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Perspective

# 5G charging standards: contributors and implications for service providers

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# 1. Executive summary

5G is the focus of a significant proportion of telecoms operators' investments and is directly influencing how telecoms service providers are planning to evolve their operations and monetisation environments. These environments need to be prepared in advance of 5G deployments to capitalize on the compelling and sophisticated uses cases that are prompting industry analysts to predict that 35% of mobile connections and 60% of total mobile service revenue worldwide will come from 5G networks and services in 2026.

The predictions depend on service providers unlocking a range of new services that are being defined within the 5G standards. Monetizing these services requires a new converged real-time charging architecture that is purpose-designed to monetize 5G services.

The new capabilities being unveiled in recent 5G standards releases include network slicing, network functions exposure, and granular quota control on any service or API-exposed function. The standards also account for all the typical operations of a mobile network as well as backward compatibility issues, so that 5G charging architecture can still interoperate with legacy billing processes.

Service providers' major strategic suppliers, such as Ericsson, Huawei, and Nokia, are contributing most of the effort, expertise, and work items that are necessary to agree on every aspect of each standard. The closer these suppliers are to the standards, the more able they are to align their own development pipelines, and those belonging to their customers, with the latest standard release while it is in development. The better the alignment, the faster adoption happens, and the more a service provider can remain at the leading edge of new 5G service offerings.

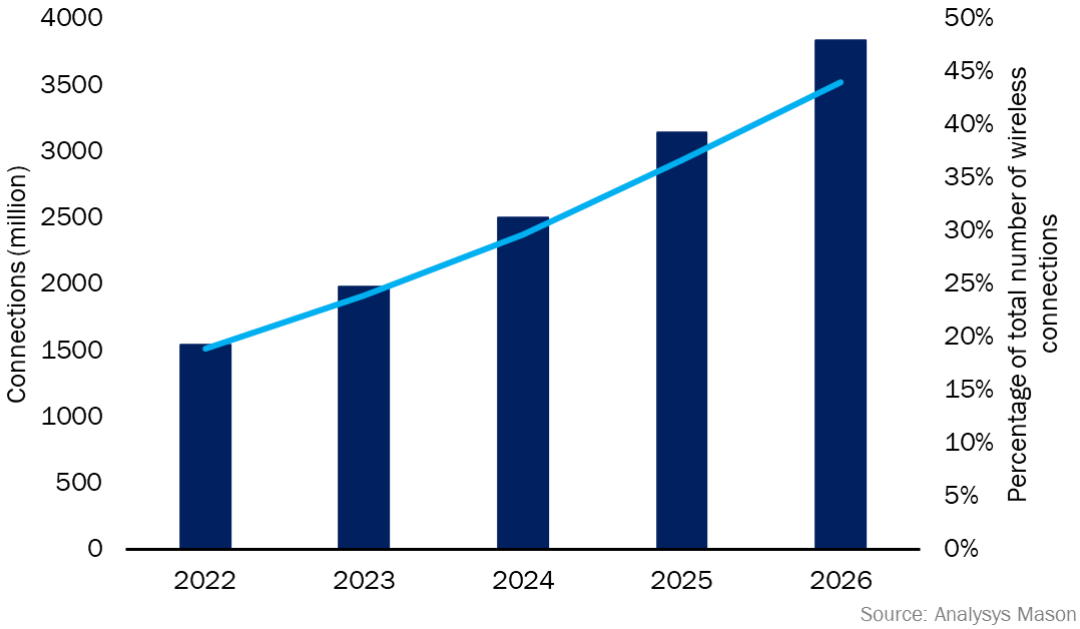
Service providers that want to continue to understand, and futureproof investments in, 5G charging architecture, should monitor the 5G working groups, such as Technical Specification Group SA Working Group 5 (TSG SA WG5). This group sets the standards and agenda for 5G charging, as well as service management and orchestration. Service providers should follow the development of the standards because monetization platforms are critical to the success of 5G standalone (SA) services. Observing which of the working group's participants makes the greatest contributions to the work items behind the standards release provides service providers with a clear view of which vendors may have the fastest path to market to monetise the latest 5G service capabilities.

In our analysis, during the crucial Release 16 and 17 phases, which defined much of the baseline for monetising 5G standalone services and use cases like network slicing, Huawei was one of the main contributors to the 5G charging standards, along with other vendors, such as Amdocs, Ericsson, Matrixx, and Nokia.

# 2. The rapid transition to 5G SA

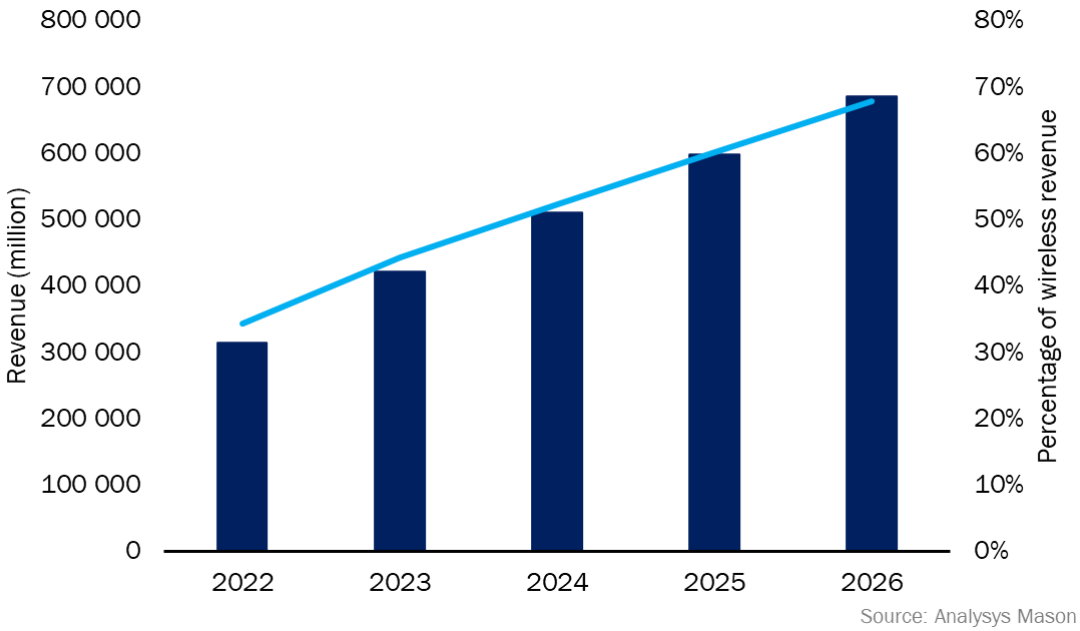
The 5G market is projected to grow substantially in terms of connections and revenue by 2026. According to Analysys Mason projections, 5G connections will nearly double from 2 billion in 2023 to nearly 4 billion in 2026.

*Figure 2.1: 5G connections and share of total, worldwide, 2022–2026*




Similarly, 5G revenue is expected to grow from roughly USD400 billion worldwide in 2023 to nearly USD700 billion by 2026, at which point it will represent 70% of all wireless revenue.

*Figure 2.2: 5G revenue and share of total, worldwide, 2022–2026*

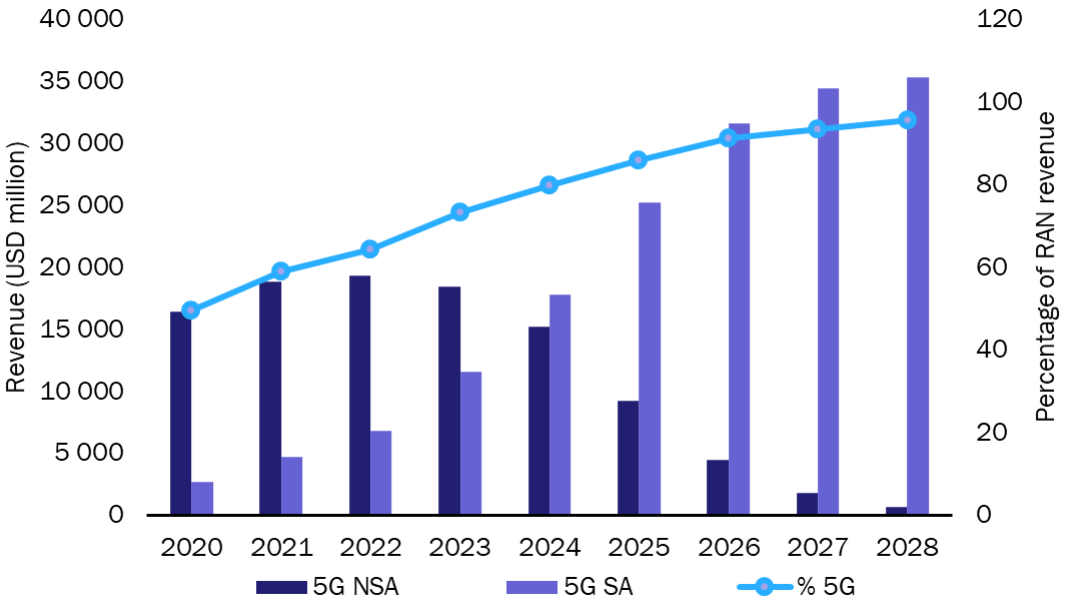



5G revenue has been increasing, but this has been largely at the expense of already-launched services and has not yielded new incremental revenue for service providers. Therefore, service providers need to add value that translates into revenue increases, while also addressing the additional costs associated with 5G roll-out. Doing so will mean that service providers will need to unlock the most compelling 5G use cases, many of which rely on the 5G SA standards to be implemented.

## 2.1 The transition to 5G SA transition is progressing

Analysys Mason projects that 5G SA revenue will exceed 5G non-standalone (NSA) revenue for the first time in 2024 and will account for more than 90% of wireless revenue worldwide by 2028. The transition from NSA to SA is happening now; 5G SA revenue is expected to exceed 50% of NSA revenue this year.

*Figure 2.3: Revenue by 5G network type and 5G's share of RAN revenue, worldwide, 2022–2026*




Source: Analysys Mason

5G SA offers new opportunities for monetization. A close look at the standards for 5G SA networks reveals eye opening innovations from on-demand network slicing to API-exposed network functions. Nearly every aspect of a 5G SA network can be virtualized, componentized, exposed via API and real-time or near real-time charged. Making this entire 5G vision a reality requires extremely detailed specification work to be delivered by the 3GPP.

## 2.2 5G SA requires new charging standards

5G SA requires a complete rethink of any service provider's real-time charging capabilities. 5G SA standards are designed to provide blueprints for new, sophisticated 5G SA solutions and use cases. The vision of 5G networks enabling autonomous drones and vehicles; remote-controlled manufacturing infrastructure; and other ultra-high capacity or ultra-low latency applications is being defined in the 3GPP 5G standards now so they can be brought to life in the market.

However, monetizing these use cases means doing the hard work to define how the 5G network's charging infrastructure will support them. This is a complex task led by experts from service providers' vendors who have vested interests in defining, adopting, and capitalizing on their expertise in these complex but business-critical charging standards. The time and effort they contribute to defining new 5G standards provides them with a clear view of where the industry is headed, for product roadmap purposes. It also allows them to influence and enable the defined standards by bringing the best of their solutions and innovations into the process.

With standards as granular as those being defined for 5G, the issues at hand go far beyond how various devices or systems will communicate. Instead, engineers are standardizing complex sets of applications, interfaces,

interactions, and transactions that govern customizable environments – like network slices configured for autonomous drone operations. Similarly, experts are defining how these potential services can be monetized based on nearly any measure or event because any network function or event could be chargeable.

Because of the Network Exposure Function (NEF) specifications within the 5G standards, a 5G network can look a bit more like a hyperscaler's platform. NEF enables any network capability, transaction, event type, or data record – really anything the 5G network can do – to be exposed via API and monetized and usage-controlled via charging in any combination.

As a result, in a 5G SA network, service providers should be able to monetize a range of potential services, solutions, transactions, event-types, or data outputs. This contrasts with a traditional telecoms network, where billing and charging support specific and mostly pre-defined, communications-centric services but are not designed to charge for component elements like a core network function, a periodic statistical measure, or a certain threshold of API calls. Nor are they designed to support vertical, horizontal, or bespoke solutions, like on-demand network slices with built-in security and live performance reporting related to specific applications running over the slice.

Within the 5G specifications, functions are distributed and called upon to execute specific roles across a range of use cases, from the relatively simple – like fixed-wireless broadband – to the complex, like any applications that combine capacity, latency, cloud-based applications, and real-time control over infrastructure. With NEF in place, any individual component or collection of components may be called as an end-to-end service or solution and charged on any basis – from real-time usage of each individual network function to an unlimited monthly subscription.

## 2.3 Limitations of the 4G online and offline charging systems

The limits of what a 4G online charging system (OCS) and offline charging system (OFCS) can support in the 5G world have become apparent because of this change in architecture and what a chargeable event can be.

### Legacy architecture reflected

Even though 4G charging interfaces are well-defined, they do not support the real-time interactions at the user or device level that 5G requires. In practice, 4G charging interfaces are effective at working with service providers' fragmented billing environments. However, for this reason, the 4G interfaces are limited when it comes to real-time charging and control. For example, many mobile operators cannot provide real-time charging data or account start/stop functions to IoT platform providers in the 4G charging world. In the 5G world, this capability is standardized.

### High cost to support and change

Service providers continue to call for reductions in the cost to customize, maintain, and adapt their charging, rating and billing systems. These systems remain highly complex, however, and organizations tend to avoid changing them due to fear of business disruption. However, the systems must be changed because the products, solutions, devices, and partner landscapes are all transforming. The complexity and disparity in charging solutions cannot change fast enough to keep up with an accelerating market. As a result, 5G charging standards have aimed to decentralize charging functionality and decouple it from legacy infrastructure to reduce cost and improve flexibility.

## Changing customer behaviour

As observed in hyperscale cloud markets, automation via mobile device is accelerating expectations of flawless and predictive customer experiences. However, the legacy and 4G charging architecture are barriers because they do not permit a service provider to transform new user behaviours into monetizable events nor to quickly recognize such patterns and productize a solution to them almost immediately, as leading cloud providers can.

## Growing data management costs

Generating, transforming, and transporting different usage data records (xDRs) for voice, data, and messaging services, and for both offline and online charging functions, is expensive in 4G. Records are gathered, manipulated, and rated or charged by terms or rules, in real-time or offline. This approach to billing mediation has become ungainly. The 5G standards consolidate it all under a real-time umbrella, eliminating the need for mediation. By reducing or eliminating complex mediation architecture, service providers can further reduce the cost and complexity involved in defining, delivering, and monetizing any service.

## Inability to support forward-compatibility

5G brings advances with it which 4G systems have no forward-looking basis to support or enable, for example, a 4G charging platform used as a temporary proxy for 5G services will not enable those services to include new capabilities like location-based charging. Similarly, 5G services are anticipated, because of their advanced ability, to deliver new high-capacity and low-latency services. However, 4G charging platforms are not designed to support the kind of high-performance real-time charging required to deliver them. Convergent charging system (CCS) standards unlock new 5G SA capabilities. The new 5G charging standards allow service providers to monetise many new capabilities (Figure 2.4).

*Figure 2.4: New 5G standard capabilities for monetization*

| Capability | Description |
|---|---|
| Ultra-high rate | For video streaming, gaming, e-health and other applications that pair video with remote control |
| Ultra-low latency | For autonomous driving, drone control, and industrial monitoring |
| Massive connection volume | To enable intelligent robotics, smart home, and smart city |
| Network slicing | Bespoke configuration of virtualized networks to suit specific applications |
| Network exposure | Make any network capability available via API and chargeable |
| Ultra-wireless broadband | High capacity, managed wireless broadband anywhere |

Source: Analysys Mason

These capabilities, in turn, enable service providers to unlock many of the more sophisticated 5G services the industry has long anticipated, including the following.

## Edge computing and ultra-low latency applications

In 3GPP release 17, charging for edge computing becomes part of the standard. This service concept did not exist before 5G. Service providers that want to monetize edge computing will need to adhere to this standard and will want to benefit from the complexity it addresses in monetizing 5G-specific capabilities like low-latency edge computing. These advanced applications can be charged at higher rates than other standard traffic and can be bundled with applications and cloud solutions to promote differentiated and higher-margin services.

### Network slicing

Network slicing is a powerful concept in 5G because it lets a service provider virtualize and abstract its physical network into separate slices, each of which is optimised for a different set of applications, such as low-latency gaming, high-capacity video production, or real-time remote infrastructure monitoring. Network slicing is covered in 3GPP release 16, which means that the 5G CCS already allows charging for distinct network slices.

### Network exposure

The 5G CCS works with the new 5G service-based network exposure function so that charging and service activation can be managed on a granular, per-network service basis, based on invoked API calls. This hyperscale-like model allows service providers to charge at a much more granular level, to define specific services down to the network level, and to market such services in different combinations.

## 2.4 What are the new 5G SA CCS standards?

The new 5G charging standards are backward compatible with 4G, but they represent a real departure from previous generations of charging architecture in a variety of ways, including the following.

### Service-based architecture

5G SA requires a vendor- and technology-agnostic service-based architecture (SBA) to enable more granular functional definitions that can be used and charged independently.

### Converged charging

Legacy offline and online charging functions are combined into a single CCS that comprises five functions:

#### *Charging function (CHF)*

The CHF covers both online charging functions (OCF) and the charging data function (CDF) previously used for offline charging but adds the ability to charge for specific network events.

#### *Nchf interface*

This message interface addresses service creation, service update, service release, charging notification and spending limit controls. It also reduces data record (xDR) processing to power near-real time charging and service control.

#### *Rating function (RF)*

The 5G rating function applies relevant rates to events. It can be a stateless function; is agnostic to the device, user and session; and makes more real-time and near real-time services possible by de-centralizing rating.

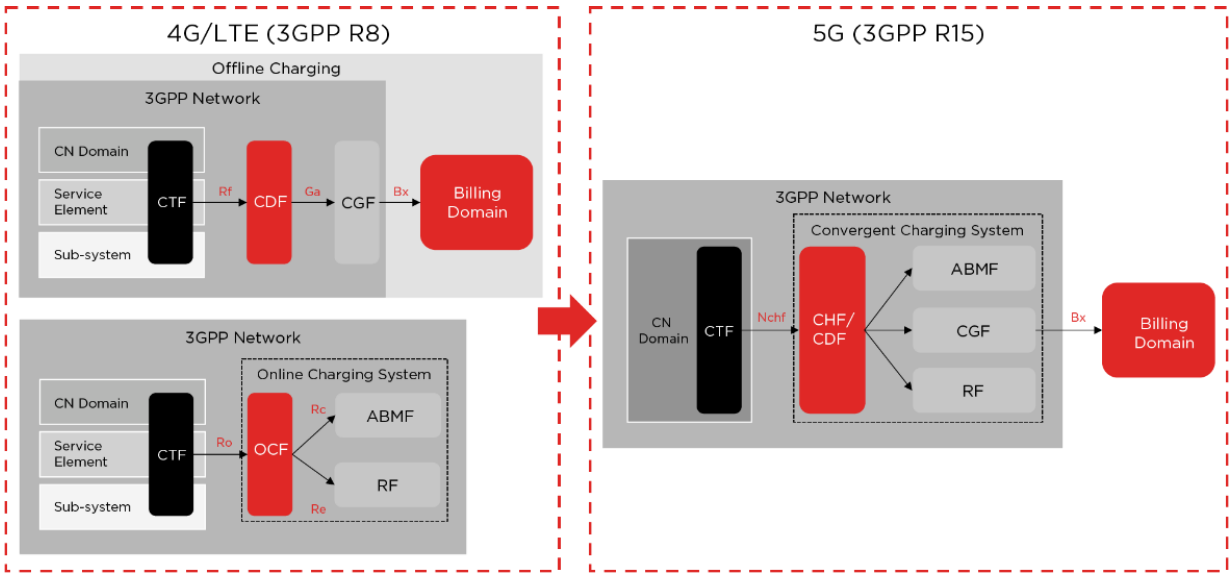
#### *Account and balance management function (ABMF)*

The ABMF tracks credit and debit balances of any type enables user or organizational controls that manage risk, cost, or usage.

#### *Charging gateway function (CGF)*

The CGF alleviates much of what mediation and data transformation systems did in previous network generations. It aggregates event data records and delivers them to billing systems in pre-defined formats.

*Figure 2.5: Evolution of charging from 4G to 5G*




Source: Huawei

The 5G standards are backward compatible to co-exist with legacy billing and mediation systems. But their intention is to move new 5G use cases and revenue opportunities forward for service providers, which is why contributions from key vendors have become central to defining standards.

# 3. Major contributions to standards from key vendors

Defining the new 5G network and charging standards requires major contributions of expertise and technical skill from people who work in a variety of committees within the 3GPP organization. The open process brings together telecoms and related technology companies from around the world to establish international standards for every aspect of 5G. Any organization can join the 3GPP to contribute. The specifications are publicly available to non-members as well as members, making for an open, transparent process.

Within the greater 3GPP organization are specific Technical Specification Groups (TSGs), which spawn detailed Working Groups (WGs) that drive the specific Work Items that comprise the actual standards.

There are three TSGs and 16 Working Groups. The three TSGs are:

- Core Network and Terminals (CT) with four active Working Groups
- Radio Access Network (RAN) with six active Working Groups
- Service & Systems Aspects (SA) with six active Working Groups.

## 3.1 Technical Specification Group SA – Working Group 5; management, orchestration and charging

It is within Technical Specification Group SA Working Group 5 (TSG SA WG5) that the specifications for management, orchestration and charging are defined. Experts from major technology suppliers like Ericsson, Huawei, Nokia, and Matrix Software are involved in the Working Group's activities and its contributions to the overall 5G standards.

TSG SA WG5 focuses on the management and orchestration aspects of the 5G standard and coordinates with other 3GPP working groups, as well as other related standards-developing organizations (SDOs) and open-source communities to ensure alignment. TSG SA WG5's purview includes operations, assurance, and fulfilment, and their automation. This Working Group also defines management interactions among entities that are external to the network operator to support service components that other service providers, partners or customers contribute or use.

TSG SA WG5's functional remit also covers charging, including everything from quota management to CDR generation as described earlier. Its formal contributions to the standards include technical architectures as well as standardized and detailed data and service definitions, which are needed to activate, manage, orchestrate, and monetize 5G services.

The series of new charging capabilities this group has produced to fulfil the full 5G SA vision is presented in Figure 3.1. It shows how new charging capabilities have been added to the standards incrementally in releases 15 to 18, the latter of which is now in the review process.

*Figure 3.1: 5G release and CCS functions*

| Release | Functional area |
|---|---|
| R15 | 5G convergent online and offline charging on a service-based architecture (Nchf converged charging API definition and corresponding CHF CDR and ASN.1 definition).<br>SMF charging; including home-routed roaming support |
| R16 | NEF charging; AMF charging; CHF control quota management; network slicing charging, including the network slice performance and analysis and network slice management charging. |
| R17 | 5G LAN charging; URLLC charging; 5G IoT charging; 5G prose charging; edge computing charging and enhanced network slice charging.<br>5G IMS charging.<br>Local breakout roaming. |
| R18 | Nchf charging services phase 2 SID<br>5G roaming charging architecture for wholesale and retail scenarios Roaming charging SID,<br>Network Slicing Phase 2 SID<br>Charging Aspects for Enhanced support of Non-Public Networks SID<br>Time Sensitive Networking charging SID |

Source: Analysys Mason

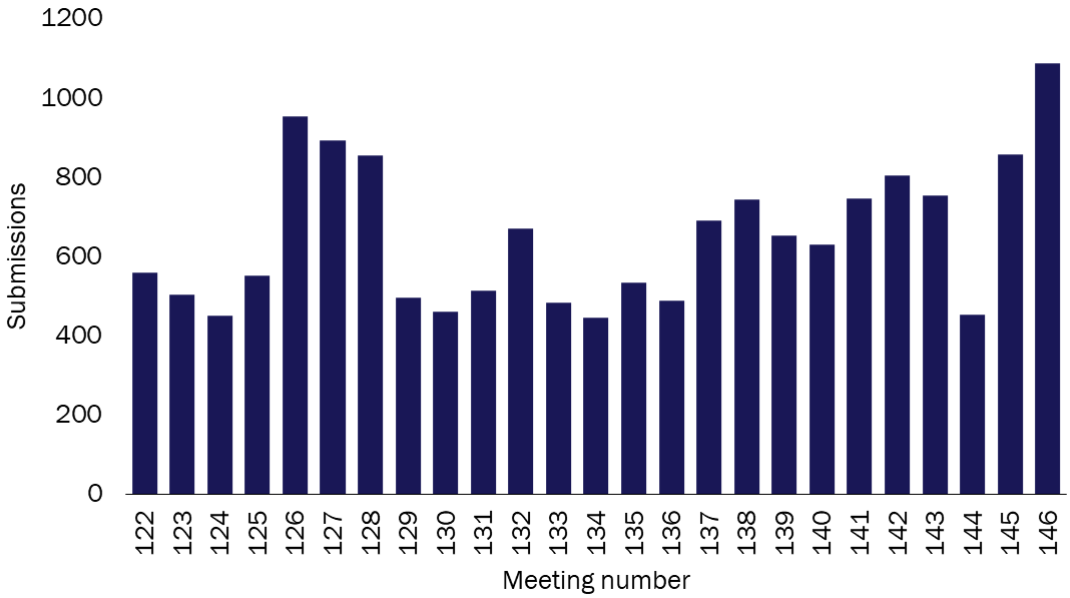
These include major milestones such as defining the converged charging architecture; charging for exposed network functions; enabling control quota management over any type of service; and charging for network slices, ultra-low latency characteristics, roaming, IMS functions, and for network handovers and roaming in the expanded 5G services environment.

## 3.2 Research methodology scope

Contributions to the standards process represent significant effort and investment on the part of the participants. Not every contribution becomes part of the standard; only 44% of the contributions to meetings 122 to 146 were accepted. Substantial effort is made to work through multiple concepts to arrive at a common standard.

Within each Working Group, new ideas or contributions are categorized into Work Item Description (WID) and Study Item Description (SID). These lead to a Technical Report (TR) from SID and Technical Specification (TS) from WID containing normative provisions and informative annex. SIDs and WIDs both generate technical documents (TDocs). TDocs include technical reports, specifications, change requests, liaison statements, discussion papers and other items. Each TDoc is submitted for review at specific 3GPP meetings that are held about six times each year normally. Each meeting has hundreds of TDocs submitted (Figure 3.2).

*Figure 3.2: Number of TDocs submitted per meeting Source: Analysys Mason, 2023 using 3GPP public data]*




Source: Analysys Mason

Analysys Mason has analysed the 3GPP meetings from March 2018, when Release 15 was approved, to the present day, accounting for 24 meetings and 16 273 submissions of TDocs in total.

Each meeting provides data on the following.

- The source of each TDoc, which includes vendors, operators, committees as well as combinations of multiple contributors.
- The status of each TDoc, which include whether it is agreed, approved, available, revised, rejected, and postponed.
- The associated 3GPP release the TDoc is related to, such as Release 17. (90% of TDocs have associated Releases.)

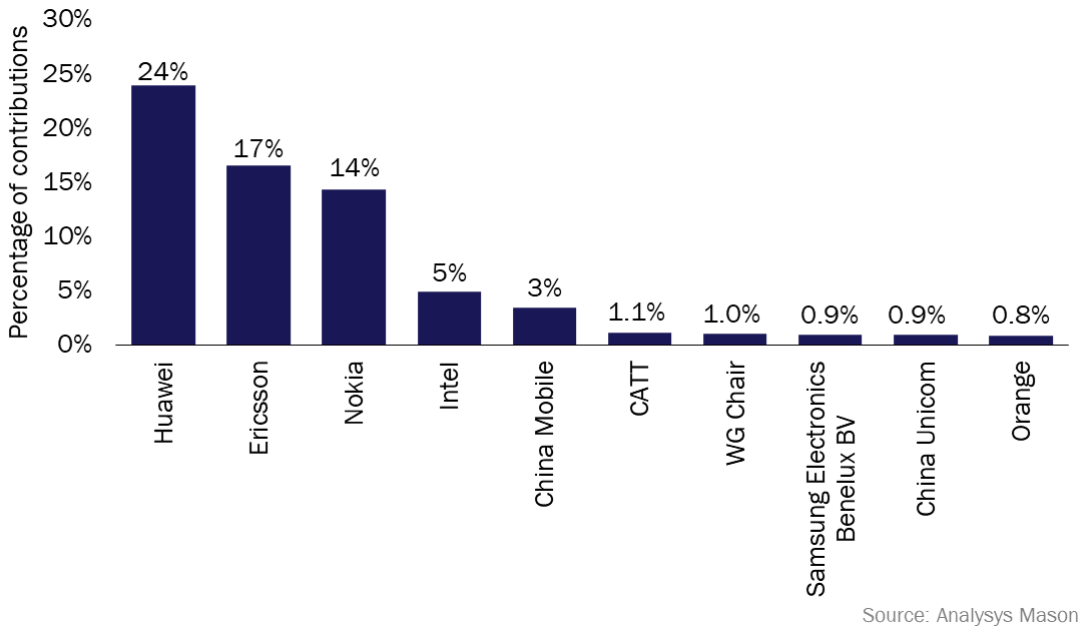
- The menu item associated with the TDoc at the meeting, which provides guidance of the topic of the TDoc. This report is concerned with contributions to the 5G charging standards, which are associated with menu item number 7, which has 3972 contributions associated with it.

The contributions to the 3GPP standards are made by various parties, most of which are major technology vendors to the service provider community, as well as service providers and other technical consortia.

## 3.3 Analysis of the contributions to 5G SA CCS standards

Overall, analysis of the meetings shows that three vendors are responsible for more than 50% of the contributions: Ericsson, Huawei, and Nokia. On all the TDocs contributed, 95% were associated with either operations, administration, maintenance, and provisioning (OAM&P) (71%) or charging (CH) (24%) for the SA5 working group as a total.

*Figure 3.3: Source analysis for all TDocs from March 2018*

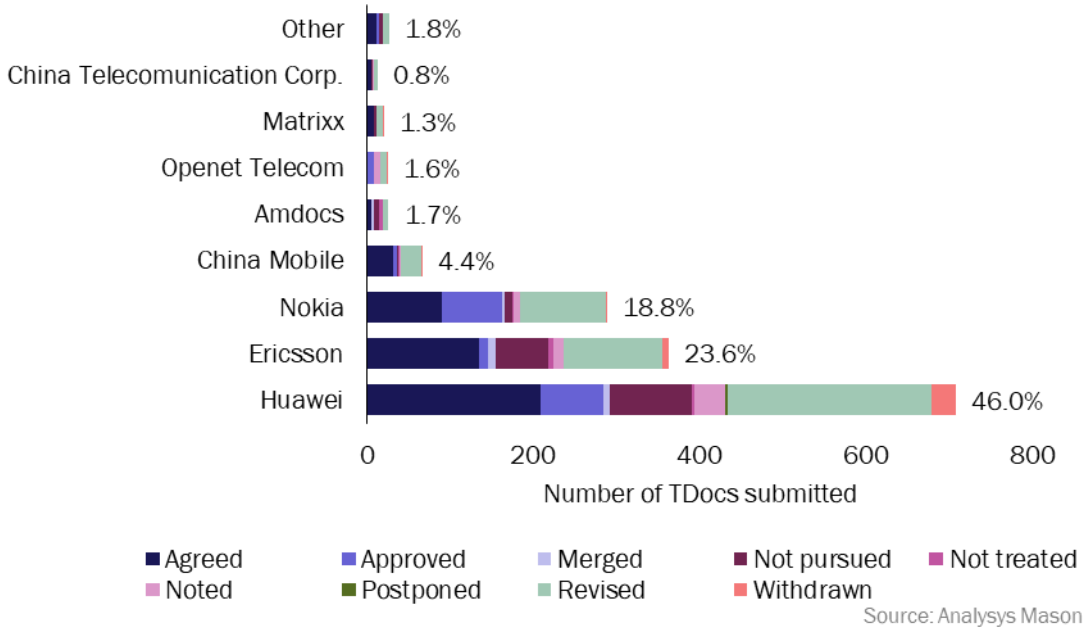



Source: Analysys Mason

### *Release 16*

During the development of 3GPP 5G standards Release 16, Ericsson, Huawei and Nokia accounted for more than 88% of contributions to the standards development effort for CCS. Huawei provided 46% of the TDocs, which represented more than 700 contributions, of which nearly 300 (or 42%) became part of the standard itself as either agreed, approved or merged. Ericsson contributed 24% of the TDocs and Nokia 19%.

*Figure 3.4: Total contributors to 3GPP 5G charging standards Release 16, by vendor, percentage of total and status*

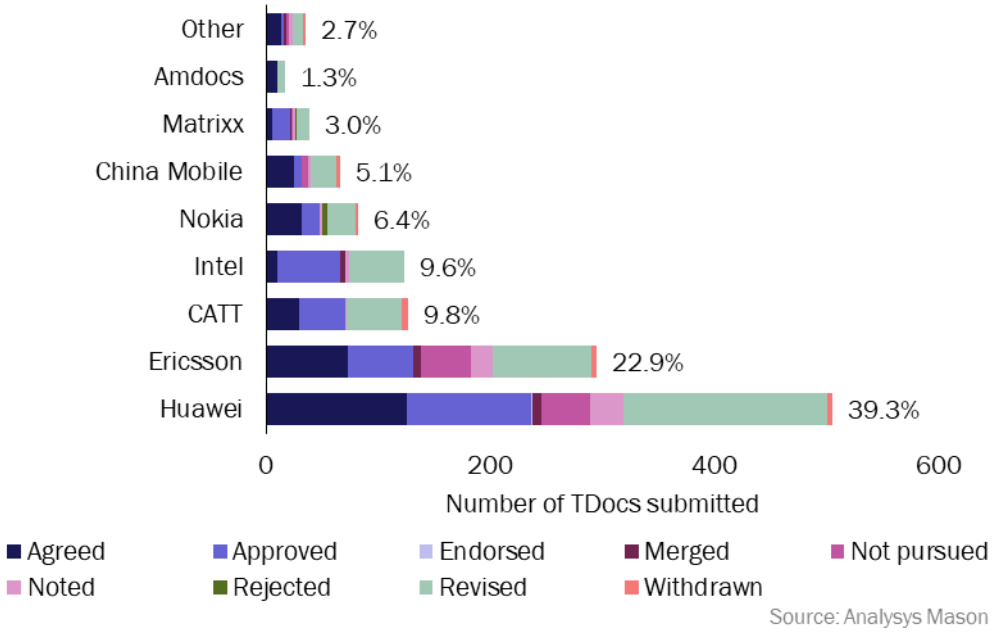



### *Release 17*

Similarly, during development of Release 17, Huawei contributed 38% of the accepted, approved, endorsed or merged proposals, equating to 255 contributions. In this phase, Ericsson provided 181 contributions and Nokia 81. In each case, key 5G suppliers to the industry have stepped up to do the detailed engineering work required to turn 5G concepts into real-world capabilities that can be delivered and monetized at extremely large scale. Other contributors such as the China Academy of Telecommunications Technology (CATT) and Intel, as well as charging vendors Amdocs and Matrixx, also became more active in Release 17.

These contributions matter for service providers because they are the most direct beneficiaries of the effort required to innovate, implement, and adopt these complex standards. Furthermore, just as development and production processes have converged in the IT and networking worlds, standardization is an ongoing process that should feed development pipelines and continuous improvement processes.

*Figure 3.5: Total contributors to 3GPP 5G charging standards Release 17, by vendor, percentage of total and status*




By being directly involved in the definition of the standard, a supplier provides a service provider with:

- a forward-looking view of what will be needed in the future
- a clear understanding of how the supplier will adopt new standards and use cases within their pipelines and roadmaps
- the opportunity to prepare business units in advance to use new capabilities as part of their competitive advantage
- less product-driven change coming from the supplier because of the visible alignment with the ongoing standards definition work.

A supplier or vendor's deep knowledge of, contribution to, and alignment with 5G charging standards should provide its service provider customers with greater network and service interoperability, faster time to market for whole categories of new services, and a lower cost to create, deliver, lifecycle manage and monetise new 5G use cases.

# 4. Conclusions

5G standards remain in the spotlight although standards have sometimes been side-lined by the greater communications industry. 5G SA standards are expansive and complex, making alignment across supplier, service provider business organizations, and standards releases even more important than in previous network generations.

Here are six key takeaways that service providers may consider in evaluating their suppliers' support for, adoption of, and conformance with 3GPP 5G charging standards:

- 3GPP Releases 15 to 18 and beyond have defined the details on how to deliver and monetize many of 5G and 5G SA's most compelling capabilities. Understanding what these capabilities are and how they are charged in the 5G architecture will be required to assess impacts on current charging infrastructure.

- Adoption of and conformance with 5G charging standards is crucial to the realization of use cases that drive the greatest value from 5G such as network slicing, network exposure functions, and ultra-low latency services. These new charging standards are highly sophisticated, but they need to enable the socioeconomic and cultural value creation that 5G has been predicted to promote worldwide.

- New 5G charging standards can power new categories of services, where service providers can charge for any combinations of API calls, network interactions, or other evocations of functions including those from third-party networks. Because these were not anticipated or accounted for in previous generations of mobile charging standards, service providers will need to adopt new, standards-compliant 5G charging capabilities on an ongoing or continuous improvement basis to remain in step with the 5G innovation pipeline.

- The shortest path to alignment with that standards pipeline runs through the greatest contributors to 5G charging standards, who are among service providers' most important strategic technology suppliers. Vendors such as Huawei continue to invest substantially to provide expertise, effort, research and development assets, innovations and work items to ensure that the standards produced will bring 5G's economic promise to fruition.

- Working closely with the key contributors to the standards does not rule out developing a healthy and interoperable 5G supplier ecosystem. On the contrary, attentive conformance with standards on an ongoing basis and as part of an overall supplier roadmap and business alignment effort will help service providers to ensure that they remain at the cutting edge of 5G developments while maintaining an adaptable and more future-proof supplier ecosystem.

- New services such as those that support extended reality (XR) (augmented virtual and mixed reality) will need 5G services to satisfy their requirement for high bandwidth, low latency and reliable connectivity. The ecosystems and complex supplier value chains will need the flexibility to charge for services in innovative ways, the new charging standards enable service providers to achieve this.

# 5. About the author

**Justin van der Lande** (Research Director) leads the *Applications* practice. He specialises in business intelligence and analytics tools, which are used in all telecoms business processes and systems. In addition, Justin provides technical expertise for Analysys Mason in consultancy and bespoke large-scale custom research projects. He has more than 20 years' experience in the communications industry in software development, marketing and research. He has held senior positions at NCR/AT&T, Micromuse (IBM), Granite Systems (Telcordia) and at the TM Forum. Justin holds a BSc in Management Science and Computer Studies from the University of Wales.