

# **Survey Report on**

## **5G Essential Patents , Declared 5G-SEPs**

### **and 5G Standardization Contributions**

#### **For 5G-Standard Essential Patents (SEPs)**

#### **(Second Version) (Excerpts)**

#### Chapter 1 Positioning, Purpose and Background of Survey

The fifth-generation wireless communication system (hereinafter 5G) is being actively discussed by a standardization project called 3GPP (3rd Generation Partnership Project) as the next generation telecommunication standard. The results of 3GPP work will become ITU standards after they go through certain approval procedures. 3GPP has already completed the FINAL Rel. 15 standards, which will enable 5G implementations, in June 2019, and is currently working on Rel.16.

Cyber Creative Institute Co., Ltd. has devised an analysis method for “5G Essential Patents” which is essential for the realization of 5G, and launched a research report (first edition) in February 2019.

This newly revised Survey Report summarizes the findings from the analysis of four survey items: “the Declared 5G-SEPs (new item)”, “5G-SEP promising patents (new item)”, “5G Essential Patents” and “5G standardization contributions”.

5G-SEP promising patents are 5G Essential Patents and Declared 5G-SEPs.

For the latter two, we have analyzed what has been added to them in the one-year period since they were analyzed in the last survey. Based on the analysis, we have identified the power of leading companies, major technologies and trend of technological development for services.

This revised report consists of the following chapters: Chapter 1 stating the positioning, purpose and background of the survey, Chapter 2 describing the results of survey on the application trend of 5G Essential Patents , Chapter 3 describing the results of survey on the Declared 5G-SEPs, Chapter 4 describing the results of survey on the 5G standardization contributions, Chapter 5 describing

the results of survey on the 5G-SEP promising patents , Chapter 6 describing the results of comprehensive analysis and Chapter 7 providing a summary.

The following is the summary (excerpts) of the Survey Report (revised version).

## Chapter 2 Results of Survey on 5G Essential Patents

### Section 1 Overview of the Survey

#### 1. Details and method of the survey

This survey was conducted with the use of the proprietary method devised by Cyber Creative Institute Co., Ltd.

The purpose and goal of this survey are as follows.

The target scope of the survey is patent applications related to major technologies supporting 5G (5G element technologies). The advantage of using this method is that it covers not only the patents related to the requirements that need to be standardized for 5G but those related to the implementations and technologies for differentiation that do not need to be standardized (non-SEPs) . We believe that analysis of the trend of non-SEP applications is meaningful as license negotiations for Non-SEPs are conducted between individual parties unlike SEPs.

In addition, it is necessary to innovate the structure (basic concept) of standardization of radio access technologies for 5G in many aspects to accommodate the fact that 5G is designed to enable a wide range of use cases requiring capabilities such as low latency and massive device connectivity in addition to supporting high speed/high capacity communications as has been the case for the previous generations such as 4G.

We therefore extracted the target patents for this survey, focusing on and taking into consideration such unique features of 5G.

The findings from this survey are expected to offer new insights as it provides the results of analysis in a way that one can compare them between the Declared 5G-SEPs, SEPs and contributions submitted for standardization.

5G Essential Patents are given in Table 1.

The element technologies listed below include IoT and V2X, which assume new

use cases in 5G as well as key technologies for 5G implementation such as MIMO and network slicing.

Table 1 5G element technologies

No.	Element Technologies
1	NOMA
2	Massive MIMO
3	Signal waveform
4	Unlicensed band use
5	Frame structure
6	Data flow aggregation (Multiple connectivity)
7	C plane / U plane separation
8	URLCC implementation technologies
9	Network slicing / NFV
10	Initial access related
11	5G reference signal related
12	Millimeter wave band support
13	Flexible duplex
14	mMTC / IoT related
15	D2D / V2X related

## 2. Survey conditions

For the survey, we used Derwent Innovation as a search system with the analysis unit being an INPADOC family.

The period we surveyed is from January 1, 2013 to June 30, 2019 (to June 30, 2018 for the last survey) based on the issue dates of official gazettes in light of the time to start 5G discussions.

## Section 2 Results of survey on the overall trend of 5G Essential Patents

### 1. The number of patent families surveyed and the number of families of 5G Essential Patents

The number of patent families surveyed is 43,765, 15, 131 (34.6%) of which are selected as 5G Essential Patents. In the initial report issued a year ago, the number of patent families surveyed was 29, 697, 7,348 (24.7%) of which were

selected as 5G Essential Patents .

The number of 5G SEPs shows a twofold increase over the one-year period.

## 2. Changes in the number of 5G-SEP candidate families

As shown in Figure 1, the number of patent families surveyed has been continuing to double almost every year, increasing from 113 in 2011 to about 6,500 in 2017. The ratio of 5G Essential Patents to the number of patent families surveyed has been also on the rise. In 2017, the 5G Essential Patents accounted for over 60 % of the patent families surveyed.

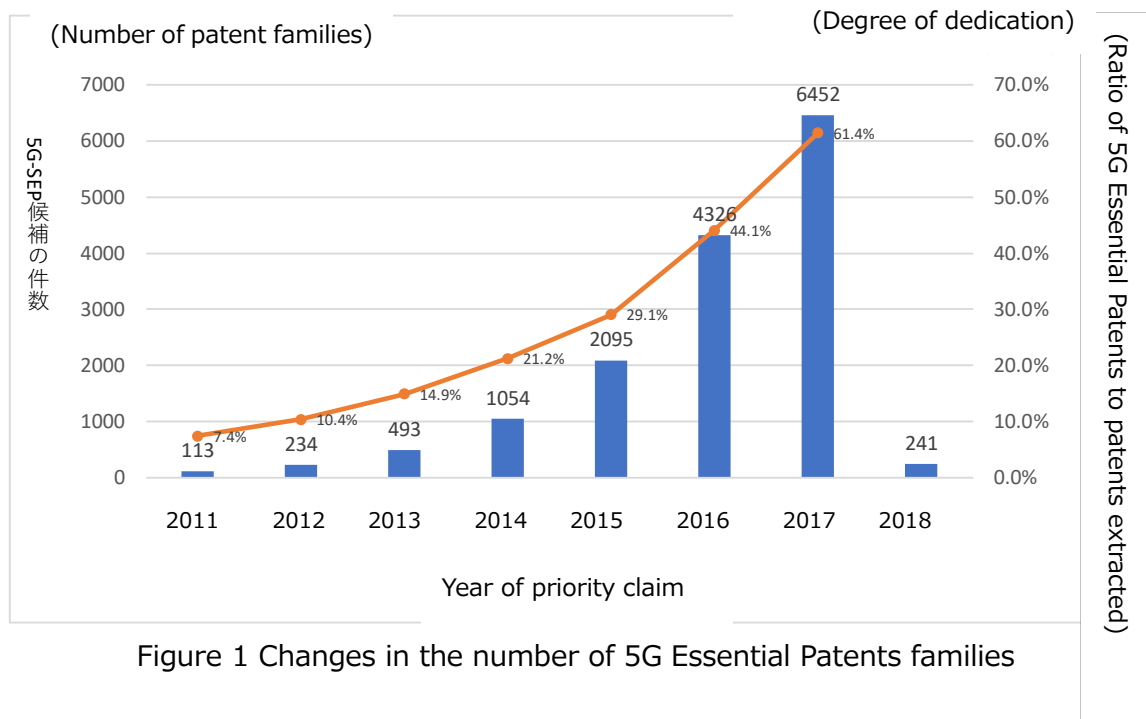


Figure 1 Changes in the number of 5G Essential Patents families

## 3. Top companies in the number of 5G-SEP candidate families

Figure 2 shows the names of companies that rank in top positions in terms of the number of 5G-SEP candidate families.

These top companies have drastically increased the number of their patent families.

The names of the companies that hold the top positions, Qualcomm, Huawei and Samsung, remain unchanged since the last survey, but there are some changes in the ranking where QUALCOMM and SAMSUNG have switched their positions.

As for Japanese companies, NTT DOCOMO ranks 6th in the world. NTT DOCOMO ranks 1st among Japanese companies as well as among telecom operators in the world as it did in the last survey.

We can see the name of a new comer, SHARP, who was not on the list of top 10 companies in the last survey. In terms of rank changes, Ericsson and LG have switched their positions to rank 4th and 5<sup>th</sup>, respectively.

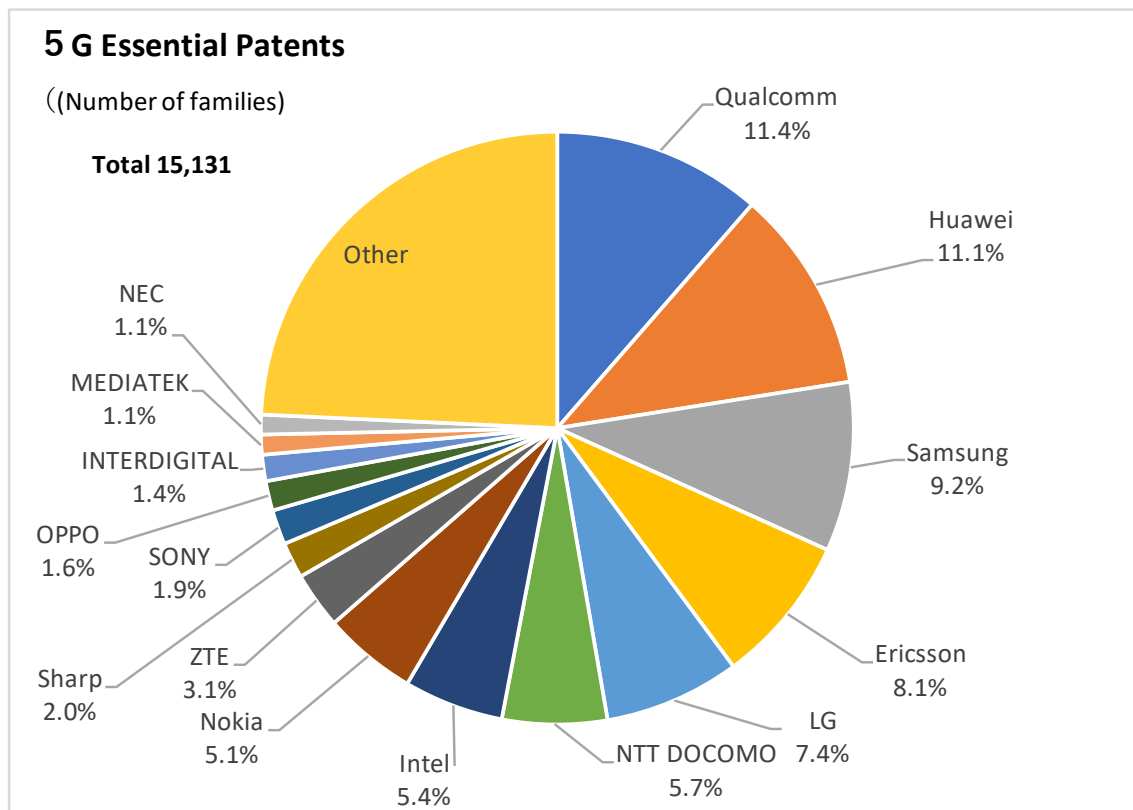


Figure 2 Top companies in the number of 5G Essential Patents applications

#### 4. Companies with a high degree of dedication to 5G standardization

The average ratio of the number of 5G Essential Patents to the number of patent families surveyed is 35% among all companies and 44% among top 10 companies. Both of the ratios have increased since the last report when they were 25% and 37%, respectively.

As shown in Figure 3, NTT DOCOMO stands out with a remarkably high degree of dedication among the top 10 companies, which is approx.70%. DOCOMO is followed by Samsung with approx.58%. It is clear that these two companies are significantly focusing their energy on 5G.

Qualcomm, who had a low degree of 29 % in the last report, has greatly stepped

up its dedication to 45%, as well as the number of applications, which has increased 2.5 times since the last report.

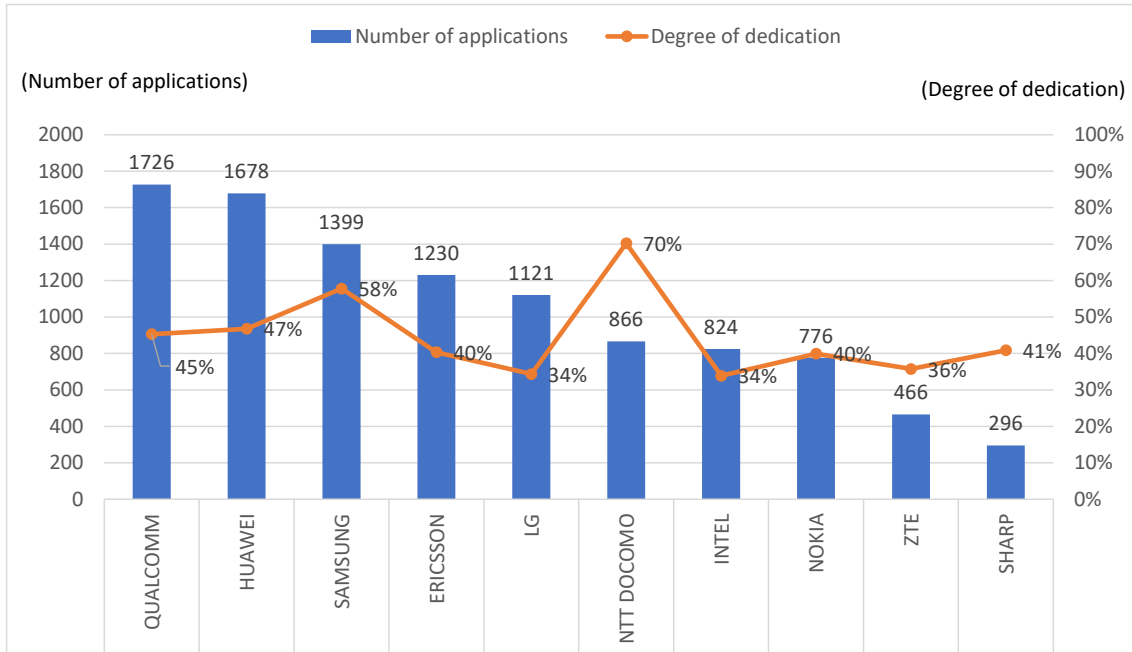


Figure3 Degree of dedication to 5G Essential Patents

### Section 3 Results of analysis of technological trend of 5G Essential Patents

#### 1. The number of applications by technological category

The top 3 categories are radio resource management, beam control and MIMO. MIMO has declined to the 3rd place from the 1st by switching positions with radio resource management, which ranks 1st this time. Behind these ranking changes, there seems to have been a shift in patent applications, which have been more gravitated toward radio resource management for achieving higher performance as basic MIMO and beam control schemes have been established.

### Section 4 Results of analysis of 5G Essential Patents by major applied

companies

(For details, please refer to the full Survey Report.)

## Section 5 Results of analysis of 5G Essential Patents from particular standpoints

(For details, please refer to the full Survey Report.)

## Chapter 3 Results of Survey on the Declared 5G-SEPs

### Section 1 Overview of the Survey

#### 1. Details and method of the survey

ETSI publishes a list of patents that merges the patents that companies have declared as essential for standards to ETSI twice a year (hereinafter SEP declaration list).<sup>1</sup>

Each company declares patents it considers to be in conformity with the applicable standards at its own discretion. Since the declarations are made according to each company's judgement, it is necessary to be careful in surveying those patents, especially in relation to each company's standardization strategies, because some declared patents are not necessarily relevant or essential to standardization while not all patents required for standardization are declared.

In spite of such imperfection, the SEP declaration list is a valuable source of information as the list provides details including target standards for declarations, names of meetings to which declarations are made, declarants and date of declarations. Such details are helpful for capturing the overall trend of standardization.

#### 2. Survey conditions

The target of this survey is the patents contained in the declaration list published in November 2019 and declared to 5G meetings.

The patents surveyed are those of INPADOC families (on an idea based).

Note that companies can make declarations anytime and that ETSI publicizes them in a timely manner. It is possible therefore to access to declared patents even when the relevant standardization is not complete.

## Section 2 Results of survey on the overall trend of Declared 5G-SEPs

### 1. Number of Declared 5G-SEPs

This time we have added the Declared 5G-SEPs as the target of analysis as major companies seemed to have almost completed their declarations.

The number of patent families declared as 5G-SEPs is 25,771.

### 2. Number of Declared 5G-SEPs by company

The top 3 companies are HUAWEI, SAMSUNG and LG. QUALCOMM, who ranks 1st in 5G Essential Patents, goes down to the 6<sup>th</sup> position in declarations.

As for Japanese companies, NTT DOCOMO ranks 9th in the world and 1st in Japan. NTT DOCOMO ranks 1st among telecom operators in the world as well.

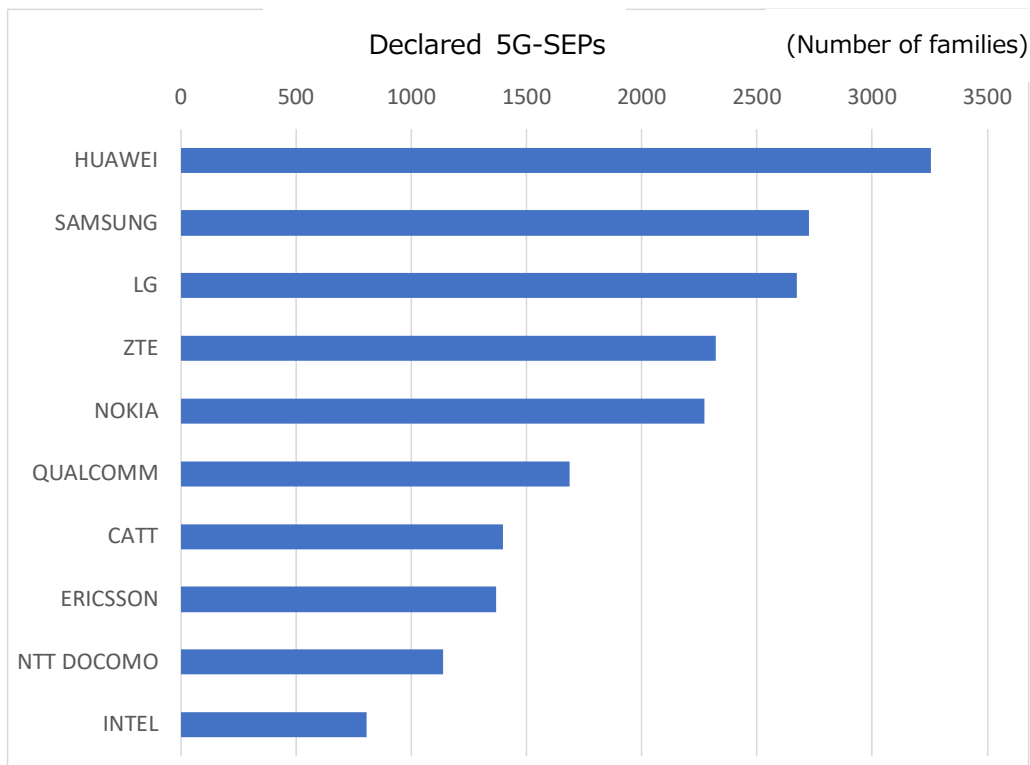


Figure 4 Top companies in Declared 5G-SEPs



### Section 3 Results of analysis of technological trend of Declared 5G-SEPs

(For details, please refer to the full Survey Report.)

### Section 4 Results of analysis of Declared 5G-SEPs by major declared companies

(For details, please refer to the full Survey Report.)

### Section 5 Results of trend analysis of Declared 5G-SEPs from particular standpoints

(For details, please refer to the full Survey Report.)

## Chapter 4 Results of Survey on 5G Standardization Contributions

### Section 1 Overview of the Survey

#### 1. Details and method of the survey

Standardization activities (discussions on standard specifications) of 3GPP are conducted by TSGs (Technical Specification Groups) and WGs (Working Groups) under them. Today there are three TSGs by category, which are further divided into 16 WGs: RAN (WGs 1-6), SA (WGs1-6) and CT (WGs 1, 3, 4 and 6).

Basically those TSGs and WGs meet four times a year. Proposals are submitted to each of their meetings in the form of contributions.

The survey and analysis of this survey have been conducted based on the contributions made public.

Our analysis level is set to the level at which technical issues are recognizable.

## 2. Survey conditions

The target period of this survey for Rel.15 was from March 2016 when 5G-related discussion was officially started in WGs, to the end of September 2019, and for Rel.16, it was from December 2017 to the end of November 2019.

## Section 2 Results of the survey on the overall trend

### 1. The number of 5G standardization contributions by WG

The number of contributions submitted during the survey period is approx. 200,000, up 80,000 from approx. 120,000 in the last survey.

Among WGs, RAN1 handled the largest number of contributions during the period, followed by RAN2 and RAN4, and SA ranks 4th.

Note that each WG is in charge of different areas of work. RAN1 studies radio layer 1, RAN2 studies radio layer 2 and 3, RAN3 studies RAN architecture (radio access network) and SA2 studies services and system architecture.

### 2. The number of 5G standardization contributions by company

Figure 5 shows the number of contributions submitted by each of top contributing companies to 3GPP.

Top three companies are Huawei (20%), Ericsson (16%), Nokia (10%). The number of contributions by the top four companies including Nokia (4th) account for more than 50% of the total.

As for Japanese companies, NTT DOCOMO ranks 10th among companies in the world, and ranks 1st among telecom operators in the world.

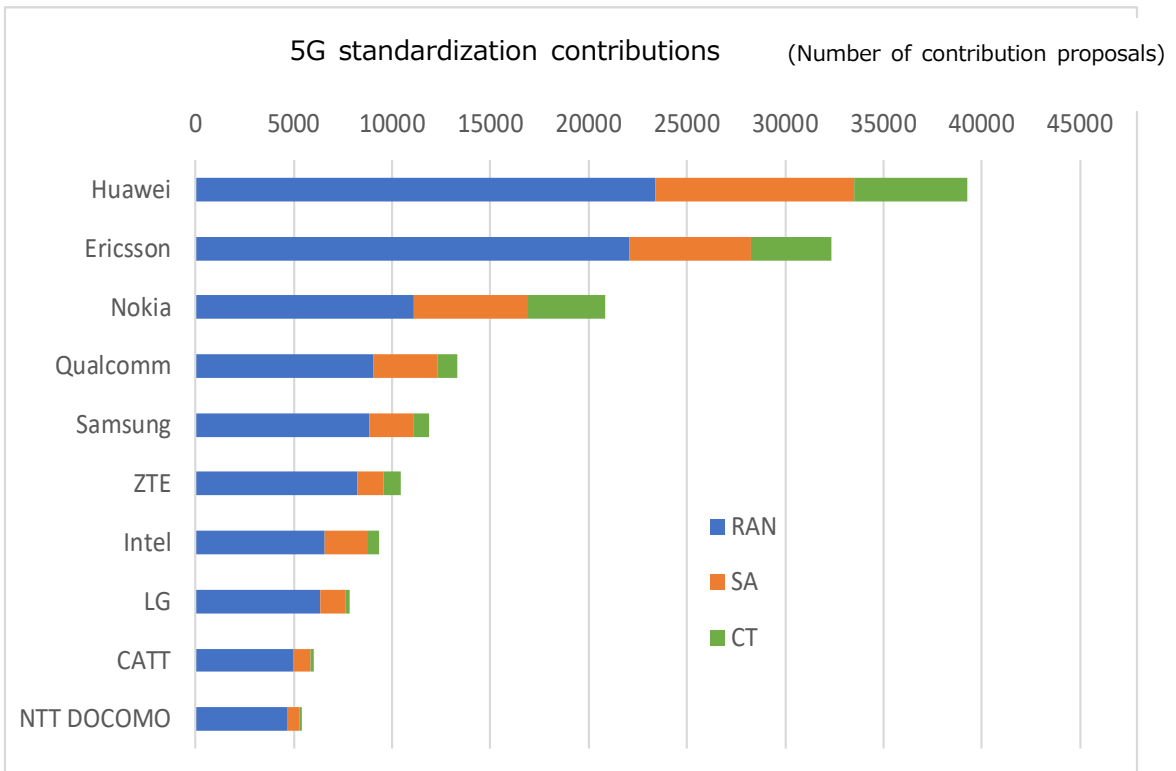


Figure 5 Top companies in 5G standardization contributions

### Section 3 Results of analysis of technological trend of 5G standardization

contributions

(For details, please refer to the full Survey Report.)

### Section 4 Results of trend analysis of 5G standardization contributions by

major contributing companies

(For details, please refer to the full Survey Report.)

### Section 5 Results of trend analysis of 5G standardization contributions from

particular standpoints

(For details, please refer to the full Survey Report.)

## Chapter 5 Results of Survey on 5G-SEP promising patents(5G Essential Patents $\cap$ Declared 5G-SEPs )

### Section 1 The number of 5G-SEP promising patents

Among 5G-SEP candidate patents, 4000 patents or approx. one-fourth of them are Declared as 5G-SEPs. Among patents extracted as 5G Essential Patents but not considered 5G element technologies (approx. 290,000), 4000 patents are declared as 5G SEPs. Although these patents are related to technologies of the previous generations including 4G, they seem to have been considered essential for 5G implementations as well.

### Section 2 The number of 5G-SEP promising patents by company

(For details, please refer to the full Survey Report.)

### Section 3 Results of analysis of technological trend 5G-SEP promising patents

(For details, please refer to the full Survey Report.)

### Section 4 Results of trend analysis of 5G-SEP promising patents by major contributing companies

(For details, please refer to the full Survey Report.)

### Section 5 Results of trend analysis of 5G-SEP promising patents from particular standpoints

## Chapter 6 Results of Comprehensive Analysis

### Section 1 Positioning of major companies

#### 1. Comparison of top 3 companies in three survey items

The table below compares the ranks of top patent applicants for 5G Essential Patents derived from the survey.

Qualcomm is highly dedicated to 5G element technologies, but it remains in a low position in the number of standardization contributions and Declared 5G-SEPs. Judging from this analysis result, there is a high possibility that Qualcomm is focusing its energy on implementations and differentiation technologies. We may need therefore to keep a watchful eye on this from the standpoint of royalties outside the scope of FRAND terms.

Among Japanese companies, NTT DOCOMO keeps its top position for all of the three survey items among Japanese companies as well as among telecom operators in the world.

(Each figure shows a rank)

Top companies	5G Essential Patents		Declared 5G-SEPs	5G standardization contributions	
	This survey	Last survey	This survey	This survey	Last survey
QUALCOMM	1	3	6	4	5
HUAWEI	2	2	1	1	1
SAMSUNG	3	1	2	2	4
NTT	6	6	9	10	9
DOCOMO	1 (Japan)	1	1 (Japan)	1 (Japan)	1
SHARP	10	-	-	-	-
SONY	-	10	-	-	-

Table 2 Comparison of top companies' positions in the 3 survey items

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i Standard Essential Patents (SEPs) and their importance

Provision of 5G services and technologies requires a number of patents that conform to the applicable standards.

Companies must submit IPR declarations to SDOs (Standards Development Organizations) of their relevant countries or regions (ETSI, ARIB, TTC, etc.), stating their readiness to grant licenses for their patents under de-facto FRAND terms in order for their patented technologies to be adopted in standards. 3GPP will request ITU-R to approve its 5G standards currently being discussed at 3GPP as ITU-R Recommendations once discussions within 3GPP are settled. After being approved by ITU-R, such standards will be established as standards by SDOs of relevant countries or regions according to the applicable ITU-R recommendations. Companies who own patents that conform to standards are considered to have satisfied the requirements for their patented technologies to be adopted as standards when they declare their relevant patents as SEPs to ETSI, etc. We must note however that whether to declare SEPs is at the discretion of each company and that we need to put each patent application under a third party's scrutiny to determine if it is really essential to standards.

FRAND: Fair, Reasonable And Non-Discriminatory

ii The evaluation method devised by Cyber Creative Institute works as follows. We first focus on the patent applications relevant to the technological elements considered essential for 5G and determine if the technology claimed by each of the patent applications contributes to implementing 5G standards being discussed in 3GPP. By using this method, we can determine the possibility of conformance with the applicable 5G standards for patents even when they have not been declared as SEPs to ETSI, etc.