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3GPP Contribution Analysis – *Who Leads the Mobile Infrastructure Race?*

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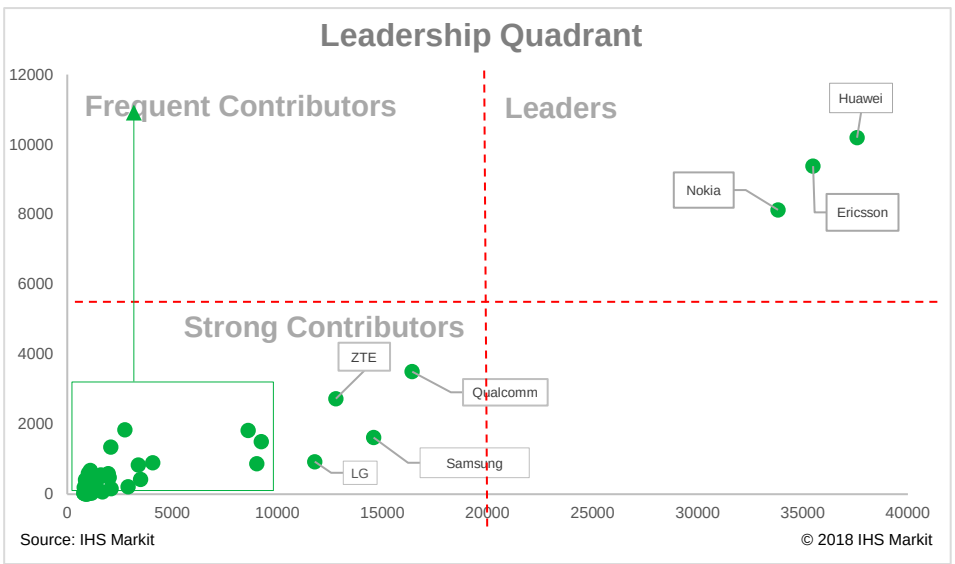
Executive Summary

To achieve leadership in mobile infrastructure market, suppliers must combine substantial internal research and development with engagement in standardization. This report analyses the contributions vendors and operators have invested in 3GPP standards. This includes holding rapporteur roles in technical specifications groups and contributing work items for technology evolution. The report covers all contributions made between the years 2005 and mid-2018 and focuses primarily on 5G and LTE. However, some other hot domains such as, eMTC, NB-IoT, and V2X will be look at as well.

The research was based exclusively on data extracted from the 3GPP portal. Using the search engine available on the portal, data was extracted and transformed using automated as well as manual means. The data transformation process consisted of sorting raw data in different groupings to match different working groups, technologies, and years. It also, involved manually manipulating data record to improve its quality, which is done by fixing typos, filling in missing data, verifying some existing data, and filtering out some categories.

The report highlights the challenges faced while conducting this research, all of which are related to the quality of the extracted data. The manual manipulation of data was used to mitigate these problems but not to a full extent. That is why the results in this report are prone to some error.

The result of the analysis shows the leading vendors that contribute the most in the categories analyzed by this whitepaper. These vendors are Huawei, Ericsson, and Nokia. This result is in fact in line with the market reality as the mentioned companies not only have the highest market share in the telecom market, but also have the highest R&D spending, which translates directly into more 3GPP contributions.



The leadership quadrant shows the position of every contributor relative to the others.
Leaders have total contribution (between 2005 – 2018) of more than 20K and approved contribution of more than 6K (30%).
Strong Contributors contributed more than 10K WIs and have approvals of more than 4K.

In general, all vendors and operators are becoming more and more active over the years in contributing proposals and work items. Moreover, some trending companies became active in 3GPP. These companies showed a steep increase in the number of contributions over the last few years. This is the result of these companies seeking more market power through 3GPP contribution leadership. Not only that, having their contributions patented into the resulting standards allow them to license their inventions to other market players and cash in premiums.

It is worth mentioning that contributions also depend on the companies' overall strategy and products roadmap. For instance, we can see how LG Electronics is among the top players in V2X category.

Methodology

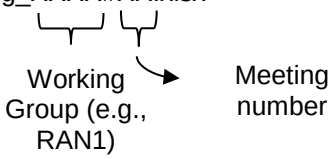
Research Objective:

The purpose of this research is to gain insights into the amount of contribution by telecom vendors and operators into 3GPP standards.

Research Approach:

This research is based exclusively on data extracted from 3GPP website and FTP platform. The data highlights the contributors for every work done within the 3GPP standardization process. For every meeting conducted, there is a comprehensive list of all work done during the meeting and the vendor(s)/operator(s) responsible for the work. The research is based primarily on these lists, namely TDoc_List files.

TDoc_List filename structure: TDoc_List_Meeting_XXXX#XX.xlsx



Sampling Method:

The data sample used for the purpose of this research falls within the following criteria:

- Belong to working groups: RAN 1, RAN 2, RAN 3, RAN 4, RAN 5, SA 1, SA 2, SA 3, SA 4, SA 5, SA 6, CT 1, CT 3, or CT 4.
- Treated between: Jan 2005 to June 2018

Data Extraction and Transformation Methods:

Data extraction was done by downloading TDoc_list file for all meetings that falls within the research timeframe. Data was, then transformed and manipulated using several techniques including:

1. 'R' programing language was used to combine data from several TDoc_list files, select the necessary fields, add missing fields, group records based on different grouping criteria such as technology, year, release, and working group.
2. Manual data manipulation was used to overcome data inconsistencies, and filtering out unneeded categories, document types (e.g. agenda, work plan, etc.), and documents status (e.g. withdrawn, revised, etc.)
3. Excel tools (e.g. Pivot Tables) were used to develop counts based on: technology, year, and release.

Counting Methodology:

Counting contributions is based on record (row) status: 'TDoc Status'. Whenever a record matches statuses: Submitted or Approved, a record is added to the respective count. All counted records are then grouped by company name, technology, year, and release.

Challenges:

There were many challenges during this research, all of which can be attributed to data inconsistencies. Data on the 3GPP is highly inconsistent in many forms:

- Inconsistent data format. Data in TDoc_list files lacks uniformity in terms of format, similarity, and even spelling. For instance, some companies' names were misspelled several times, which let to inaccurate count. Other companies' names were written without proper separators, the thing that made it extremely difficult to apply automated methods to separate companies' names for proper counting.

Error Rate:

Based on the above challenges, counting inaccuracy exists at many levels. We expect an error rate that ranges between 0.15% and 1.5%.

Guidelines

Research Scope:

The scope of this research consists of covering vendor(s)/operator(s) contributions to 3GPP standardization efforts within the following areas:

- Radio Access Network working groups: RAN 1, 2, 3, 4, & 5.
- Service & Systems Aspects working groups: SA 1, 2, 3, 4, 5, & 6.
- Core Networks & Terminals working groups: CT 1, 3, & 4.
- 5th Generation Technology: 5G
- Long-Term Evolution: LTE
- Narrow-band Internet of Things: NB-IoT
- Enhanced Machine Type Communications: eMTC
- Vehicle 2 Everything: V2X

The scope is confined to only the period between January 2005 and June 2018. In other words, only meetings that occurred between 2005 and 2018, inclusive, shall be included in the analysis.

Based on this time frame, the following 3GPP releases will be covered: Rel-8 to Rel-16.

Counting Guidelines:

Counting contributions is based on ‘TDoc Status’ flag. ‘TDoc Status’ is the last status the work item is on. This field can take many statuses depending on the decision made on the work item. Example of which: approved, agreed, withdrawn, noted to name only a few.

For the sake of this research, all ’TDoc status’ possible values were mapped to one of the following 3 statuses:

- *Submitted;* includes all possible statuses except: withdrawn, revised, and reserved.
- *Treated;* includes noted, treated, agreed, approved, endorsed, not pursued.
- *Approved;* includes approved, agreed, partially approved, endorsed, conditionally agreed, conditionally approved.

Some records did not have ‘TDoc Stats’ value. Such records were considered part of the Submitted category listed above.

Filters

Type:

The following types of work items were excluded from the count:

- Agenda
- Report
- Workplan
- ToR

All other work items types were taken into consideration.

Technology:

The field ‘Related WIs/SIs’ was mapped to one of the following technologies: 5G, LTE, eMTC, NB-IoT, and V2X. The mapping was done using keywords matching. For example:

- NR_newRAT, NR_eMIMO, NR_CPUP_Split → 5G
- E-UTRAN, eHNB, eMBMS→ LTE
- NB_IOTenh → NB-IoT
- LC_MTC_LTE→ eMTC
- eV2X, V2XLTE → V2X
- EVSoCS-CT → NA

All other records that did not map with any of the 5 technologies were excluded. That includes GSM, UMTS, and empty cells.

Assumptions:

- Source count is based on multi-source method as defined in the project scope. Multi-source method means that for any work item more than one source can be counted as a responsible party. No weights are applied toward sources’ contributions.
- A vendor can be both a rapporteur AND a contributor at the same time (within the same specification version).
- Work items (records) with missing ‘TDoc Status’ values are considered as “submitted” and counted towards the company(s) contributions.
- Work items (records) with no valid 3GPP ‘Release’ are not included in the Count Per Release.
- All work items prior to 3GPP release 8 were not taken into consideration.

Contributions Analysis

This whitepaper discusses vendors' and operators' contributions in the 3GPP standardization process. The analysis covers, primarily, 2 major technology domains: 5G and LTE. Both domains are today the major topics in all 3GPP meetings; LTE being the primary technology generation for almost all mobile communication networks nowadays, and 5G being the next step that all operators are planning to take sooner or later.

That said, it is worth taking a deep look into the contributions made by all stakeholders into these two major technologies.

It is worth mentioning that the work done by every vendor and operator in the 3GPP gets reflected directly into the future market domination and expected cash flow of this vendor and/or operator.

The whitepaper analyses companies' contributions on two main levels: rapporteur and contributions. The rapporteur is responsible for organizing the work item (WI) or study item (SI) and driving the technical evaluation and design and development of the technical specifications. Usually the rapporteur is one of the proponents of the technical feature in the work item or study item. WI/SI, on the other hand, is the result of every vendor's or operator's R&D efforts. It is the actual technical piece that makes up the 3GPP standard, if approved.

Every technology will be analyzed based on the above mentioned two levels. Beside 5G and LTE, other vertical industries will be investigated. These verticals are: Vehicle to Everything (V2X), Narrow-band Internet of Things (NB-IoT), and enhanced Machine Type Communications (eMTC). The choice of these verticals was made based on the importance that these emerging technologies are expected to have on the future and its impact on several industries.

1. 5G Contributions Analysis

5G is a very important step in the development of wireless communication technologies. This generation not only enhances user experience in terms of speed and latency, but also made possible other use cases that cannot tolerate any slowness or latency. Smart factory use case is one famous example. Because a second delay matters when it comes to factory operations, older technology generations were not able to satisfy the requirements.

5G commercialization is probably very soon. As users' applications became more and more speed demanding, network operators became eager to launch new technologies that can satisfy that demand. In addition, operators with faster 5G go-to-market might be able to capture consumers in the new verticals discuss earlier establishing market leadership position.

The following analysis will highlight the contributions made by the top vendors and operators within the 5G domain.

1.1. 5G Rapporteur Analysis

The table below lists all the rapporteurs for 5G technical specifications groups. Because 5G is still considered an emerging technology generation, the numbers shown are not as big compared to that of LTE.

The rapporteur role for 5G is dominated by Huawei with a total of 28 rapporteurs. Nokia and Ericsson come next with 23 and 20 rapporteurs respectively.

Rapporteur	Count
Huawei	28
Nokia	23
Ericsson	20
Qualcomm	19
Intel	18
China Mobile	13
Samsung	10
LGE	8
Vodafone	8
China Unicom	5
NTT DOCOMO	5
Thales	5
ZTE	5
Motorola	4
China Telecom	3

Source: IHS Markit

Table 1: Number of 5G Rapporteurs per Vendor/Operator – 2015 to 2018H1

The graph below illustrates the position of every company. 36% of the total number of rapporteurs is held by only 3 companies: Huawei, Nokia, and Ericsson.

The total number of rapporteur for 5G is expected to increase and be comparable to that of LTE and older technology generations as 5G matures and operators start to commercialize it.

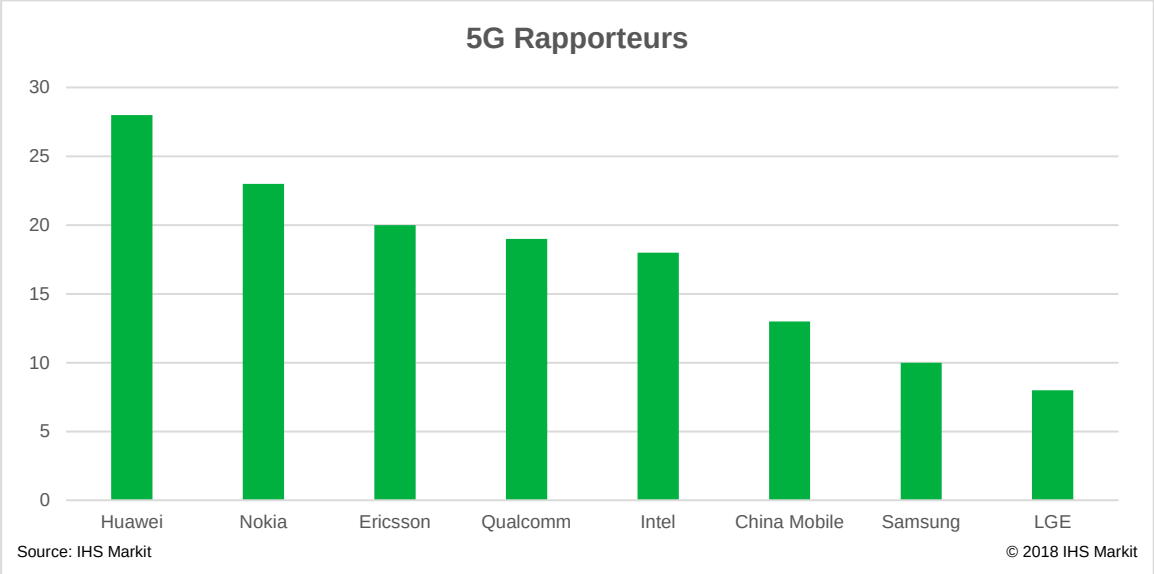


Chart 1: Number of 5G Rapporteurs per Vendor/Operator – 2015 to 2018H1

As shown below, the majority of the rapporteur roles, started to appear in 2016. During 2017, however, some companies experienced an increase in the number of roles like Huawei (15), and Qualcomm (12). In the first half of 2018, the lead continued to be for Huawei (9), joined by Ericsson that had also 9 rapporteurs in the same year.

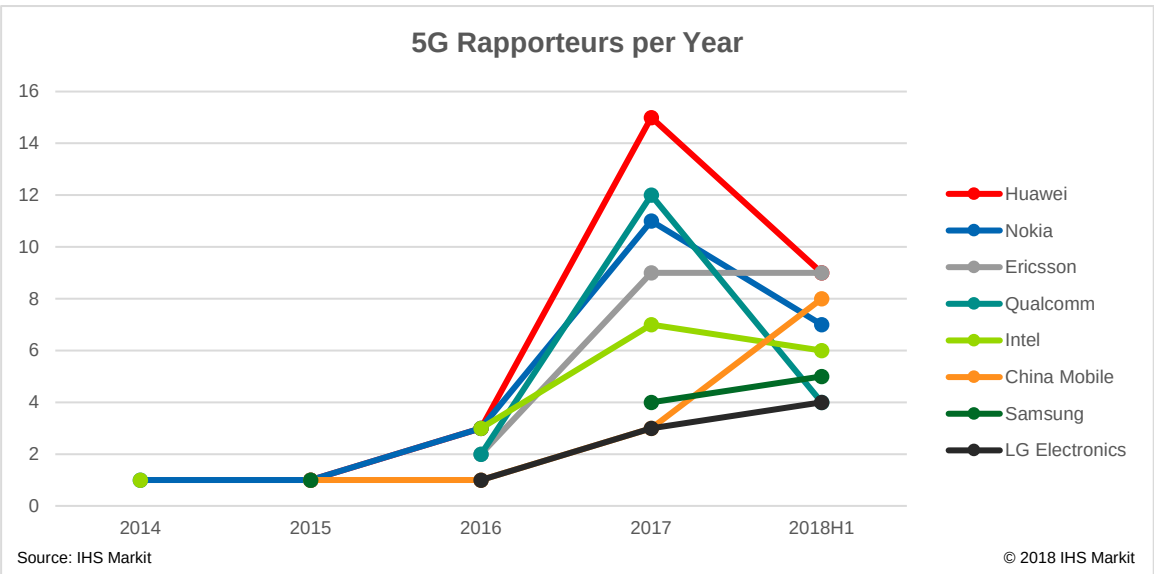


Chart 2: Number of 5G Rapporteurs per Vendor/Operator per Year – 2015 to 2018H1

1.2. 5G Submitted Contributions Analysis

On the work item (WI) or Study item (SI) level, the analysis focuses on the top 8 contributors. The lead is for Huawei and Ericsson where both companies contributed 15% and 13% of all 5G contributions, respectively. Overall, the top 8 contributors bring in 68% of all WIs/SIs related to 5G technology development.

These figures are aligned with contribution history, in general, where the below top 8 companies were almost always the leader in contributing in the development of new technology generations.

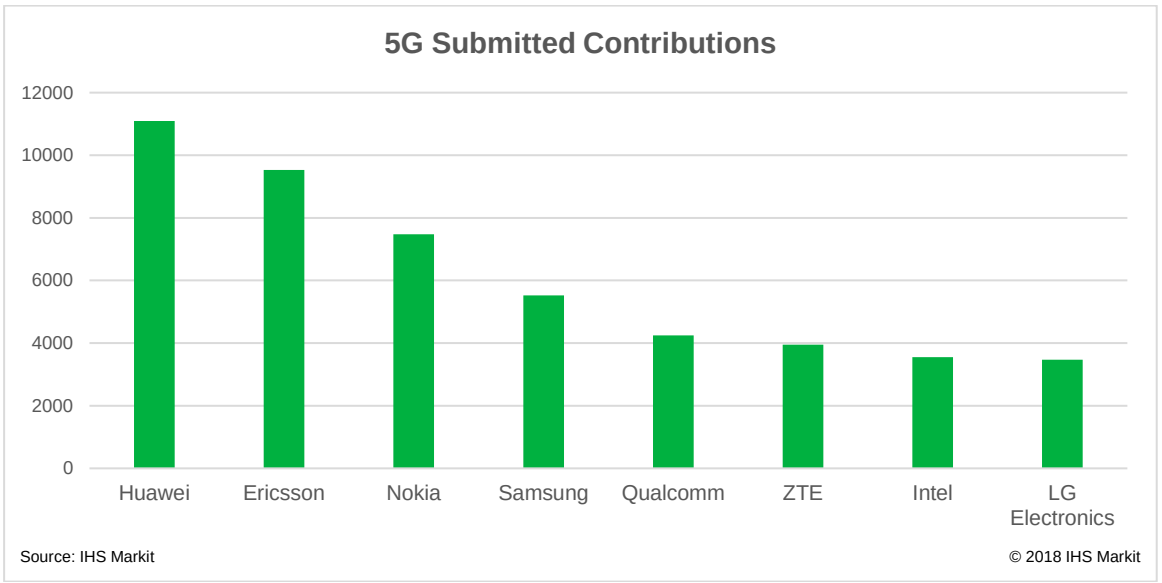


Chart 3: Number of 5G Contributions per Vendor/Operator – 2015 to 2018H1

In general, companies' contributions have been increasing between 2015 and 2018. The total number of contributions in 2015 was 2,554. This number jumped to 16,969 in 2018. That is more than 550% increase in the total number of contributions by the top 8 companies.

Understanding the reason behind that increase would require a deep dive into the type of contributions, the target technologies, and, perhaps, companies' strategy when it comes to 3GPP participation. It is valid, however, to assume that at least part of that increase comes from the fact that 5G commercialization is just few steps away. So, vendors and operators started to focus their attention away from LTE and more towards 5G.

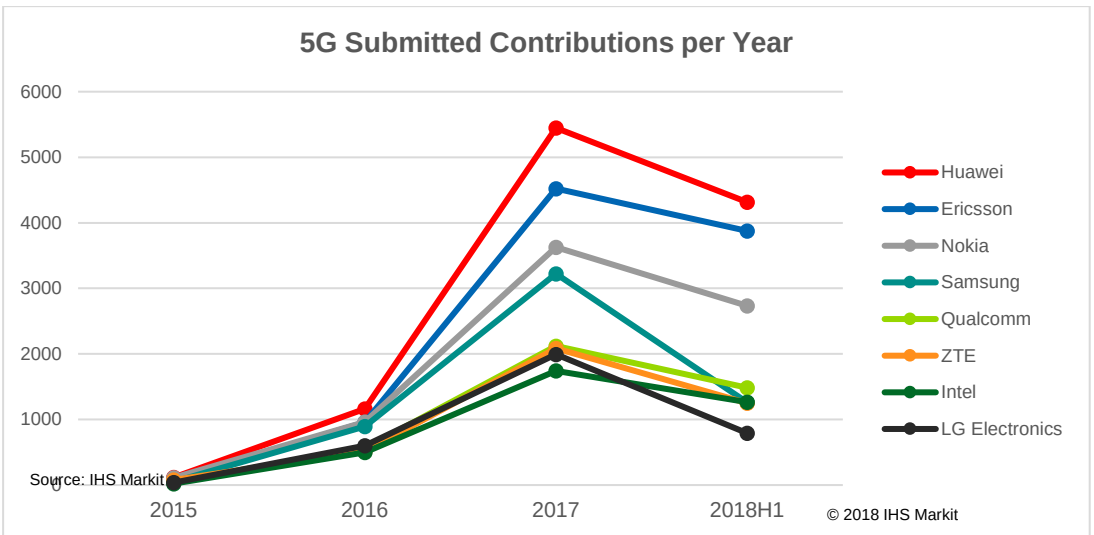


Chart 4: Number of 5G Contributions per Vendor/Operator per Year - 2015 to 2018H1

Radio Access Network (RAN) work group has the highest number of contributions due to the nature of the technology aspects handled within this group. Next comes Service and System Aspects (SA) work group. It is mostly concerned with support services and add-on features such as network management. Core Network & Terminal (CT) work group which is concerned with mobile network core and users' equipment, comes last in the number of contributions.

As shown below, Huawei and Ericsson are leading the top 8 list in the TSG RAN. Both companies combined contribute 27% of the total number of contributions in that TSG. In SA, on the other hand, Nokia comes second after Huawei, followed by Ericsson.

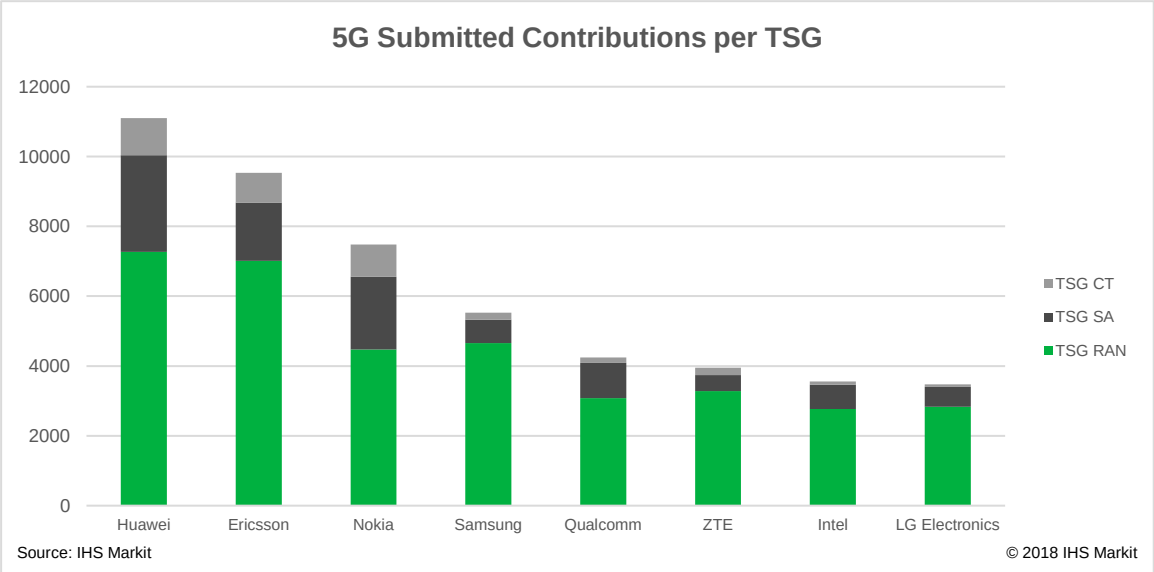


Chart 5: Number of 5G Contributions per Vendor/Operator per 3GPP TSG – 2015 to 2018H1

	Huawei	Ericsson	Nokia	Samsung	Qualcomm	ZTE	Intel	LG Electronics
TSG RAN	7267	7010	4474	4654	3083	3284	2768	2834
TSG SA	2774	1670	2080	669	1003	456	695	571
TSG CT	1056	849	923	205	159	214	90	67

Source: IHS Markit © 2018 IHS Markit

Table 2: Number of 5G Approved Contributions per Vendor/Operator per 3GPP TSG – 2015 to 2018H1

1.3. 5G Approved Contributions Analysis

The work items approval is an important milestone after which the technical piece might be included as a standard part of the technology generation. It also gives the contributor the chance to patent the work item and later license it to others.

The approval rate might be difficult to be used as a measure of quality of the work submitted. This is because every WI/SI goes through many stages of modifications and fine tuning before it is ready for approval. Therefore, deciding on the quality of initial submission by a contributor by looking on the approval rate might not be a straight forward process.

The top 3 contributors have, on average, 2,700 approved contributions. All other top contributors in list below are far below that average. Whether the future will bring in more balance in the number of approvals among the top companies is not yet clear.

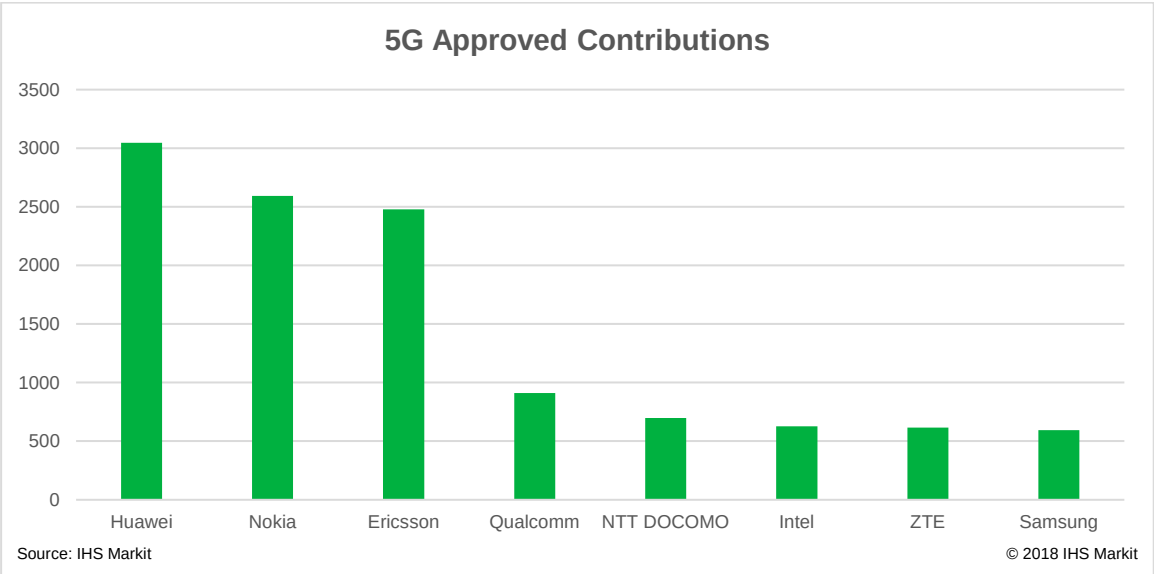


Chart 6: Number of 5G Approved Contributions per Vendor/Operator – 2015 to 2018H1

The below chart for the yearly analysis of the approved contributions closely follows that of the total contributions. The companies who lead in the top 8 list in the total number of contributions do so with the number of approved contributions.

It is apparent from the upward shift of graphed lines that more WIs/SIs are being approved as year passes. The top 3 companies, namely: Huawei, Ericsson, and Nokia achieved much higher number of approvals in the years 2017 and 2018. 2018 will also show huge improvement over 2017. This can be deducted from the figures of 2017 which are almost doubled during only the first half of 2018.

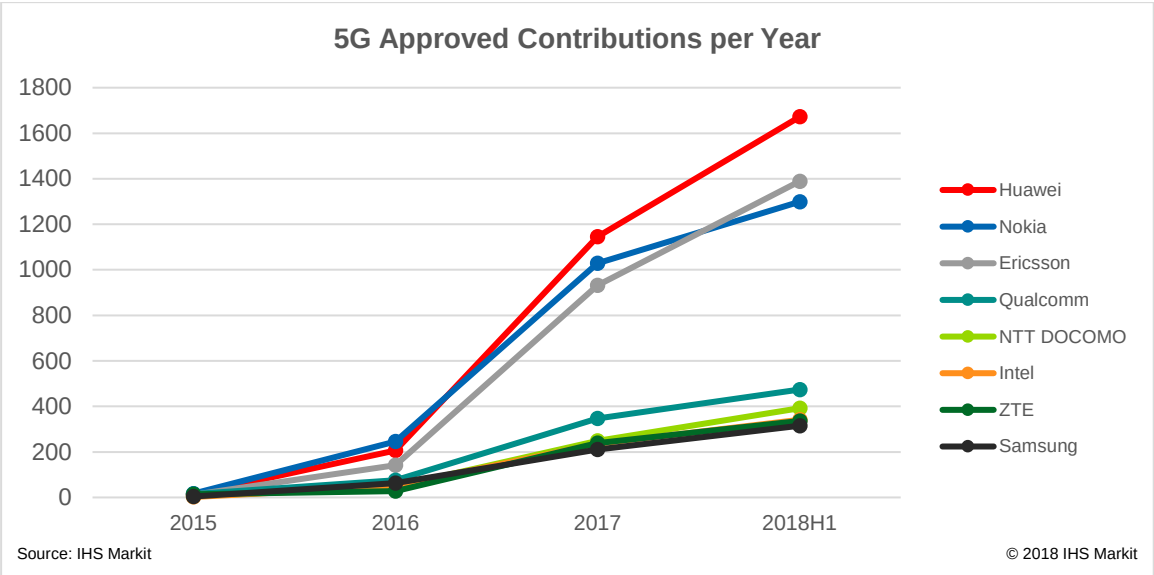


Chart 7: Number of 5G Approved Contributions per Vendor/Operator per Year – 2015 to 2018H1

The TSG analysis for the 5G approved contributions shows much higher approval rate in the TSG SA as compared to the TSG RAN and TSG CT.

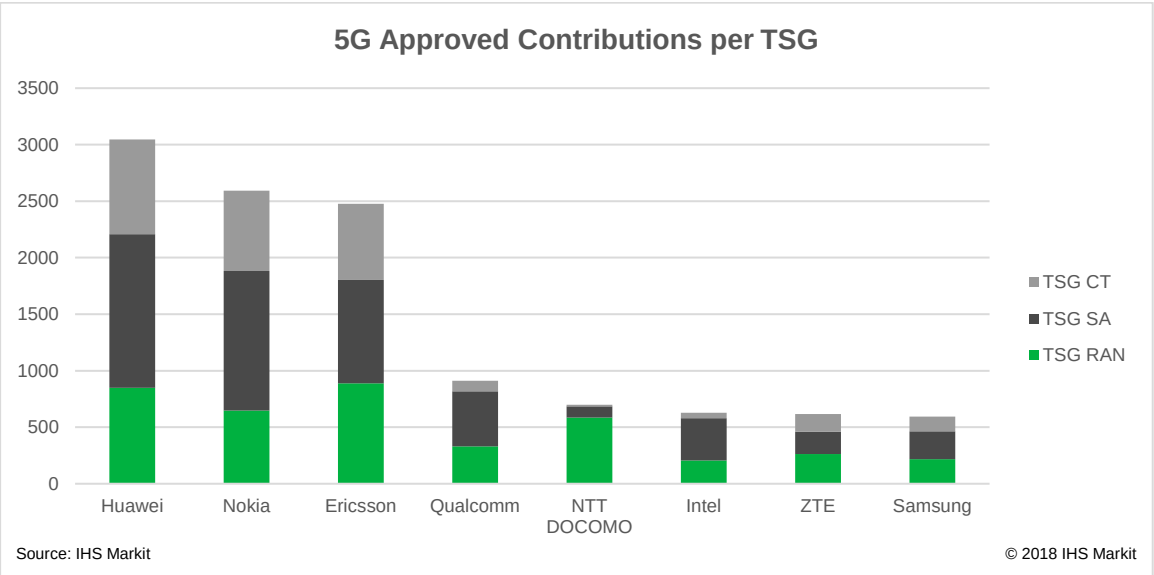


Chart 8: Number of 5G Approved Contributions per Vendor/Operator per 3GPP TSG – 2015 to 2018H1

	Huawei	Nokia	Ericsson	Qualcomm	NTT DOCOMO	Intel	ZTE	Samsung
TSG RAN	850	648	888	331	585	206	264	218
TSG SA	1358	1233	914	488	101	373	198	246
TSG CT	837	711	676	92	13	49	154	129

Source: IHS Markit © 2018 IHS Markit

Table 3: Number of 5G Approved Contributions per Vendor/Operator per 3GPP TSG – 2015 to 2018H1

The analysis above demonstrates the increasing interest of vendors and operators in 5G. As we saw, the numbers are going up as years pass. Moreover, because some operators are planning to rollout their 5G network soon, the numbers are expected to rise even more. With commercialization, many standard work items require some modifications and fine tuning. That is in addition to the work-in-progress work items that are still on the contributors' agenda.

2. LTE/EPC Contributions Analysis

2.1. LTE/EPC Rapporteur Analysis:

For a more mature technology like LTE, the list of rapporteurs is much bigger than 5G. There is a total of 906 rapporteurs working on LTE-related work items. The list is led by the big three: Nokia, Huawei, and Ericsson. Combined, they contribute 40% of the total rapporteurs for LTE/EPC. The table below lists the top 15 rapporteurs contributing companies.

During the lifetime of LTE, there were many acquisitions among telecom vendors. Perhaps, the most famous is Nokia's acquisition of telecom giant Alcatel Lucent (ALU). Before its acquisition, ALU was a big contributor in 3GPP. Now, all these contributions moved under Nokia. Nokia finalized the acquisition of ALU in 2016, and, before that, took full control over Nokia Siemens Networks (NSN), by buying Siemens' 50% stake in the merger, in 2013. Nokia's number of contributions was augmented since. In order to simplify the LTE contributions analysis from 2005 to 2018H1, Nokia* is used to refer to Nokia, ALU and NSN.

Rapporteur	Count
Nokia*	133
Huawei	122
Ericsson	108
NTT DOCOMO	49
AT&T	42
Qualcomm	41
China Mobile	37
Intel	30
ZTE	24
Vodafone	21
Samsung	19
U.S. Cellular	19
China Telecom	16
KDDI	16
CATT	14

Source: IHS Markit

Table 4: Number of LTE/EPC Rapporteurs per Vendor/Operator – 2005 to 2018H1
Note: Nokia*（Nokia, ALU, NSN）

The chart below illustrates the top 8 rapporteur contributors from the list above.

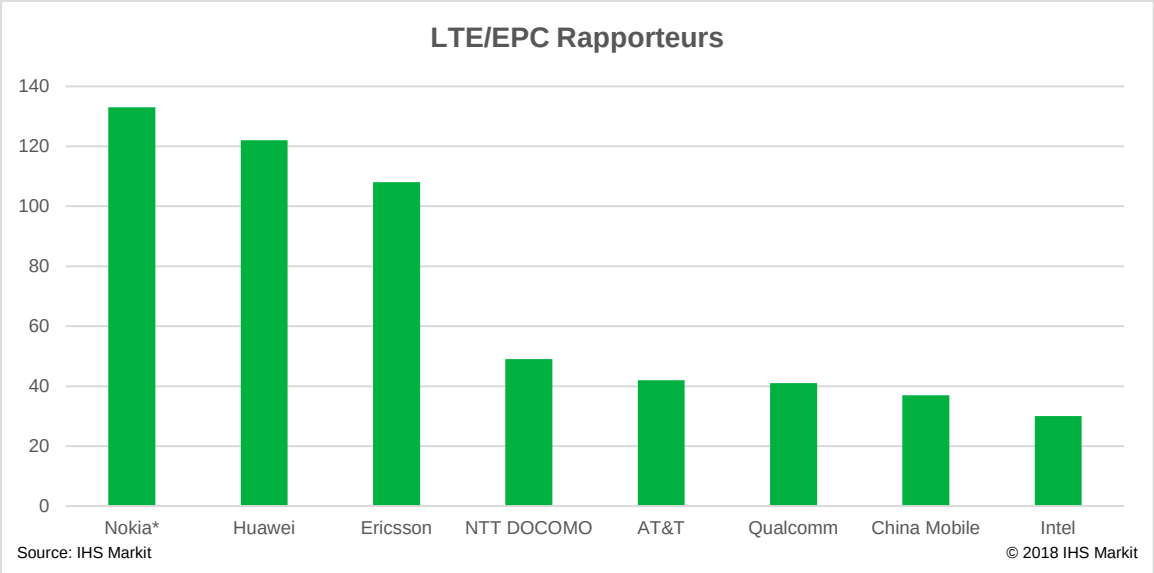


Chart 9: Number of LTE/EPC Rapporteurs per Vendor/Operator – 2005 to 2018H1
Note: Nokia*（Nokia, ALU, NSN）

The yearly analysis shows high rapporteur contributions during 2015 for Huawei, Ericsson, Nokia, and NTT DOCOMO. Actually, 2015 was the peak for Huawei, Ericsson, and NTT DOCOMO. Nokia, on the other hand, peaked during 2014. Overall, 2015 had the highest number of rapporteur contributions, followed by 2014 and 2013, respectively.

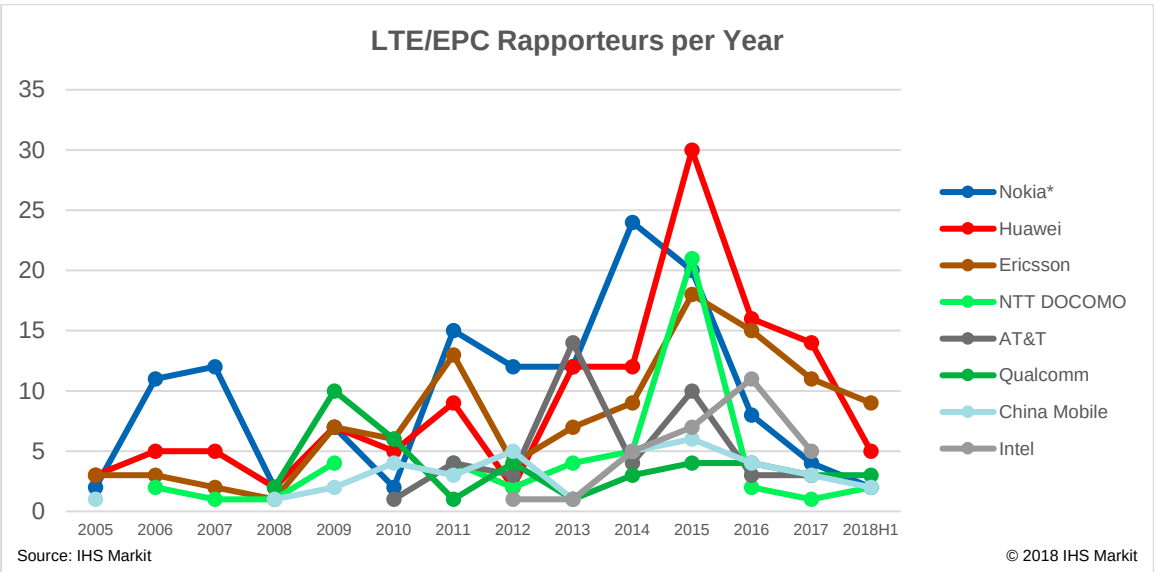


Chart 10: Number of LTE/EPC Rapporteurs per Vendor/Operator per year – 2005 to 2018H1
Note: Nokia*（Nokia, ALU, NSN）

2.2. LTE/EPC Submitted Contributions Analysis

The total number of LTE contributions reaches 237,157 by the end of the first half of 2018. For LTE, the big three: Nokia, Ericsson, and Huawei still lead the list of contributors. They contribute 40% combined. The top 8 contributors, shown below, contributes 68% of all the total LTE contributions.

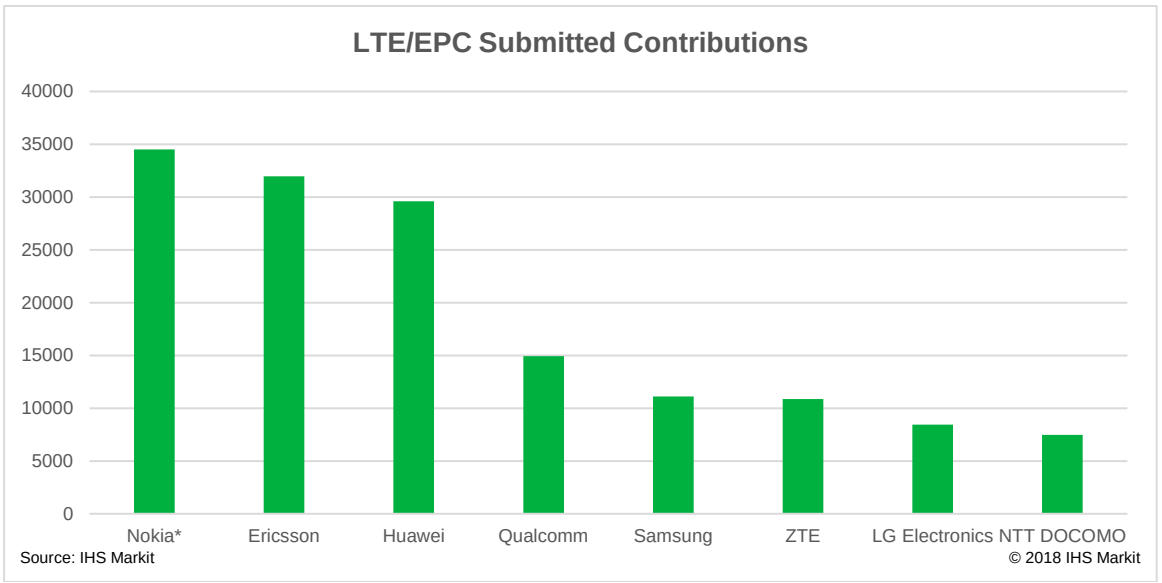


Chart 11: Number of LTE/EPC Contributions per Vendor/Operator – 2005 to 2018H1
Note: Nokia*（Nokia, ALU, NSN）

Based on the chart below, Huawei and Ericsson brought in the highest number of LTE contributions in 2016. Nokia, on the other hand, made its highest number of LTE contributions in 2009, a year before the first commercial rollout of an LTE network. 2015 and 2016 had the highest LTE contributions from the top 8 companies. However, starting 2016, contributors' attention switched to 5G. That is why we see 2017 and 2018's figures shifting downward.

It is worth mentioning that 2007 witnessed a huge jump in LTE contributions from as little as 80 in 2006 to 4,375 in 2007.

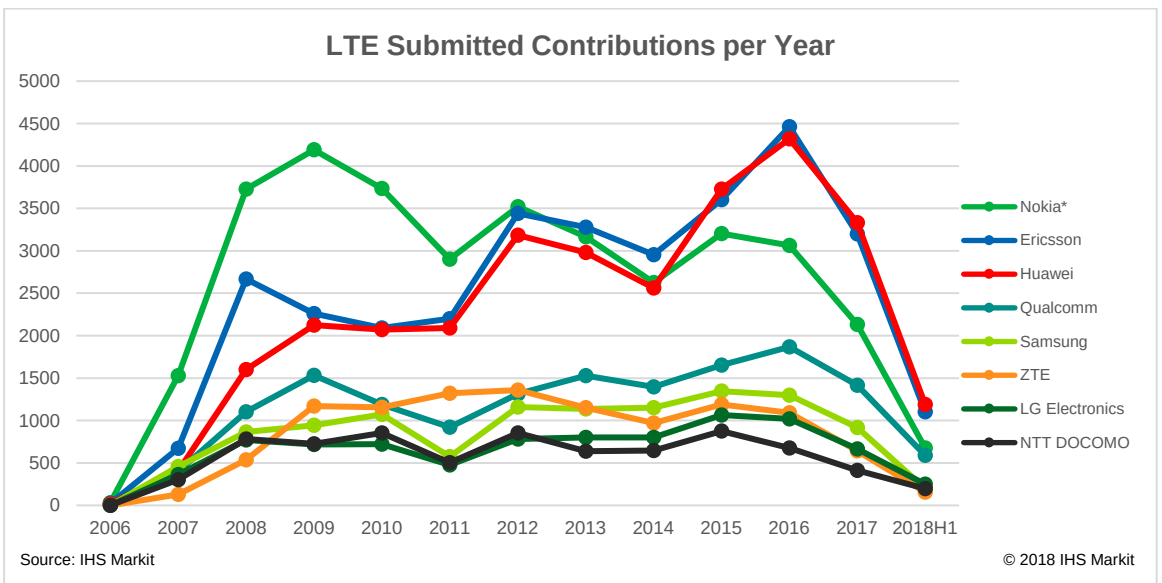


Chart 12: Number of LTE/EPC Contributions per Vendor/Operator per Year – 2006 – 2018H1
†2005 has negligible number of LTE /EPC contributions, hence not shown on the chart.
Note: Nokia*（Nokia, ALU, NSN）

As Nokia is leading LTE total contributions, it also leads within each TSG. The company has the highest contributions in TSG RAN, SA, and CT.

Again, TSG RAN receives the biggest portion of contributors' efforts.

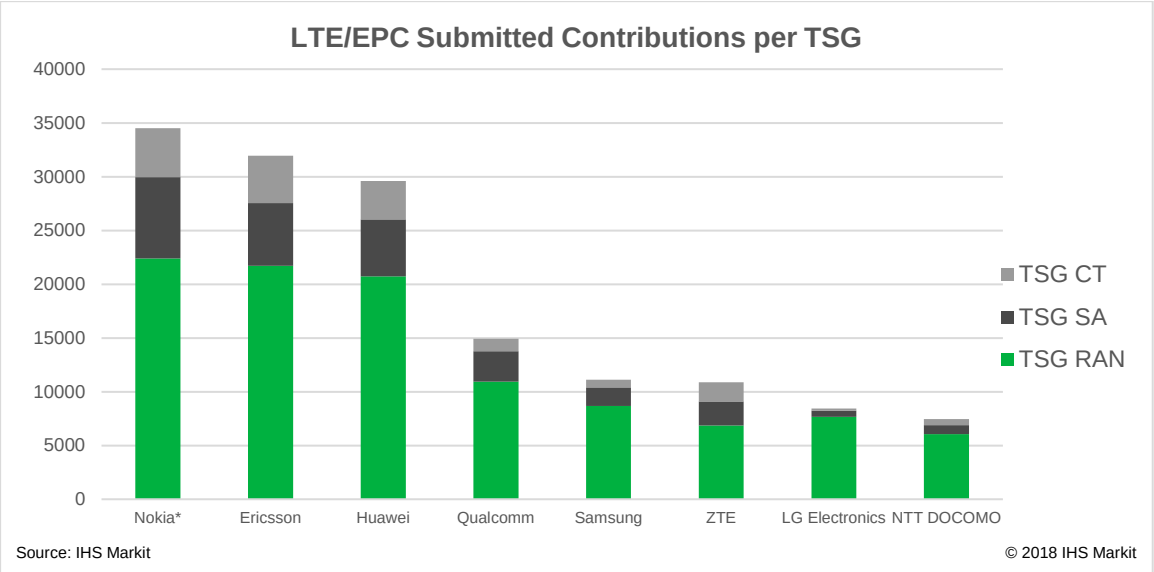


Chart 13: Number of LTE/EPC Contributions per Vendor/Operator per 3GPP TSG – 2005 to 2018H1

Note: Nokia*（Nokia, ALU, NSN）

	Nokia*	Ericsson	Huawei	Qualcomm	Samsung	ZTE	LG Electronics	NTT DOCOMO
TSG RAN	22394	21726	20737	10936	8679	6876	7676	6044
TSG SA	7570	5824	5282	2831	1712	2217	549	861
TSG CT	4538	4407	3588	1148	730	1778	214	561

Source: IHS Markit

Table 5: Number of LTE/EPC Contributions per Vendor/Operator per 3GPP TSG – 2005 to 2018H1

2.3. LTE/EPC Approved Contributions Analysis

For LTE/EPC, Ericsson leads in the number of approved contributions followed by Nokia and Huawei. The average number of approved contributions for LTE/EPC is 5,294 approvals per vendor/operator for the period from 2005 to 2018h1. The range goes as high as 10,711 approvals (Ericsson) to as low as 1,590 (Intel).

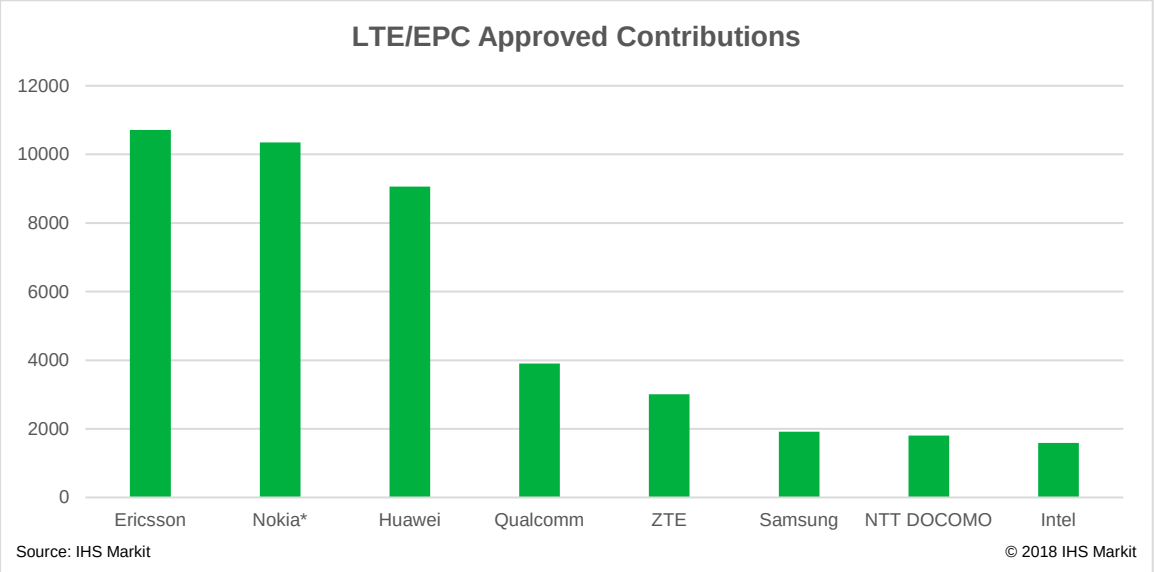


Chart 14: Number of LTE/EPC Approved Contributions per Vendor/Operator – 2005 to 2018H1
Note: Nokia*（Nokia, ALU, NSN）

The chart below follows closely the chart for the yearly submitted contributions analysis. The years with the highest number of contributions is also of the top years in the number of approved WIs/SIs.

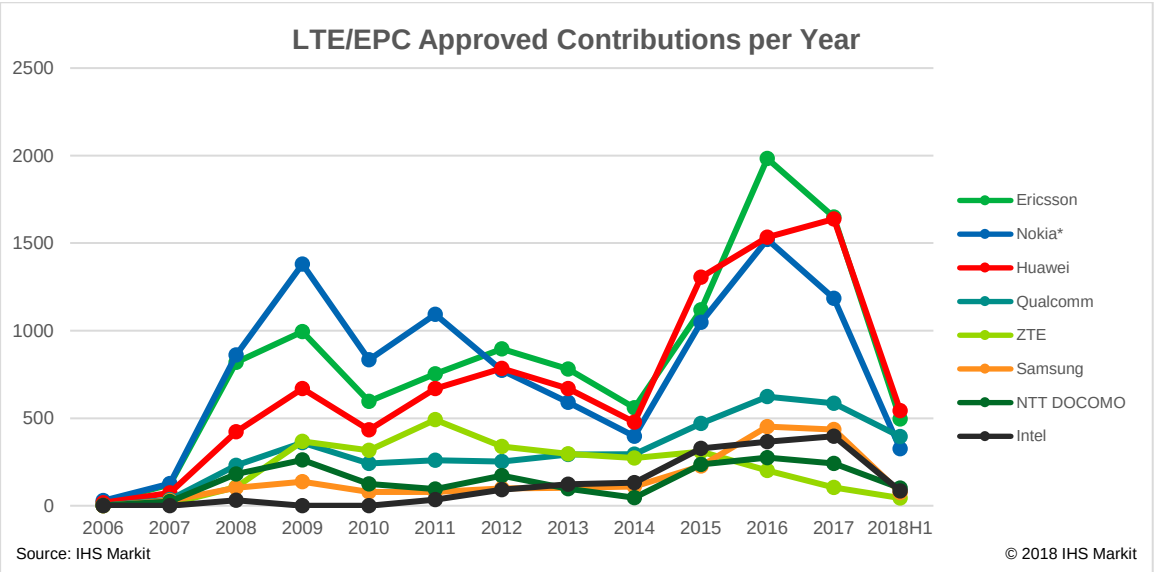


Chart 15: Number of LTE/EPC Approved Contributions per Vendor/Operator per Year – 2006 to 2018H1
†2005 has negligible number of LTE /EPC approved contributions, hence not shown on the chart.
Note: Nokia*（Nokia, ALU, NSN)

On the TSG level, Huawei and Ericsson leads the TSG RAN in the number of approved contributions. Nokia, on the other hand, is in the lead in TSG SA.

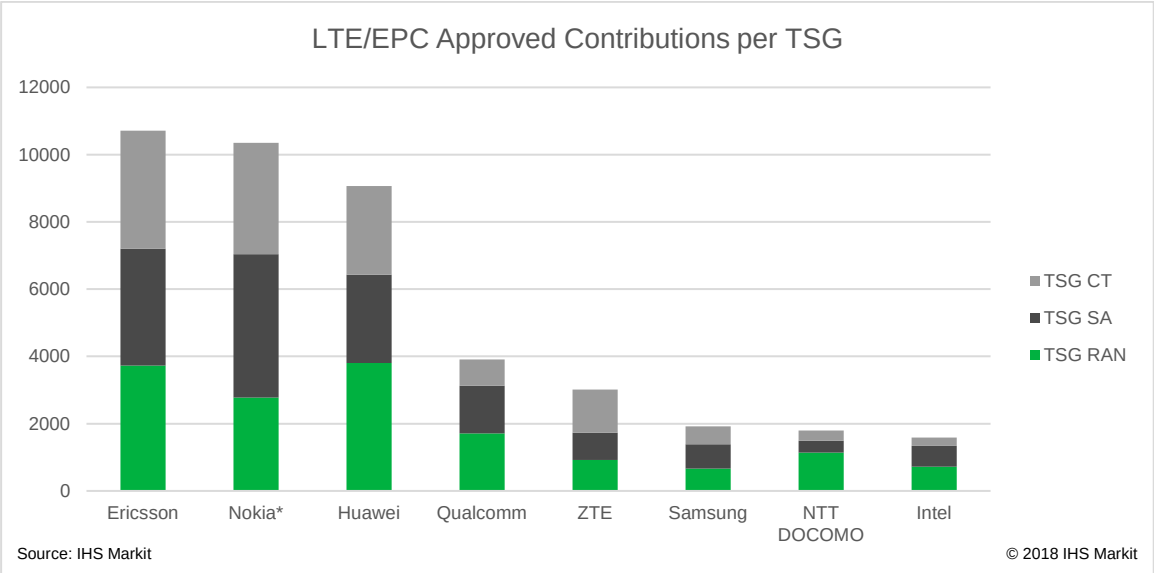


Chart 16: Number of Approved Contributions per Vendor/Operator per 3GPP TSG – 2005 to 2018H1

Note: Nokia*（Nokia, ALU, NSN）

	Ericsson	Nokia*	Huawei	Qualcomm	ZTE	Samsung	NTT DOCOMO	Intel
TSG RAN	3730	2780	3801	1711	918	668	1139	723
TSG SA	3469	4264	2625	1414	816	715	351	621
TSG CT	3512	3308	2636	781	1278	536	310	246

Source: IHS Markit © 2018 IHS Markit

Table 6: Number of Approved Contributions per Vendor/Operator per 3GPP TSG – 2005 to 2018H1

The analysis above demonstrates the maturity LTE technology has reached. It also puts an expectation to the future of LTE contributions which can be seen to decrease in the future as 5G kicks in. Overall, Nokia, Huawei, and Ericsson can be considered the leaders in LTE contributions. That is valid with both the total number of contributions and the number of approved WIs. It can also be deducted from the analysis that the top 8 contributors are the ones who shaped the LTE technology generation with their contributions.

3. Vertical Related Contributions Analysis

In addition to traditional (e)MBB services by LTE and 5G, 3GPP also develops standards specifically for vertical industries, including IoT and V2X. This section provides contribution statistics for these areas.

3.1. V2X Contributions Analysis

Vehicle to Everything (V2X) technology is a hot topic in the tech world. Once commercialized, the technology will open the door for huge number of applications and use cases. This is by itself an enough reason to analyze how vendors and operators are contributing within this domain.

As the chart below suggests, Huawei has the highest number of contributions for V2X. The second place is filled by LG Electronics, which suggests how LG is approaching this emerging technology. Ericsson comes third.

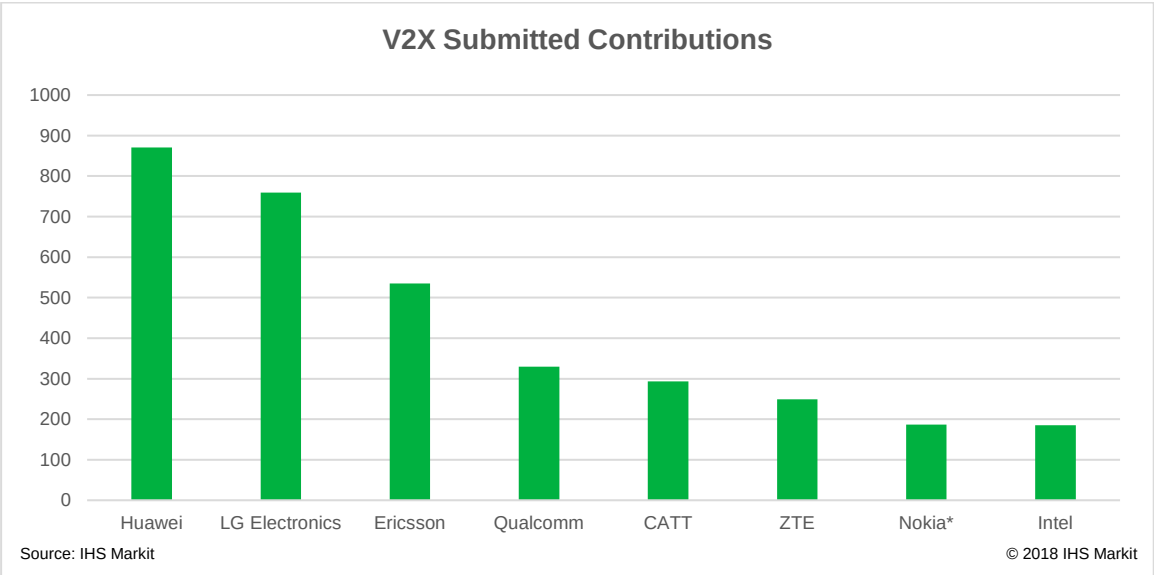


Chart 17: Number of V2X Contributions per Vendor/Operator – 2015 to 2018H1
Note: Nokia*（Nokia, ALU, NSN）

The list for the approved contributions is no different. Huawei and LG Electronics leads. Qualcomm comes in third place with approximately 50% approval rate.

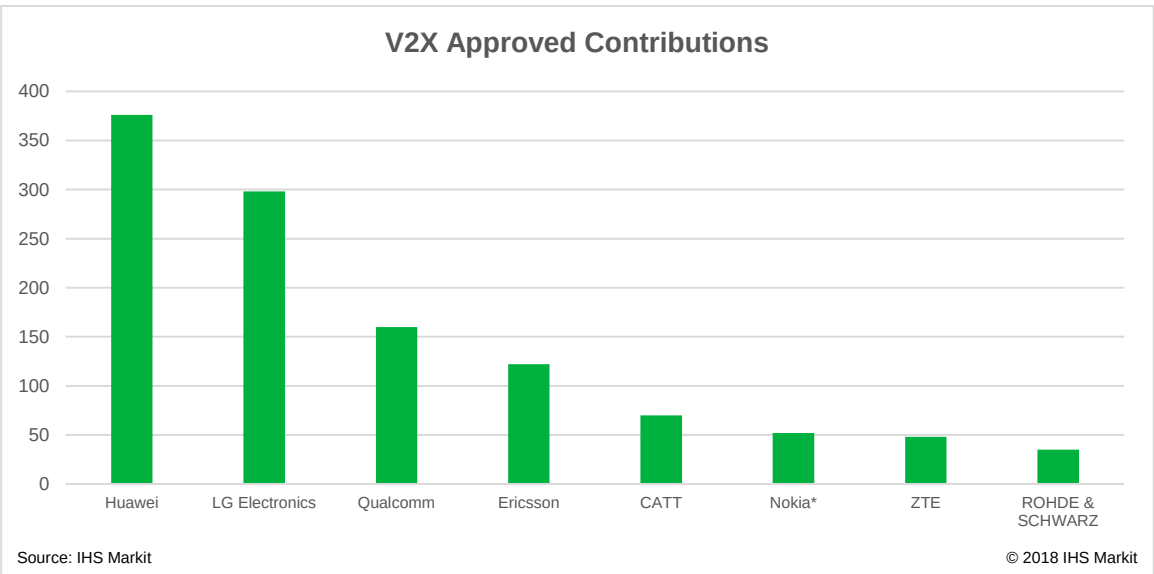


Chart 18: Number of V2X Approved Contributions per Vendor/Operator – 2015 to 2018H1
Note: Nokia*（Nokia, ALU, NSN）

It is not clear whether other companies will penetrate this area in the future. As a vertical industry, it might not be aligned with companies' strategy and/or products' offering. What can be seen in the near future, however, is more use cases and pilot projects between vendors/operators and vehicle OEMs.

3.2. NB-IoT and eMTC Contributions Analysis

Another hot domain is the Internet of Things (IoT). It is a broader use case for wireless communication technology which includes machine-to-machine and human-to-machine communications. It is expected to see more interest from other vendors and operators in this area than in V2X.

This is also apparent in the total number of contributions and the number of contributors. As shown below, Huawei, Nokia, and Ericsson lead this space. The top 8 list is almost similar to that of LTE and 5G.

NB-IoT study items started from the 3GPP TSG GERAN, however at that time GERAN studied several different technical directions and it is not easy to calculate the contributions dedicated to NB-IoT, so here we only cover the NB-IoT contributions of TSG RAN, SA, and CT.

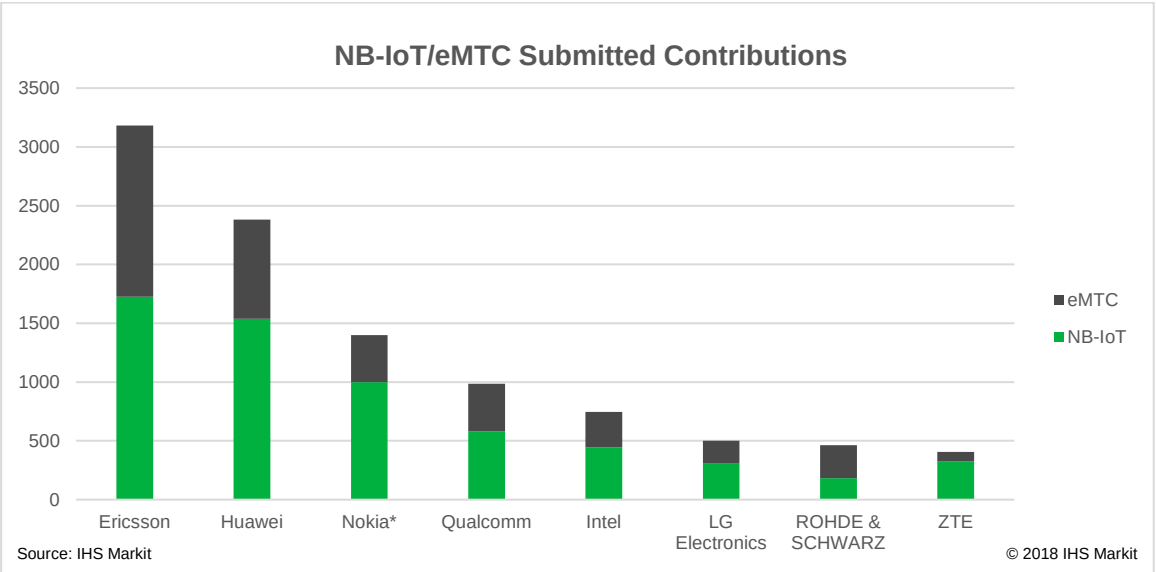


Chart 19: Number of NB-IoT and eMTC Contributions per Vendor/Operator– 2005 to 2018H1
Note: Nokia*（Nokia, ALU, NSN）

	Ericsson	Huawei	Nokia*	Qualcomm	Intel	LG Electronics	ROHDE & SCHWARZ	ZTE
NB-IoT	1726	1539	999	581	445	311	182	325
eMTC	1455	844	401	404	302	190	280	80

Source: IHS Markit © 2018 IHS Markit

Table 7: Number of NB-IoT and eMTC Contributions per Vendor/Operator – 2005 to 2018H1
Note: Nokia*（Nokia, ALU, NSN）

The approval rate for IoT-related WIs is pretty high. It can reach more than 50% for some contributors.

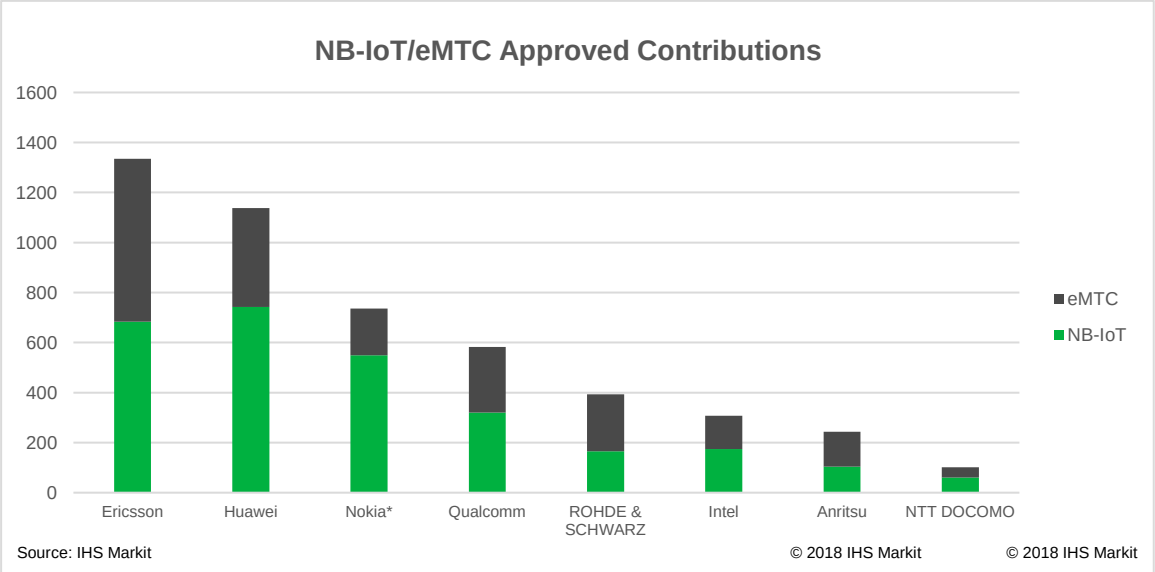


Chart 20: Number of NB-IoT and eMTC Approved Contributions per Vendor/Operator– 2005 to 2018H1

Note: Nokia*（Nokia, ALU, NSN）

	Ericsson	Huawei	Nokia*	Qualcomm	ROHDE & SCHWARZ	Intel	Anritsu	NTT DOCOMO
NB-IoT	684	743	549	320	166	175	104	61
eMTC	651	395	187	262	227	132	139	40

Source: IHS Markit © 2018 IHS Markit

Table 8: Number of NB-IoT and eMTC Approved Contributions per Vendor/Operator – 2015 to 2018H1

Like 5G and V2X, NB-IoT and eMTC are emerging technologies. This means that more and more contributions might take place in the near future. IoT, in general, has some commercial applications in the market. These applications, however, use short-range communication technologies such as WIFI and Bluetooth. However, the longer range communication, made possible by cellular technology and narrow band usage, will open the door for wider range of applications that require longer range communication field.

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CUSTOMER CARE AMERICAS
T +1 800 447 2273
+1 303 858 6187 (Outside US/Canada)

CUSTOMER CARE EUROPE, MIDDLE EAST, AFRICA
T +44 1344 328 300

CUSTOMER CARE ASIA PACIFIC
T +604 291 3600

E CustomerCare@ihsmarkit.com

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