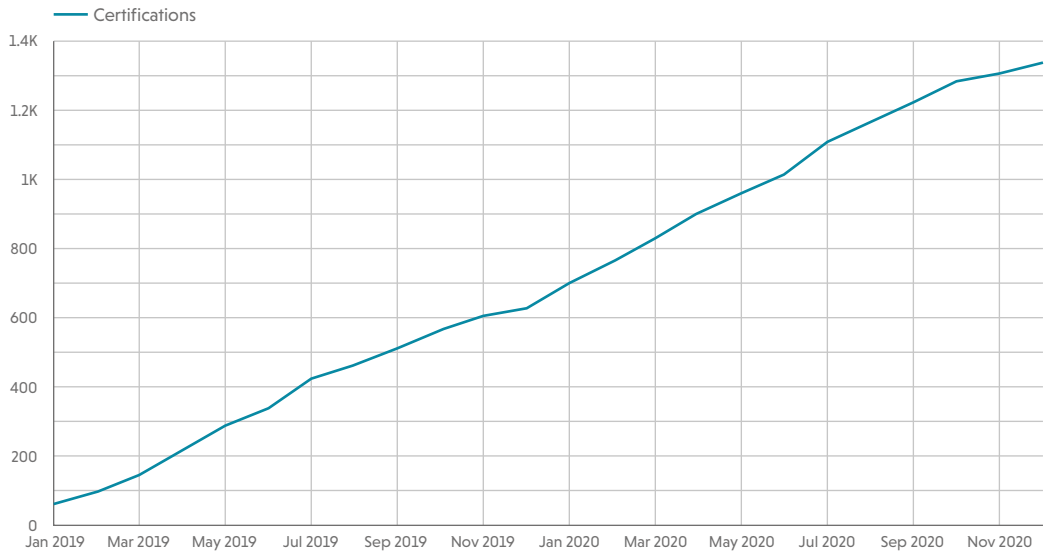


Fig 23

We therefore do not think the outbreak had a significant effect on certifications.

However, to get a better picture we have also examined the data by device type and the early stages of the pandemic (Q2) correlates with a small drop in non-5G device certification.

As a caveat, the spread of the virus and the time/ duration/ extent for which it affected each country varied, which makes it harder to pinpoint the effects of the virus reliably. At the same time, the industry was undergoing a shift in focus to create 5G systems.

It is therefore not possible to say if this dip was caused by a transition to working from home (forcing manufacturers to prioritise the certification of 5G-devices), or if the dip was caused by an industry refocus that would have occurred anyway.

The graphs showing this dip can be seen below, visualised quarter by quarter. Note - to allow comparisons between bearer technologies certified, figures 24a, b and c do not show absolute numbers. They instead show a percentage of the highest month's certifications for the category.

10.2: 5G versus non-5G devices

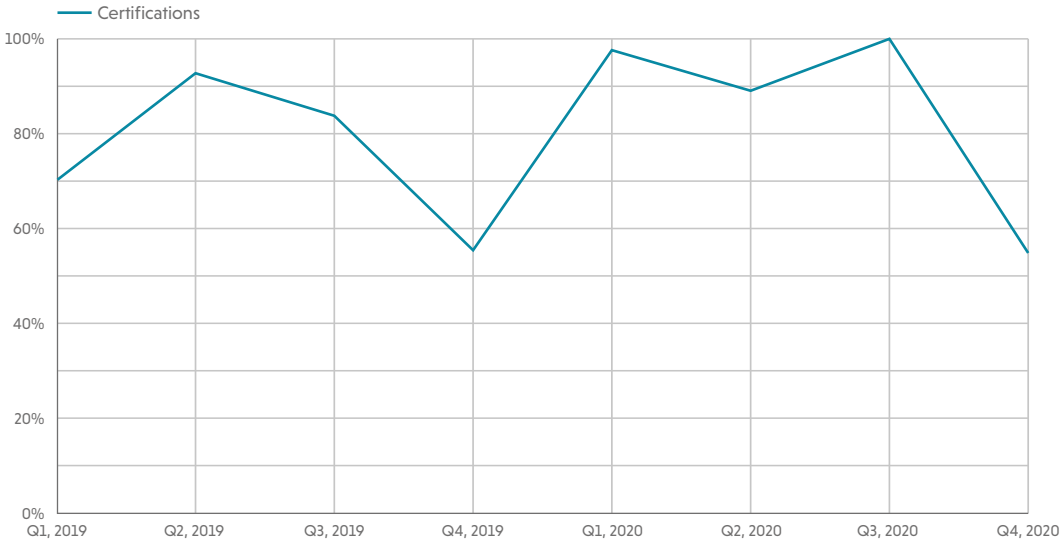
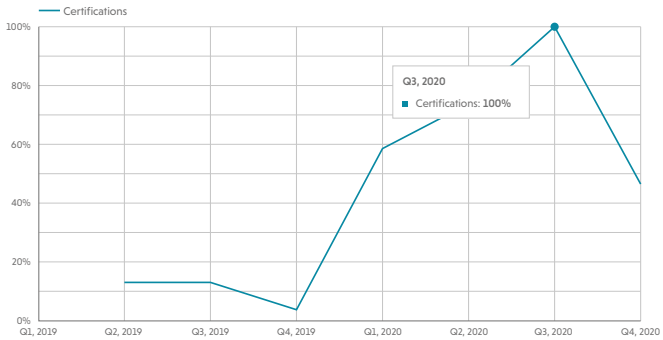


Fig 24a - all device certifications - showing a small but not unusual dip in Q2 2020
Note - Q2 2020 is comparable to 2019



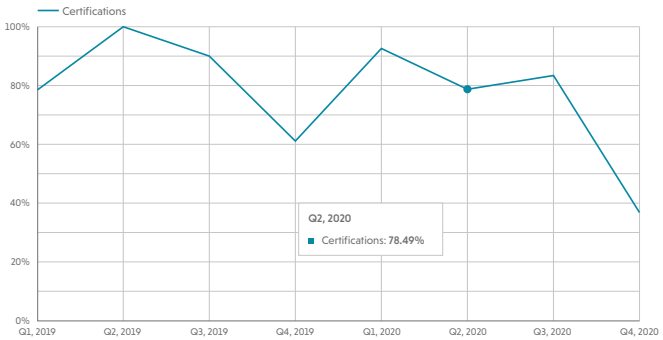


Fig 24b (5G devices) and c (non-5G devices) - showing relatively unabated 5G device growth in Q2, but a significant drop for non-5G devices in the same quarter
Note - for non-5G devices Q2 2020 is now at 80% of Q2 2019's certification level

5G is the only bearer technology that does not show a drop in certifications taking place in Q2 2020. A similar effect is also observed when certifications by type is analysed, with smartphone certifications being particularly affected, and modules proving to be relatively resilient.

11. Conclusion

In a global mobile ecosystem that now embraces multiple distinct 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 2020, the average GCF-Certified device incorporated 2.8 bearer technologies and operated across 19.8 frequency bands.

Demonstrating the conformance and interoperability of today's sophisticated multi-mode, multi-band smartphones, modules and (in the near future) vehicles to the satisfaction of the world's mobile operators and governments is therefore essential. And this GCF Device Analysis shows that the scheme remains relevant to the pre-launch testing of relatively simpler single-mode and even single-band devices.

With 2020 set to see a significant rise in the number and 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.

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, 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.

12.2: Vision and Mission

In all its activities, GCF is guided by the following principles and objectives:

VISION:

To lead the global ecosystem that facilitates interoperable devices, networks and services to enable the high quality, reliable, and secure wireless communications demanded by users and industries across the globe.

MISSION:

Our mission is to enable the 3 steps of certification: Test. Certify. Connect.

- To enable industry agreed Testing of mobile and IoT products.
- To manage industry agreed programmes to Certify mobile and IoT products.
- To provide assurance to network operators and industrial users to give them the confidence to Connect GCF certified products to networks and services.

12.3: Who GCF works with

As of January 2021, over 132 device manufacturers are participating in GCF. The scheme 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 monitoring features such as RSCP, Ec/Io, dropped calls etc. These studies have shown that devices from GCF members perform significantly better than devices from non-member companies.

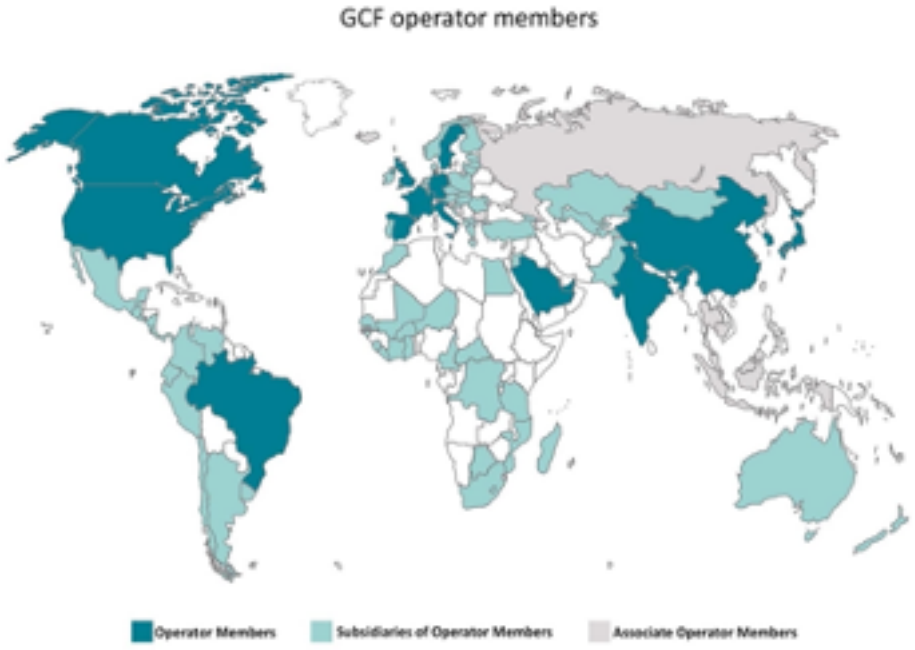


Fig 25

12.4: 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, multi-band smartphones, tablets, wireless routers, IoT modules and products.

12.5: 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 national 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, and LTE-Advanced Pro and more recently, e-Sim and 5G (sub-mmWave and Ka band).

For 2020 GCF has added vehicle-to-vehicle and vehicle-to-infrastructure compliance testing, and also MCPTT. 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 5CA.

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

13. Key GCF milestones:

Date	Event
March 2020	First IoT chipset certified
July 2019	First 5G device capable of accessing mmWave bands certified
April 2019	First 5G device certified
September 2018	GCF and TTA announce global certification solution for oneM2M
August 2018	First RSP eSIM consumer device certified
May 2018	GCF introduces MVNO membership categories
February 2018	RSP eSIM certification for consumer devices introduced
December 2017	GCF starts development of 5G device certification
September 2017	First LTE CAT M1 device certified
March 2017	First NB-IoT device certified
February 2017	Platform Certification introduced
December 2016	Certification of first device supporting Carrier Aggregation
December 2014	First CDMA2000 devices certified.
October 2013	Certification for client applications introduced
October 2012	First dual-mode FDD/TDD LTE device certified
September 2011	First LTE TDD device certified
March 2011	First LTE FDD device certified
Aug 2008	First HSUPA device certified
Jun 2008	First HSDPA device certified
Feb 2006	First 3G device certified
May 2000	Certification of first device – GSM
1999	GCF Founded

Fig 26

14. 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

oneM2M certifications can be found at:
https://onem2m.globalcertificationforum.org/all-certifications.html

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