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Standardization leadership

5G and its evolution

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Defining leadership

In telecommunications, technology leaders are in many ways defined by their leadership within standardization.

In telecommunications, standardization is essential to creating global communication systems and ecosystems. The open, consensus-based standards development process in 3GPP enables the best technology to emerge and is key to ensuring robust choices for consumers and competition in the marketplace. It generates the best products technologically, provides greater security, and ensures global interoperability.

The open standardization process also serves as one of the strongest objective indications of technology leadership for the evolution of 5G and beyond. In this report, we analyze the standardization leadership for 5G and its evolution in 3GPP – the main standardization forum for mobile communication systems.

Standardization is essential to creating global communication ecosystems

The standardization landscape

When assessing standardization leadership, it is important to understand the structure and working processes of the 3GPP organization.

3GPP has successfully defined 3G, 4G and 5G technology by producing specifications describing all aspects of the systems, including system architecture, interfaces between nodes, service-based interfaces, management interfaces, performance and testing requirements. In addition to enabling the connectivity of every mobile phone, this technology is currently being deployed for numerous new use cases, ranging from connected cars to industrial systems and metering applications. The technical specifications produced by 3GPP are further transposed to technical standards by the 3GPP Organizational Partners (regional standardization bodies), enabling a global standard for mobile systems.

3GPP has 700 individual members, including not only all major telecommunications operators and vendors,but also a wide representation from several vertical sectors, universities, research institutes and government agencies.

There are three Technical Specification Groups (TSGs) in 3GPP: Radio Access Network (RAN), Core Network and Terminals (CT) and Service and System Aspects (SA). The actual technical specification process is performed in working groups (WGs) under TSGs. Currently, there are a total of 15 working groups, as shown in Figure 1.

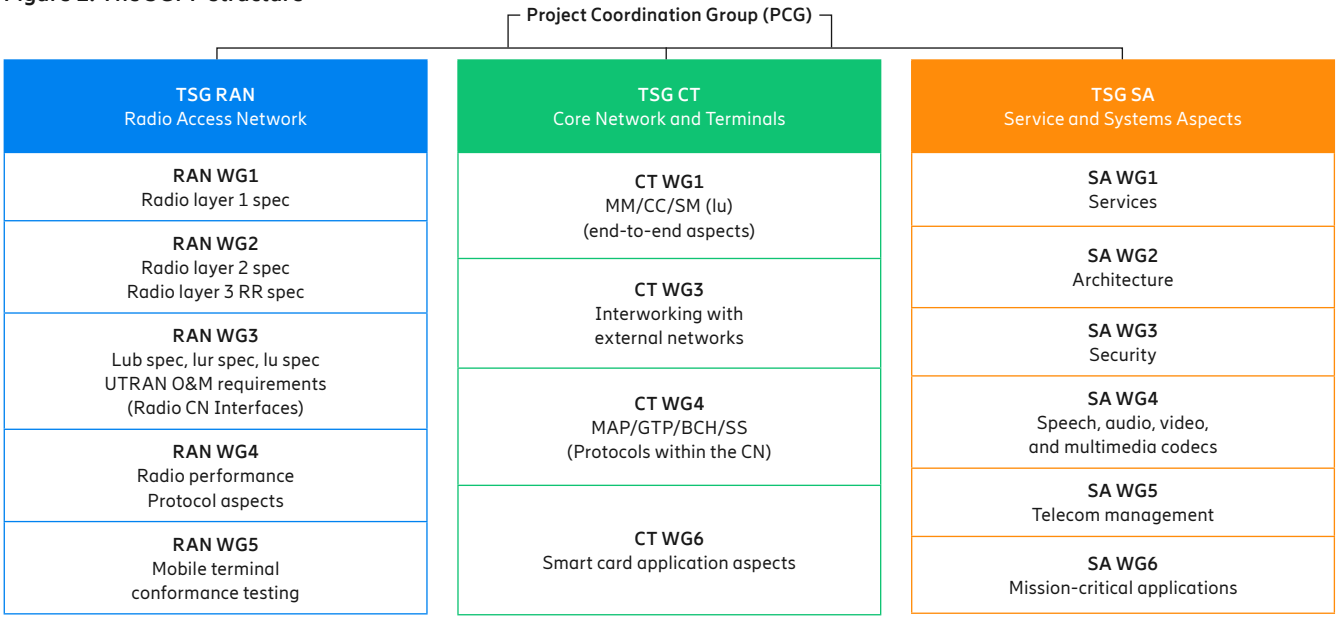
The 3GPP standardization process is contribution-driven. Each individual member can propose new work to be started by submitting proposals for new features. Approved features are then grouped by 3GPP into Releases, with a new Release being published roughly every 18 months.

Each individual member is also encouraged to submit technical contributions on current ongoing work and study items. Technical contributions are discussed and evaluated in standardization meetings based on their technical merit, and once consensus on the best technical solution is reached, specifications are created based on further input contributions. These meetings are typically held face-to-face, although during 2020, they have been conducted electronically (see page 9 on COVID-19 impact).

In general, the technical documents can be grouped into discussion papers, which typically state a position or describe an idea in an informal manner, and change requests, which propose formal changes to specifications. There are significant variations in ways of working between different groups; for example, RAN WG1 and WG2 rely heavily on discussion documents to progress work and utilize appointed rapporteurs to write the actual specification text, while the other groups primarily use change requests authored by individual companies or by groups of companies.

After completing the 5G specifications of 3GPP Release 15 (Rel-15) in March 2019, 3GPP has now completed the first enhancements to 5G with 3GPP Release 16 (Rel-16) in June 2020. As well as adding new functionality to already supported use cases, Rel-16 extends the support of 5G technology to new use cases. For example, Rel-15 mainly targeted enhanced mobile broadband (eMBB) and selected ultra-reliable low-latency communication (URLLC) use cases, while Rel-16 adds support for further use cases such as Vehicle-to-everything (V2X), Industrial Ethernet and Time Sensitive Networking (TSN) and non-public networks.

Figure 1: The 3GPP structure



Note: Technical specification work is performed in the 15 working groups (WGs) under TSGs

Measuring leadership

New limitations on the number of contributions per company have meant that the number of submitted contributions is no longer a reliable metric for measuring leadership. Instead, we must use a combination of metrics.

One commonly used metric for measuring standardization leadership, especially in groups relying on discussion documents instead of change requests such as RAN WG1 and RAN WG2, has been the number of submitted contributions. While it is clear that this number alone has never given a full picture of standardization leadership, there has normally been a correlation with the number of submitted contributions and the impact on the technical content of the standards.

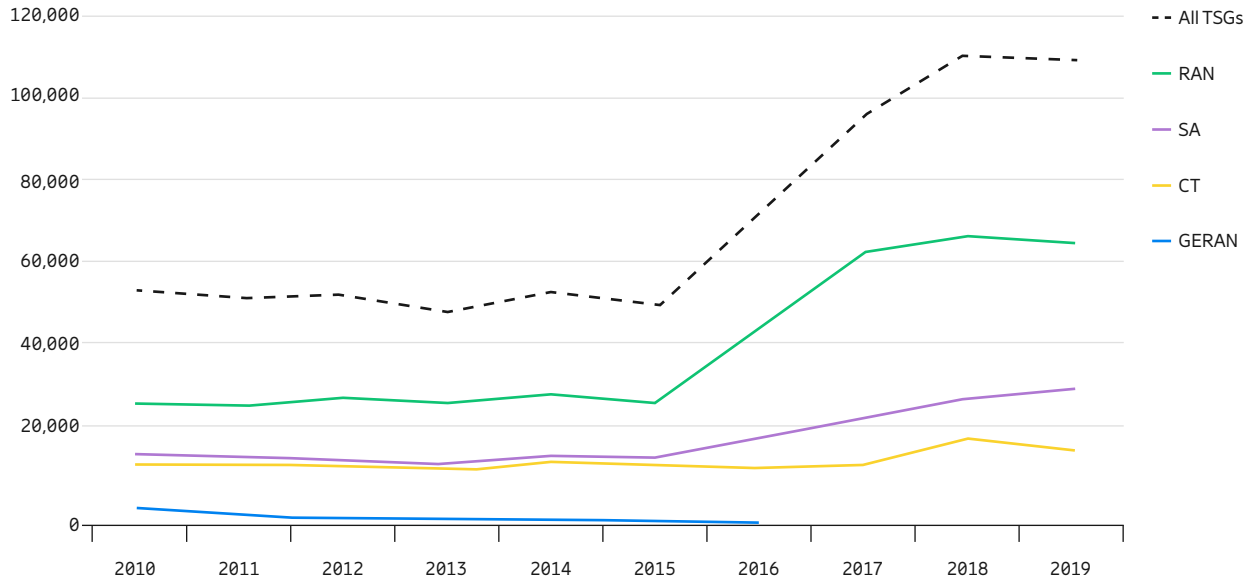
The number of contributions submitted to 3GPP has seen a dramatic increase with the standardization of 5G.

Figure 2 shows that the number of contributions more than doubled between 2015 and 2017, reaching more than 110,000 contributions in 2018.

The tremendous increase in submissions during 5G development proved to be challenging for some 3GPP working groups, and forced the working group chairs to limit the number of contributions per company. This policy was first introduced in RAN WG1 and has subsequently been extended to cover RAN WG2, RAN WG3 and RAN WG4 as well. We do not currently see a need to extend the limits beyond these groups.

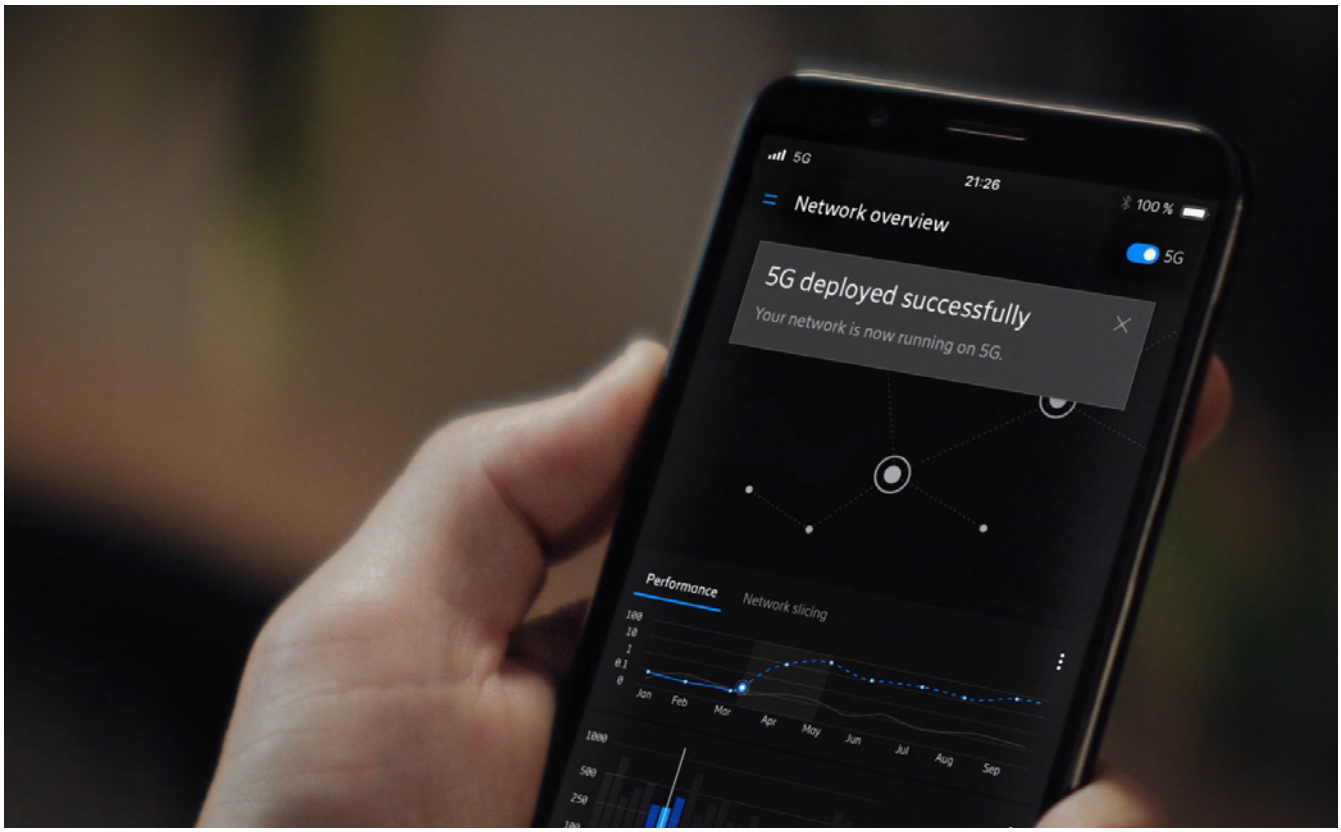
Limits on the number of contributions have proven to be effective and have allowed 3GPP to successfully complete the work on Rel-15 and Rel-16. However, limiting the number of contributions per company has also caused the number of submitted contributions to no longer be a good measurement of standardization impact, as all companies are constrained to the same number of submitted contributions.

Figure 2: Number of contributions submitted in all 3GPP groups[1]



Source: ETSI Mobile Competence Centre (MCC), in SP-200127

[1] RAN, CT and SA groups are detailed in Figure 1, while GERAN was a group focusing on GSM/EDGE development and maintenance.



3GPP saw a dramatic increase in contributions with the standardization of 5G

Instead of using the number of contributions as a single metric for standardization leadership, we have evaluated the leadership using a total of four metrics, each highlighting different aspects:

1. Number of approved contributions
This identifies on a high level how many proposals are accepted from a company. There is a strong correlation between this metric and influence in working groups that primarily work with formal documents (especially CT and SA groups in core network areas[2]), and even though this correlation is weaker in groups working primarily with discussion documents (especially in RAN WG1), the metric can still be used in those groups as well. It does not differentiate between major contributions, such as introducing new features, and minor corrections.

2. Specification impact
Weighting the contributions based on the impact they have on specifications allows for differentiation between major contributions and minor corrections. In this report, we have chosen to measure the impact by amount of text added to specifications for simplicity. Even though minor corrections can be important and long corrections less important, in general the impact of a correction can be expected to have a correlation with its length.

3. Quality
The quality of the contributions can be measured by examining the ratio of approved contributions to total contributions. We always use all available working groups[3] when evaluating this metric, as this measure is less accurate in groups working primarily with discussion documents (especially in RAN WG1).

4. Chair positions
This is an indication of trust in a company's fairness and commitment to 3GPP, especially for positions that are elected by members. In this report, we measure this by counting the number of chair-quarters for chair and vice-chair positions (in other words, the count of chair and vice-chair positions for each quarter summed over the total measurement period). Due to the small number of chair and vice-chair positions, it is necessary to use the longest time periods and as many working groups as possible. We do not think it is possible to evaluate this metric using only one or even two working groups, and always use all available working groups when evaluating this metric.

[2] Core network areas include SA WG2, WG3, and WG4, and CT WG1, WG3 and WG4.
[3] Available working groups include RAN WG1, WG2, WG3, WG4 and WG5 for radio access, and SA WG2, WG3 and WG4 as well as CT WG1, WG3 and WG4 for core network.

Standardization leadership in 3GPP

While leadership in 3GPP RAN and core network groups should usually be evaluated separately, metrics such as chair positions are notable for offering insight into a company's overall commitment to 3GPP.

Companies in 3GPP focus on different working groups depending on the impact of those groups for their businesses, leading to different companies being active in RAN and core network groups. Thus, instead of having one evaluation for the whole 3GPP leadership, it is preferable to evaluate the leadership separately for 3GPP RAN and core network groups. It is also difficult to combine leadership metrics of larger and smaller groups.

However, there are cases when looking at the data aggregated over the whole of 3GPP is justified. In particular, chair positions (shown in Figure 3) can be used to evaluate the overall trust of a company's fairness and commitment to 3GPP, due to the fact that most of these positions are elected by majority vote.

Initial Release versus later Releases

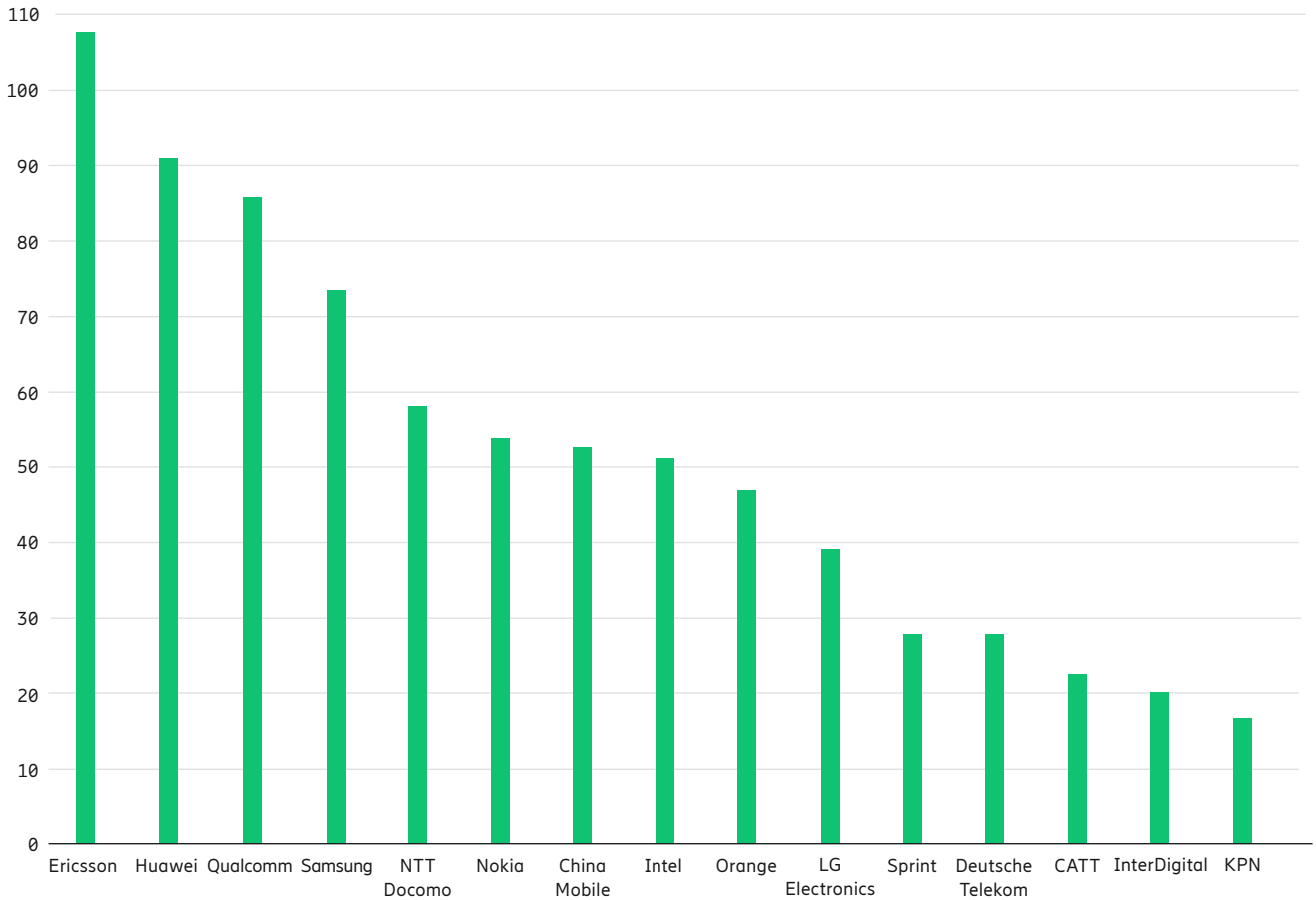
The first Release of a new generation always provides the fundamental technical foundation for mobile systems. All subsequent Releases rely and build upon the technical solutions of the initial Release, making the leadership of the initial Release a good indication of companies' contribution to fundamental 5G technologies.

For 5G, this technical foundation was completed in Rel-15.

The subsequent releases normally provide incremental enhancements, such as new functionality or support for new use cases, and while these enhancements can be significant, they will be technically dependent on the solutions of the initial release. For 5G, the first enhancements have recently been completed in Rel-16.

Below, we evaluate the contributing companies' impact to the development of 5G in 3GPP Rel-15 and Rel-16 separately.

Figure 3: 3GPP chair positions during the specification of 5G (Q2 2016 to Q2 2020), measured in chair-quarters



Leadership in fundamental 5G radio access technologies (3GPP Rel-15)

For 3GPP RAN, WG1 and WG2 define the most central technologies for 5G air interface, providing the foundation for new technologies required by handsets, devices and radio infrastructure. Thus, looking at the standardization leadership using the number of approved contributions and specification impact in RAN WG1 and RAN WG2 in Rel-15 is likely to give a good indication of a company's strength in defining the 5G air interface.

In Figure 4, we show standardization leadership in 3GPP for all 5G contributions to the fundamental 5G radio access technologies. The 5G standardization in 3GPP RAN started with a study item for New Radio (NR) in April 2016, and was completed with the functional freeze of Rel-15 (Q1 2019). The values for the metrics have been normalized to the leader to create comparable values between zero and one.

In order to demonstrate the value of using a broad set of metrics, we have also evaluated the leadership in RAN WG1 and RAN WG2 by using the more traditional metrics of total and approved contributions in Figure 5. Comparing Figures 4 and 5 clearly shows that using four metrics instead of a simple contribution count allows for better differentiation between the leaders.

Figure 4: Evaluation of standardization leadership in 3GPP RAN Rel-15

Note: Values have been normalized by dividing each measurement point by the measurement point value for the leader

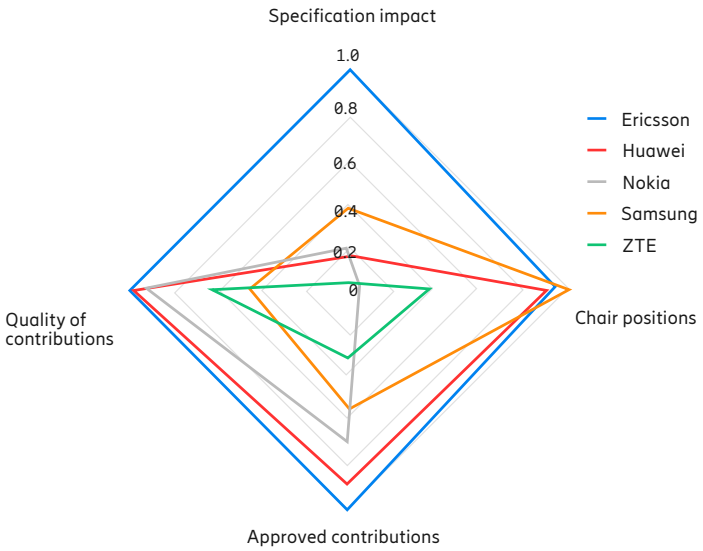
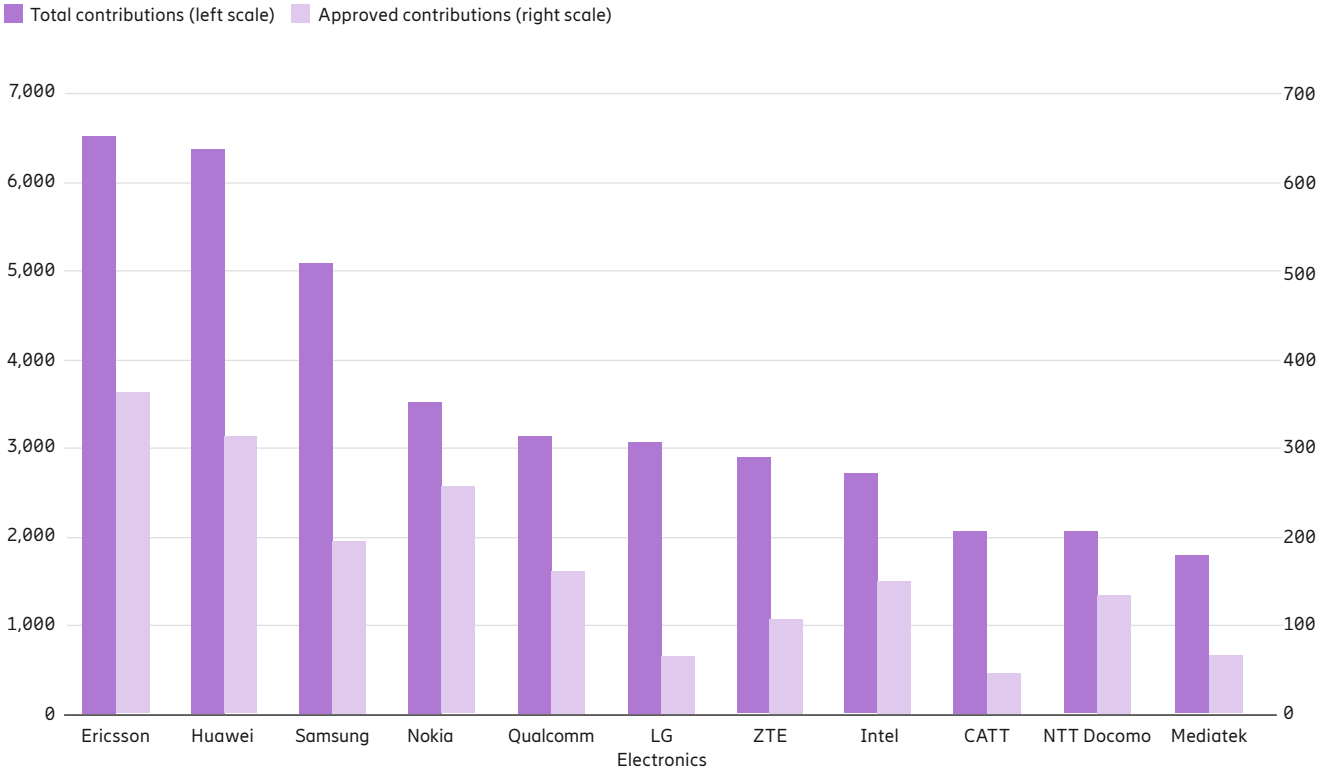


Figure 5: Number of total and approved 5G contributions in RAN WG1 and RAN WG2 up to the functional freeze of Rel-15 (Q1 2019)



Leadership in enhancements to 5G radio access technologies (3GPP Rel-16)

Figure 6 shows the evaluation of the standardization leadership for the first set of enhancements to NR (3GPP Rel-16, from April 2019 to June 2020) using the same metrics as shown in Figure 4 for the fundamental radio access technologies.

Leadership in core network protocol standardization

The main 3GPP working groups impacting core network are SA WG2, WG3 and WG4 and CT WG1, WG3 and WG4. Figure 7 shows the evaluation of 3GPP core network standardization leadership for 5G contributions in 3GPP Rel-15 and 16 respectively, using the four leadership metrics described on page 5.

For core network groups, the number of submitted contributions does not necessarily reflect actual leadership. In these groups, the majority of contributions are formal change requests, and it can be expected that valid, well-written change requests will be approved without, or with only a few, revisions. However, poorly formulated change requests will be either rejected or approved only after several revisions, leading to a large number of contributions.[4] Therefore, rather than focusing on this value, more consideration should be given to our four metrics when evaluating leadership within core network groups.

Figure 6: Evaluation of standardization leadership in 3GPP RAN Rel-16

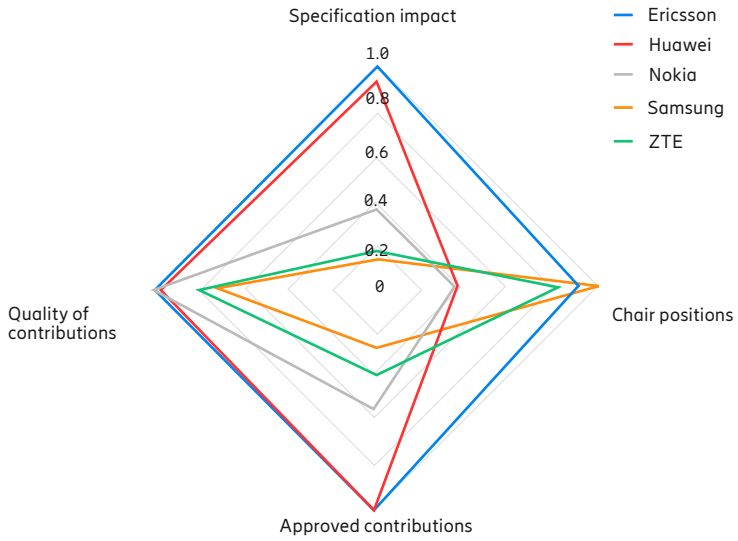
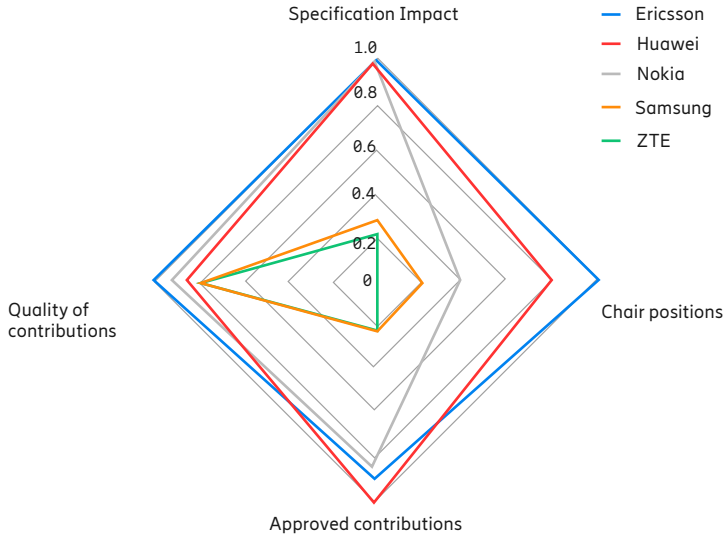
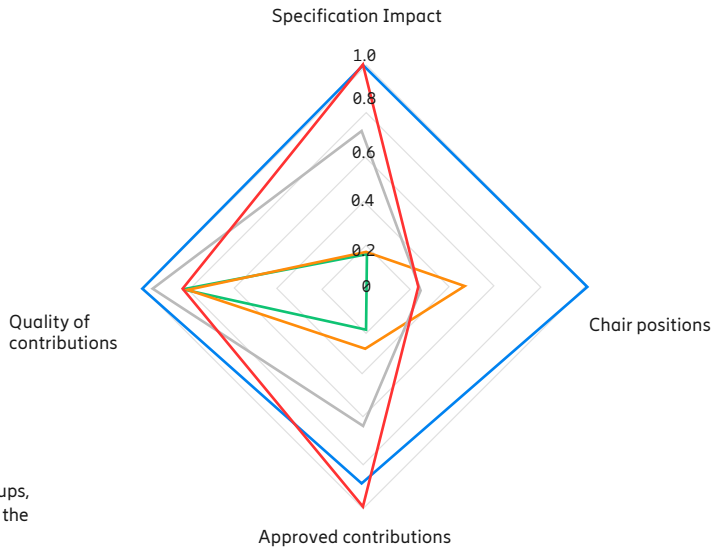


Figure 7: 3GPP core network standardization leadership using the four leadership metrics for fundamental core network technologies.

(3GPP Rel-15 up to functional freeze)



(3GPP Rel-16 up to functional freeze)



[4] Note this consideration does not hold for RAN working groups, especially RAN WG1 and RAN WG2, where the majority of the contributions are discussion documents.

COVID-19 impact

Despite a significant impact to 3GPP's ways of working, the organization has been able to successfully adapt and overcome the challenges presented on a global scale.

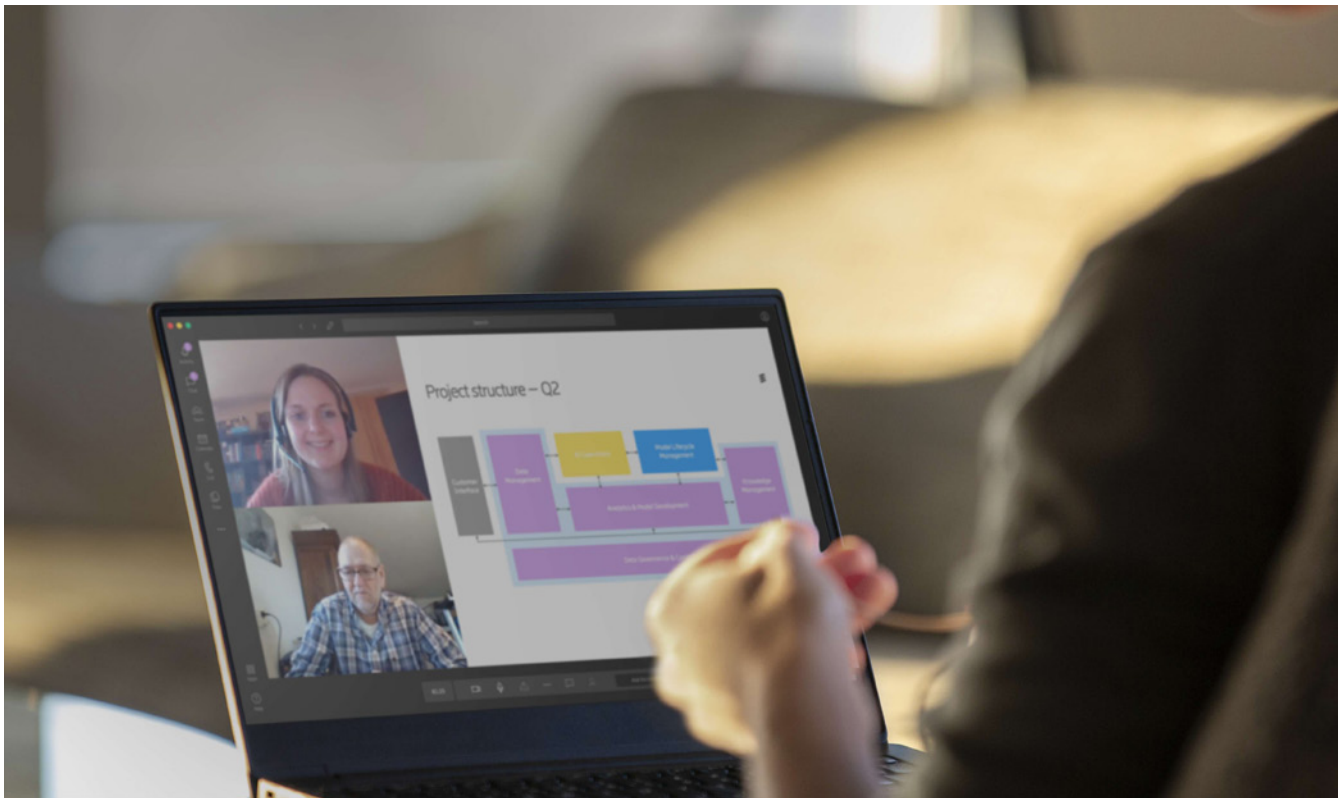
The coronavirus disease 2019 (COVID-19) outbreak in early 2020 has had a dramatic impact on how 3GPP standardization is conducted. Initially the physical meetings were replaced by electronic meetings with limited progress. Throughout the following months, 3GPP took several steps to adapt and improve the electronic meetings:

- providing clear guidelines for 3GPP chairs on how to conduct electronic meetings
- endorsing electronic collaboration tools (especially group conference calls)
- updating the working procedures to avoid deadlocks due to single company objections

Even though these improvements have increased the efficiency significantly, progress appears to still be (perhaps 30 percent) slower than before the pandemic. The main limiting factor is the consensus-building process, especially for controversial issues, and it is expected that the 3GPP progress will continue to be slower than usual until physical conferences are able to resume.

However, despite the electronic meetings not being as efficient as the regular face-to-face meetings, they have proven to be viable, and are likely to be used at least intermittently in the future as well.

There has been no notable impact to standardization leadership, as companies continue to find ways to overcome these new challenges. The pandemic has made it clearer than ever how important the global communication infrastructure is, and this sentiment is reflected in the commitment of 3GPP's members throughout this disruptive period.



3GPP has been working to improve the efficiency of electronic meetings

Summary

Ericsson stands out as a technology leader among the many companies contributing to 5G standardization, having influenced both the fundamental 5G technology and the first set of enhancements to 5G technology more than any other contributor.

In this report, we have evaluated the standardization leadership for the fundamental 5G (3GPP Rel-15) and initial 5G evolution (3GPP Rel-16). The initial 5G development in 3GPP Rel-15 contains the fundamental technical solutions upon which all subsequent releases rely and build upon, while 3GPP Rel-16 contains the first set of technical enhancements. Combined, these two releases can be expected to correspond with technology leadership in 5G in general.

The analyzed time period covers 3GPP Releases 15 (March 2019) and 16 (June 2020), which extends the support of 5G technology beyond eMBB and selected URLLC use cases; for example, V2X, TSN and non-public networks.

The specification of 5G has led to a significant increase in the number of contributions in 3GPP. This has proved to be challenging for some 3GPP working groups, leading to chairs limiting the number of contributions per company in RAN WG1-WG4. This limit makes it difficult to use the number of submitted contributions as the primary metric for standardization leadership, and so we have evaluated the leadership using a total of four metrics, each highlighting different aspects of leadership:

1. Number of approved contributions
2. Specification impact
3. Quality of contributions
4. Chair positions

We have evaluated the leadership in RAN and core network areas separately, as companies in 3GPP focus on different working groups depending on their business impact. For both RAN and core networks, it is clear that Ericsson stands out as the leader from a long tail of companies contributing to standardization. By looking at the total leadership using all four metrics, Ericsson is shown to also be a clear overall leader in 3GPP and has influenced the technology driving 5G more than any other contributor.

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