Image Courtesy: Mobile Europe

Sample Patent Landscape Study

# Edge Computing

Nov 2019

IIPRD

# Table of Contents

# 1. Edge Computing

## 1.1. What is Edge Computing?

Edge computing is a distributed computing framework that brings computation and data storage closer to data sources such as IoT devices or local edge servers, to improve response time and save bandwidth.

### Why Edge Computing?

The massive growth and increasing computing power of IoT devices have resulted in unprecedented volumes of data. Trend show there will be continuous growth of data volumes as 5G networks have increased the number of connected mobile devices.

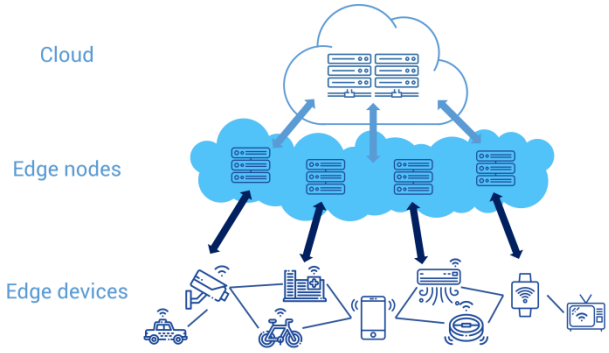
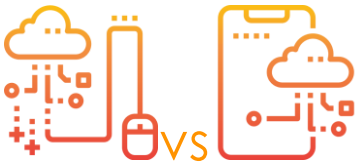



Image courtesy: Alibaba Cloud

Sending all the device-generated data to acentralized data centre or the cloud causes bandwidth and latency issues. Edge computing offers a more efficient alternative through which data is processed and analyzed closer to the point where it's created due to which data does not traverse over a network to cloud or a data cent--re to be processed and as such the latency is significantly reduced.

### Difference between Edge Computing and Cloud Computing




The main difference between cloud computing and edge computing is as to wherethe data is being processed. In cloud computing, data is collected, processed and analyzed at a centralized location. To the contrary, edge computing is based on a distributed computing environment, in which data is collected, processed and analyzed atthe edge of the network.

## 1.2. Benefits

### Speed and Latency

Every millisecond in a company is vital for their business. The downtime or latency can cost the companies thousands of dollars. Edge computing can increase network speed by reducing latency as it processes data closer to the source of information. So the speed, quality and the responsiveness of the overall service can be increased.

### Security

The information present on the cloud tends to get hacked easily. As the edge computing only sends the relevant information to the cloud this can be prevented. Sometimes the edge computing does not require a network connection at all. Even if the hackers manage to infiltrate the cloud, not all

of the information of the user is at risk. However, this does not assure that edge computing is completely free of risks.When comparing it to a cloud, edge certainly has alower number of risks.

### Cost Savings

Adopting an IoT service can be costly due to the need for a larger network bandwidth, data storage and computational power. Using edge computing for IoT allows users to reduce the bandwidth and data storage requirement and replace datacenters with device solutions. Thus, there is a significant cost reduction in implementing IoT devices and applications.

### Scalability

In a cloud computing architecture, data must first be forwarded to a centrally located datacenter. This process is adopted in most cases. Expanding or even slightlymodifying dedicated datacenters is an expensive proposition. Besides, IoT devices can be deployed along with their processing and data management tools at the edge in a single implantation.

### Reliability

Edge computing handles the reliability part very well. Most of the time, edge computing does not even depend on internet connection orservers, yet it offers an uninterruptible service. Users do not need to worry about network failures or slow internet connections. Moreover, it can store and possess data locally by using microdata centres. Due to this a reliable connection can be assured for all the IoT devices.

## Benefits

Speed and Latency

Security

Cost Savings

Scalability

Reliability

## 1.3. Drawbacks

By far the greatest challenge of thr edge computing is making the distributed networks secure. Although there are significant security advantages to an edge network, a poorly implemented system could leave itself vulnerable. Edge computing's reliance uponsmaller data centers and IoT edge devices presents a different range of security concerns than traditional cybersecurity approaches. Any company looking at edge computing solutions needs to take these threats seriously, especially if they plan to rely more heavily upon IoT edge devices.That's why industry experts are alreadysuggesting about how to implement new approaches like zero trust security to ensure that the IoT devices powering edge computing framework aren't being turned against users and organizations. With so much data being gathered, organizations can't afford to tolerate the risk of a data breach. Fortunately, many of these security concerns can be alleviated by edge data centers that demonstrate a commitment to protecting their customers and their data. Compliance standards such as ISO 27001 and HIPAA/HITECH ensure that a data centeres provid both resilient infrastructure and strong brand protection.

## 1.4. Current State

Tech Pro Research had conducted a survey of several enterprises. As per their reports, 52% of respondents confirmed that they are currently using edge computingand; 51% plan to employ edge computing within the coming 12 months.As per reports from Gartner, 10% of enterprises have shut down their data center in 2018 and 80% of the remaining enterprises are predicted to follow by 2025. As per reports from the Markets, the edge computing market is expected to rise. The estimate rise in worth could range to $6.72 bn by2022 from $1.47 as recorded in 2017.

Hybrid Cloud Solutions predicts that 5.6 billion IoT devices will rely on edge computing for data collection and processing by 2020.

## 1.5. Future

Edge computing is expected to impact IoT more than any other industry by a wide margin. It will make IoT technology more realistic, scalable and powerful in the long term by reducing the load on external servers and improving the capabilities of IoT devices. Networks will also become substantially faster due to improvements in edge computing. With devices doing the majority of the computing work - rather than sending requests off to remote servers - networks will be freer and less encumbered by streams of data from devices. Networks will only be used when they have something to offer that devices don't.

Edge computing offers several advantages over traditional forms of network architecture and will surely continue to play an important role for companies going forward. With more and more internet-connected devices hitting the market, innovative organizations are only expected to dive deeper and explore the possibilities of edge computing.

# 2. Objectives

- To perform detailed analysis of granted patents and published applications pertaining to Edge Computing and to understand underlying technologies.
- In depth analysis of patents/applications, in order to categorize them and to understand focus areas of applicants.
- Graphical representation of trends (Filing, Publication, etc.) from the mined data of relevant patents/applications.

# 3. Search Methodology

We adoptedrenowned patent databases-- Questel Orbit and Derwent Innovation (DI)--as our data sources--and executed search queries to retrieve a patent literature dataset for the identification of relevant patent literature. Keywords (in Title, Abstract, Claims and Full Text Fields) and International patent classification (IPC and CPC)search was carried out to get a dataset of relevant/related patents.

# 4. Summary

- This report explores the global landscape of patents and/or patent applications pertaining to Edge Computing.

- A set of 624 patent families (that bifurcates to a total of 1151 individual patents/applications) filed in the Edge Computing domain were analyzed.

- Patent publications particularly having focus on Edge Server/ Edge Node (272), Base Station (194), End User Devices (36), GPRS/ 2G/ 3G/4G/ LTE(197), 5G (137), Wi-Fi (96), Bluetooth (65), ZigBee (42), LoRa (24), V2X (21), Sensors (157), Data Processing (150), Security & Privacy (133) Resource Allocation/Resource Management (115), Edge calculation (96), Power Saving (89), Task offloading (63), Handover (47), Anomaly Detection (44), IoT Smart Environment (151), Location Services (109), Intelligent Transportation (81), Navigation (63), Energy Management (28), Entertainment & Games (28), Health Care (26) and Others (530) have been considered.

## Key Report Findings

Edge computing filings have grown 50% each year, The year 2018 has witnessed maximum number of patent application filings.

Intel is the top global innovator in this domain, with 31 patent families.

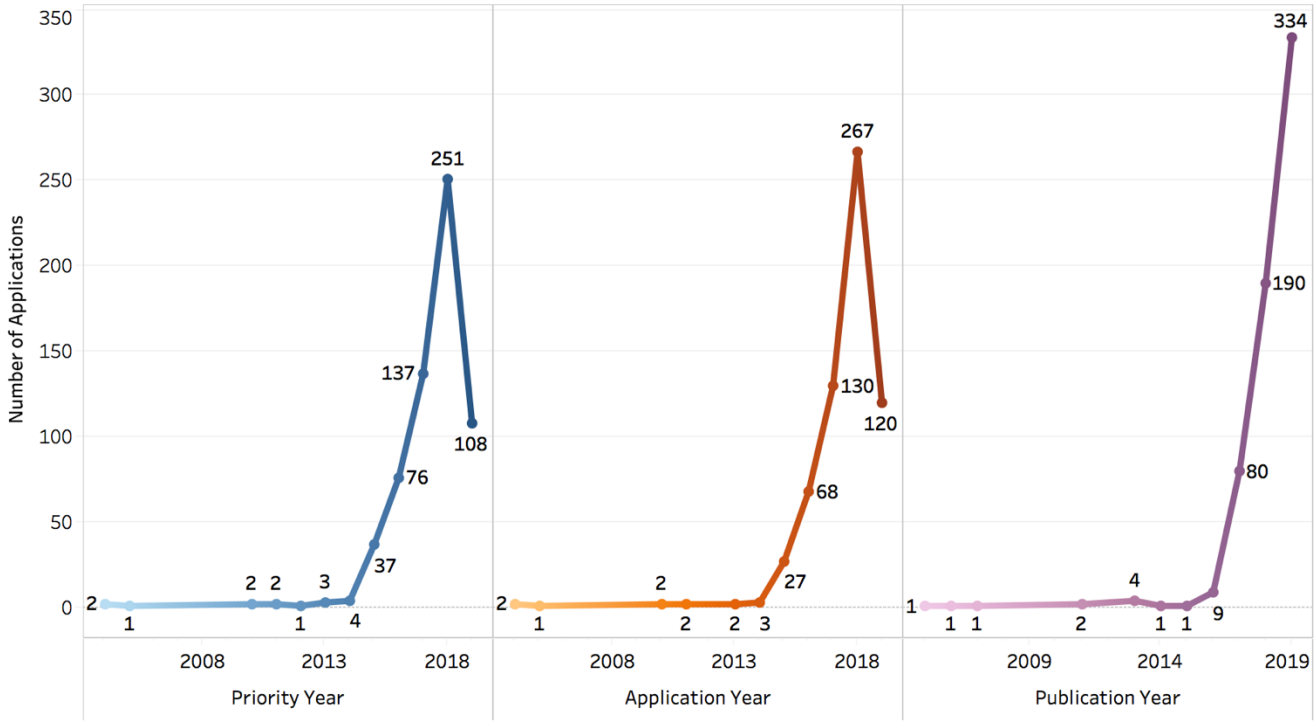
China (374 patent applications) is the larget filing destination.

Wen Hong, Sabella Dario, and GuimBernatFrancesc with 9 patent applications emerges out as the leading inventors in Edge Computing Technology.

# 5. Non-TechnicalAnalysis

## 5.1. Priority, Filing, Publication Year Based Trend Analysis

Below graph represents priority,application and publication year trends for the patent applications pertaining to Edge Computing.




# Note: Attributed to non-published patent applications, there may be a higher count in the years 2015-2018.

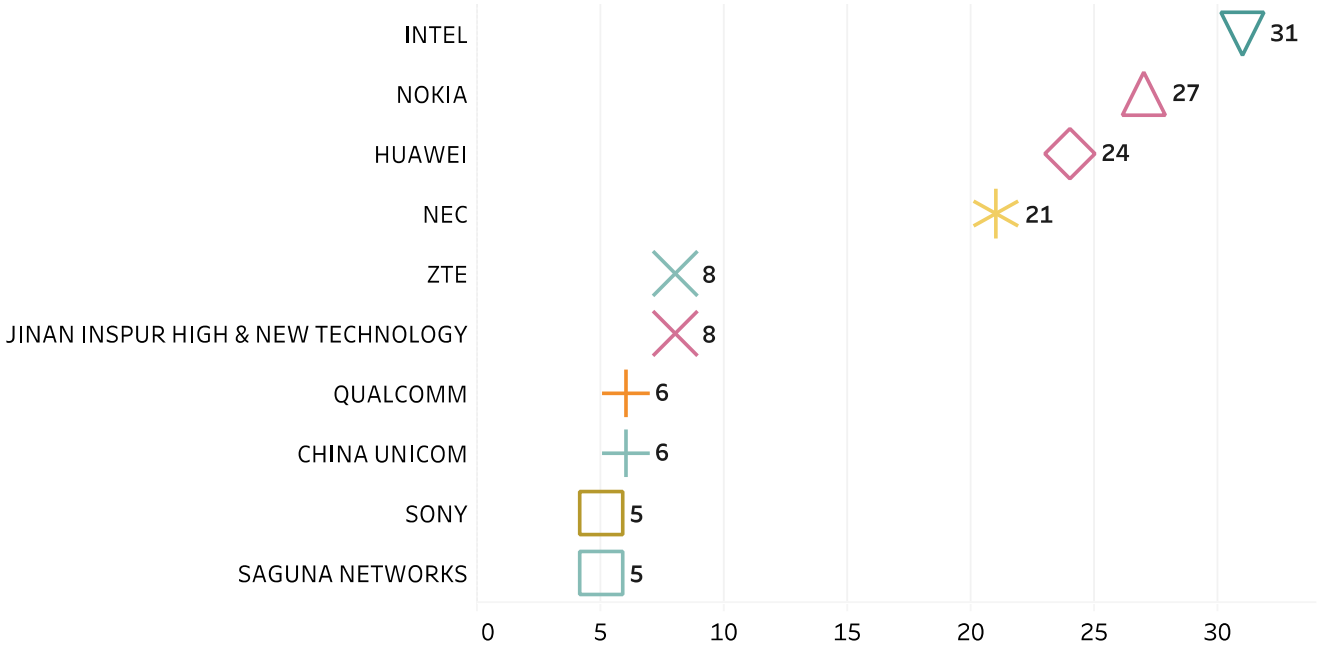
Priority year trend provides insights related to priority years of the patent applications. Most patent applications claim priority in between the years of 2015-2018.

Filing year trend provides insights for the number of applications filed across the years. As depicted in the graph, there is a gradual rise in patent applications filing over the years, wherein maximum numbers of patent applications were filed in the years 2015-2018.

Publication trend provides insights for the number of applications published across the years. As indicated in the graph, there is a gradual rise in publication over the years, wherein maximum numbers of patent applications were published in the years 2016-2019.

## 5.2. Assignee Based Trend Analysis

The below graph represents major assignees in the domain.

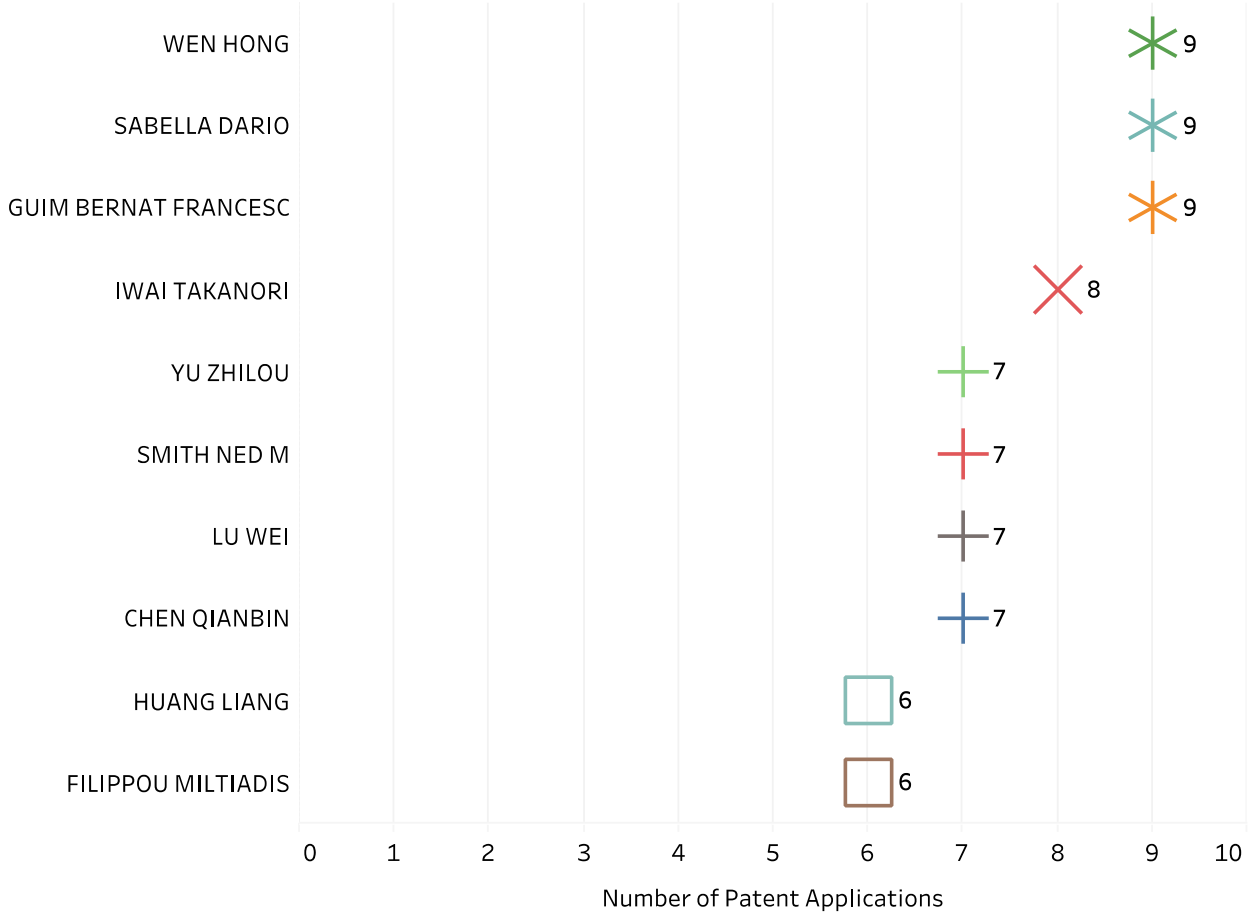



# Note: Attributed to non-published patent applications, there may be a higher count in the years 2015-2018.

As evident from the chart herein above, “Intel” (31 patent families), “Nokia” (27 patent families), “Huawei” (24 patent families)” and “NEC” (21 patent families) are key applicants/assignees with significant filing activity worldwide.

## 5.3. Key Inventors

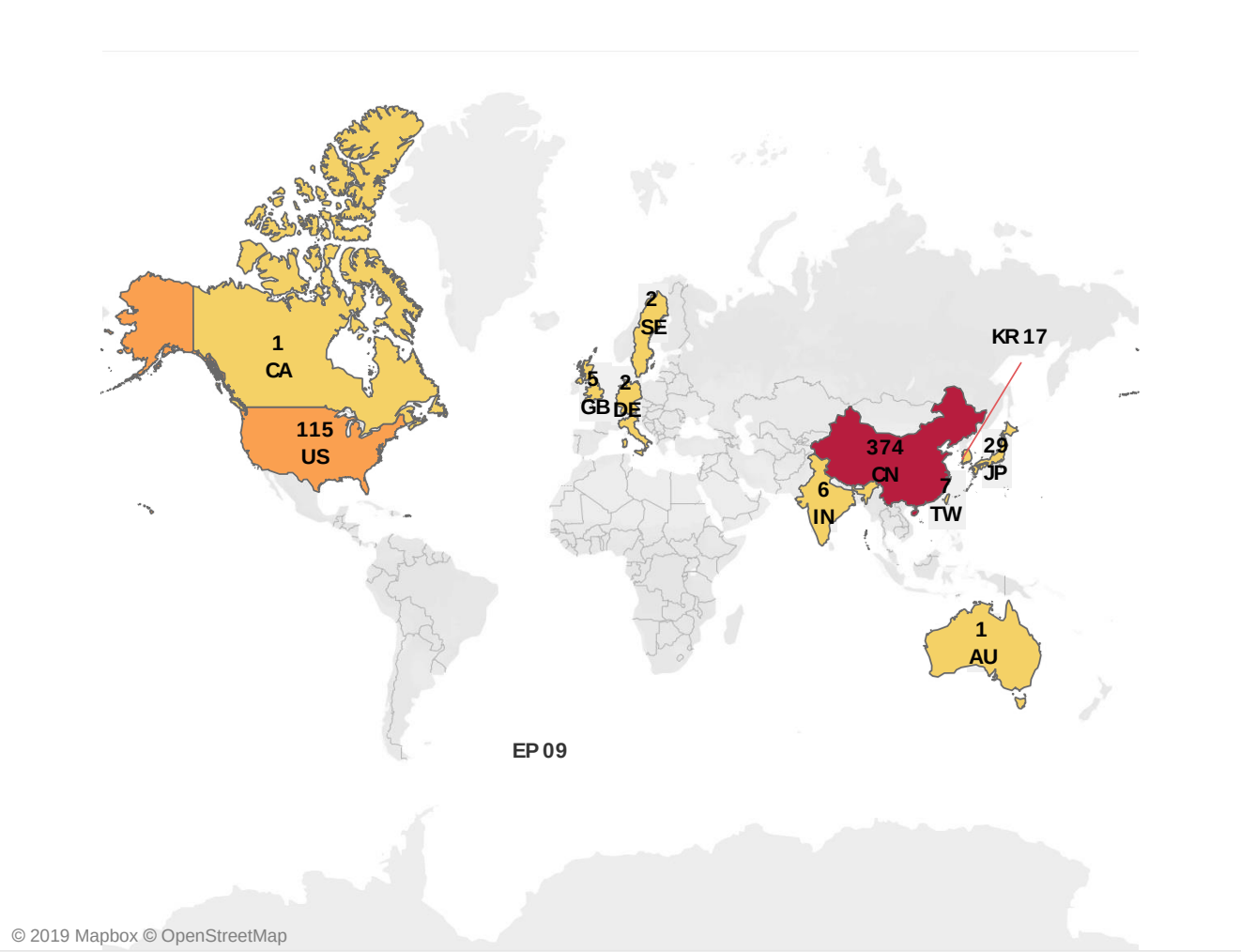
The below graph names the inventors with most number of innovations on their name.




# Note: Attributed to non-published patent applications, there may be a higher count in the years 2015-2018.

The chart demonstrates top inventors, wherein 'Wen Hong' and 'Sabella Dario', 'GuimBernatFrancesc' emerge as the leading inventors in Edge Computing Technology followed by Iwai Takanori, Yu Zhilou, Smith Ned M, Lu Wei, and Chen Qianbin.

## 5.4. Geography Based Trend Analysis

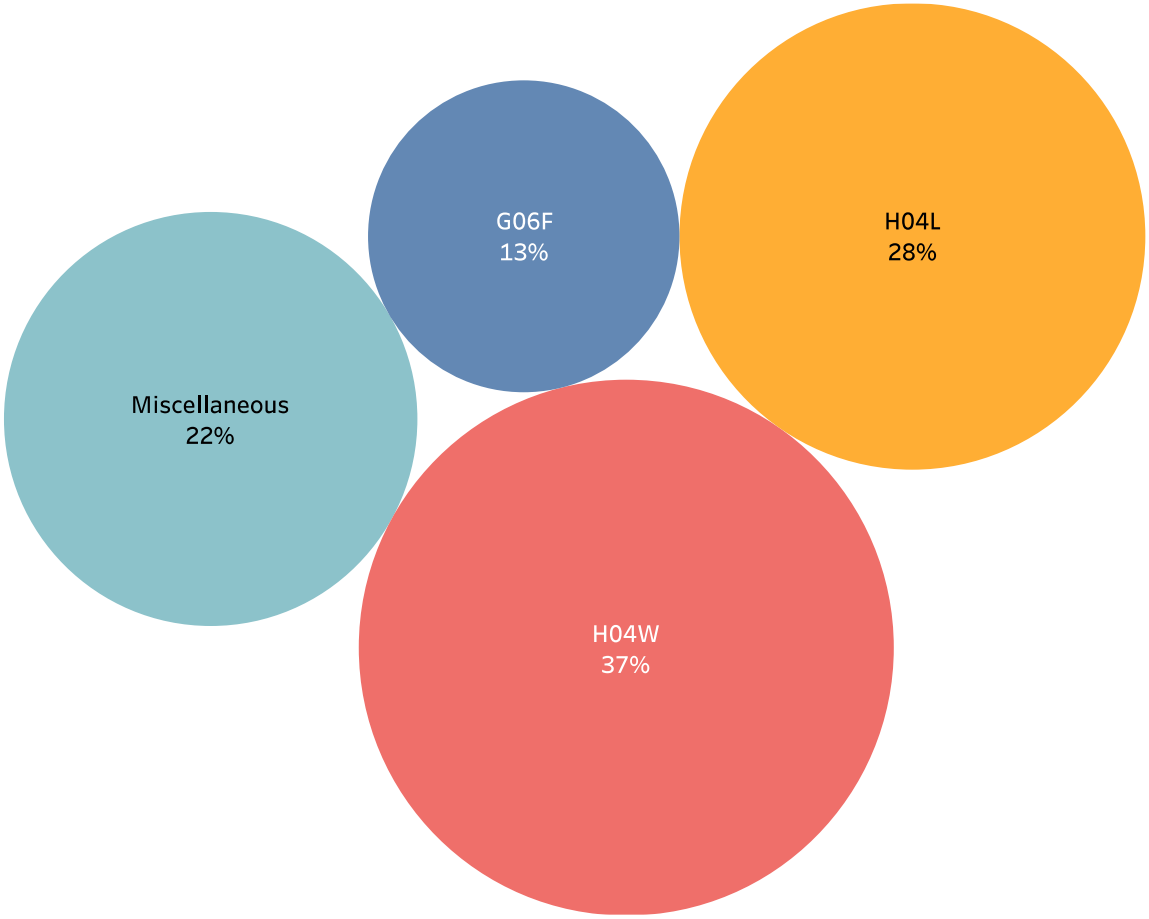



# Note: Attributed to non-published patent applications, there may be a higher count in the years 2015-2018.

Trend related to Geographical filing demonstrates that the maximum number of filings were originated from China (CN) followed by USA (US) and Japan (JP) jurisdictions.

## 5.5. International Patent Classification Based Trend

The Below Packed Bubbles Represents Frequently Assigned International Patent Classes.



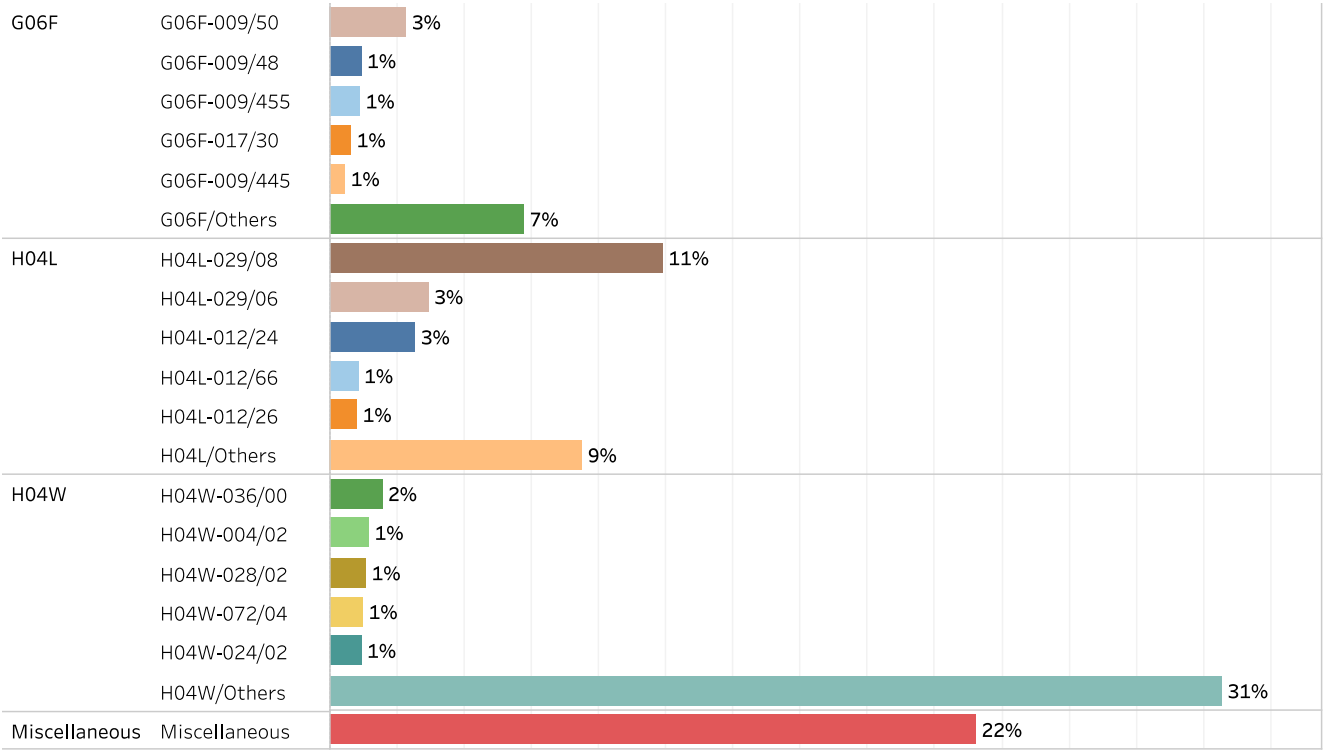

Majority of patent applications were assigned with IPC H04W (Wireless communication Networks) followed by H04L (Transmission of digital information).

IPC Definitions

| IPC | Definition |
|---|---|
| H04W | WIRELESS COMMUNICATION NETWORKS |
| H04L | TRANSMISSION OF DIGITAL INFORMATION, e.g. TELEGRAPHIC COMMUNICATION |
| G06F | ELECTRIC DIGITAL DATA PROCESSING |

## 5.6. International Patent Sub-Classification Based Trend

The below graph represents sub-classes pertaining to one of the top/main patent classes.



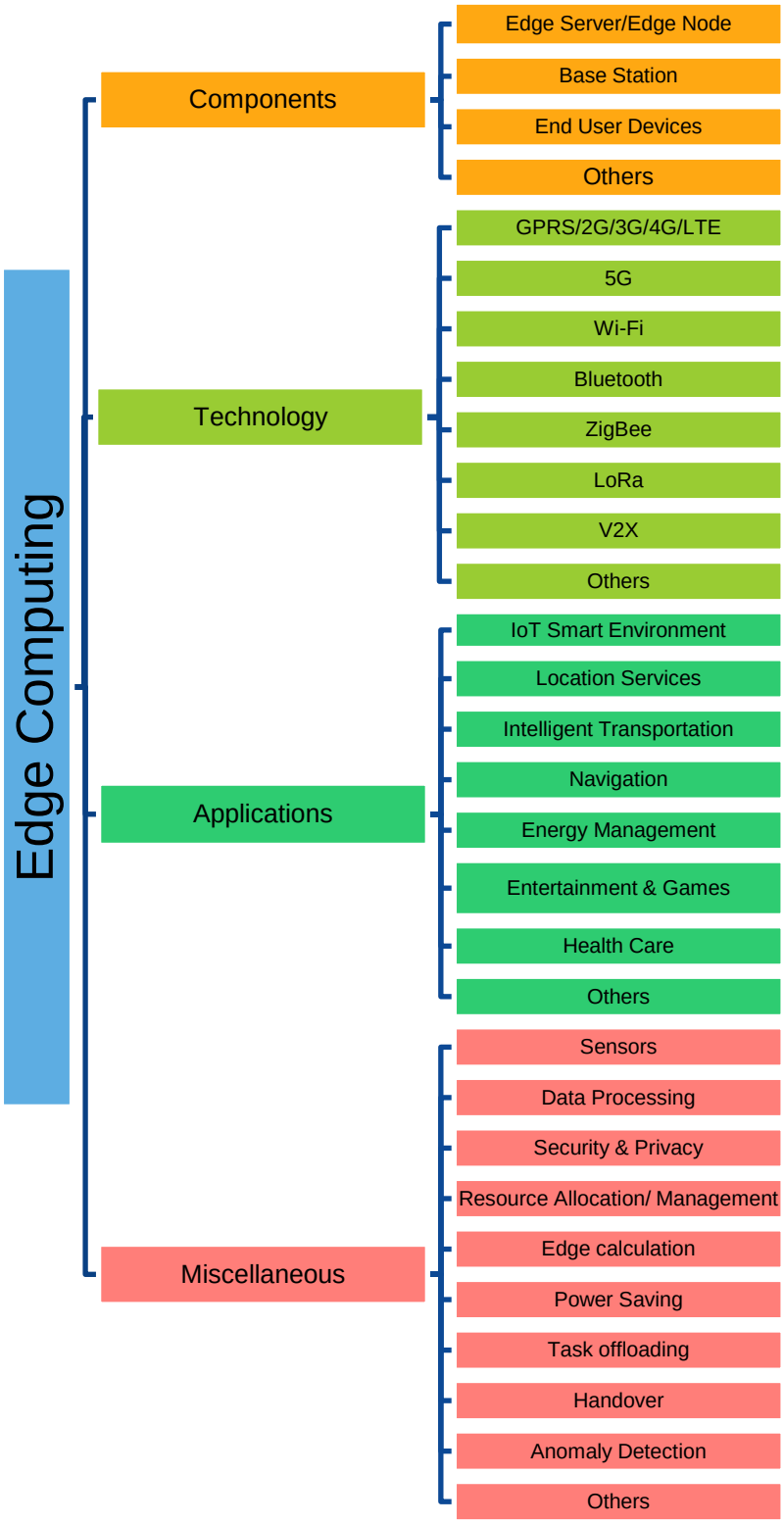

### IPC Subclass Definitions:

| IPC Subclass | Definition |
|---|---|
| H04W | WIRELESS COMMUNICATION NETWORKS |
| H04W-004/00 | Services specially adapted for wireless communication networks; Facilities therefor |
| H04W-004/02 | Services making use of location information |
| H04W-024/00 | Supervisory, monitoring or testing arrangements |
| H04W-024/02 | Arrangements for optimising operational condition |
| H04W-028/00 | Network traffic or resource management |
| H04W-028/02 | Traffic management, e.g. flow control or congestion control |
| H04W-036/00 | Handoff or reselecting arrangements |
| H04W-072/00 | Local resource management, e.g. selection or allocation of wireless resources or wireless traffic scheduling |
| H04W-072/04 | Wireless resource allocation |
| H04L | TRANSMISSION OF DIGITAL INFORMATION, e.g. TELEGRAPHIC |

| | |
|---|---|
| | COMMUNICATION |
| H04L-012/00 | Data switching networks (interconnection of, or transfer of information or other signals between, memories, input/output devices or central processing units G06F 13/00) |
| H04L-012/24 | Arrangements for maintenance or administration |
| H04L-012/26 | Monitoring arrangements; Testing arrangements |
| H04L-012/66 | Arrangements for connecting between networks having differing types of switching systems, e.g. gateways |
| H04l-029/00 | Arrangements, apparatus, circuits or systems, not covered by a single one of groups H04L 1/00-H04L 27/00 |
| H04L-029/06 | characterised by a protocol |
| H04L-029/08 | Transmission control procedure, e.g. data link level control procedure |
| G06F | ELECTRIC DIGITAL DATA PROCESSING |
| G06F-009/00 | Arrangements for program control, e.g. control units (program control for peripheral devices G06F 13/10) |
| G06F-009/48 | Program initiating; Program switching, e.g. by interrupt |
| G06F-009/50 | Allocation of resources, e.g. of the central processing unit [CPU] |
| G06F-009/445 | Program loading or initiating (bootstrapping G06F 9/4401; security arrangements for program loading or initiating G06F 21/57) |
| G06F-009/455 | Emulation; Interpretation; Software simulation, e.g. virtualisation or emulation of application or operating system execution engines |
| G06f-017/00 | Digital computing or data processing equipment or methods, specially adapted for specific functions (information retrieval, database structures or file system structures therefor G06F 16/00) |
| G06F-017/30 | Information retrieval; Database structures therefor; File system structures therefor; |

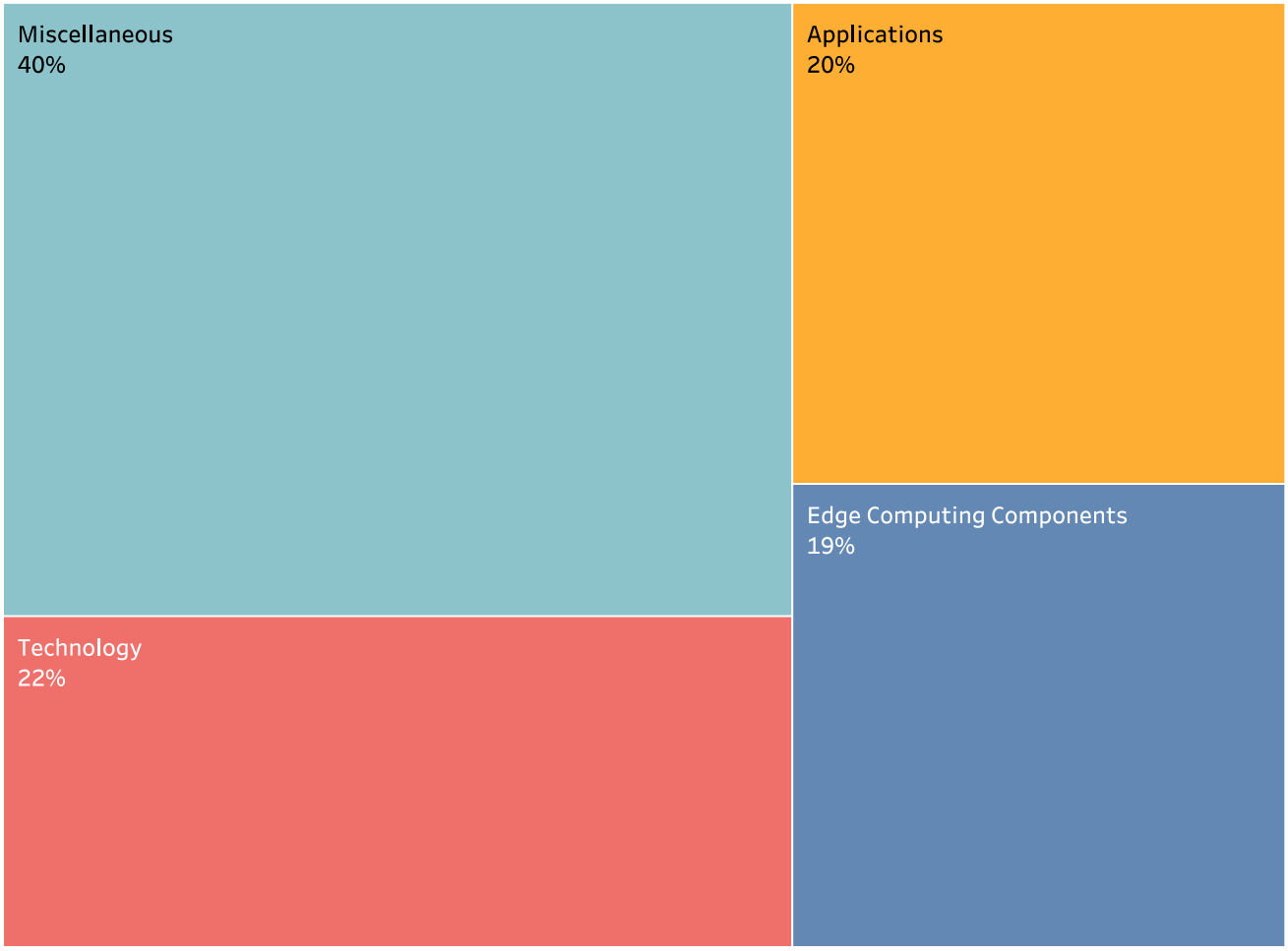
# 6. TechnicalAnalysis

## 6.1. Taxonomy Developed for Bucketing of Relevant Patent Documents



## 6.2. Distribution of Patents/Applications Pertaining to 'Edge Computing'

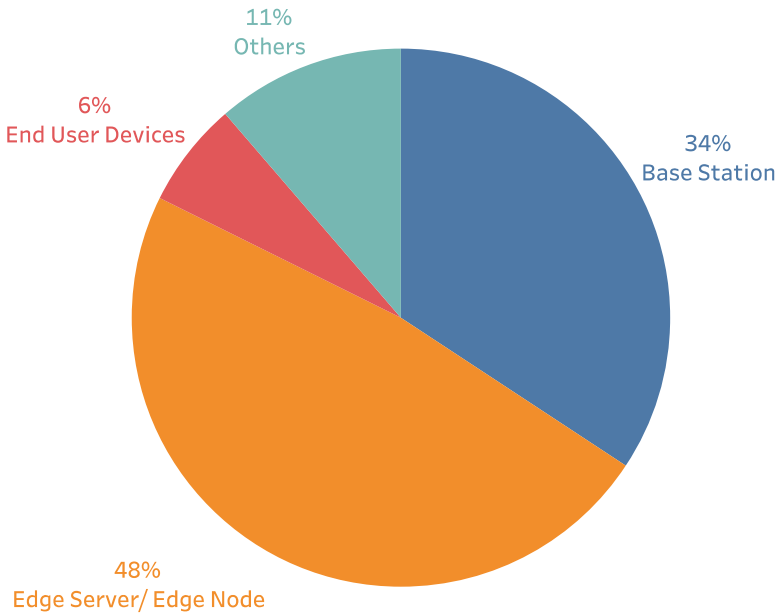
This category deals with patents/applications pertaining to dissection of Edge Computingtechnology. Below representation shows the dissection in terms of Edge Computing components, Technology, Applications and Miscellaneous.




As evident from the tree map, maximum number of patents/applications are falling under Technology (22%) followed by Applications (20%), and Edge computing Components (19%).

### 6.2.1. Bifurcation of Patents/Applications Pertaining to 'Components'

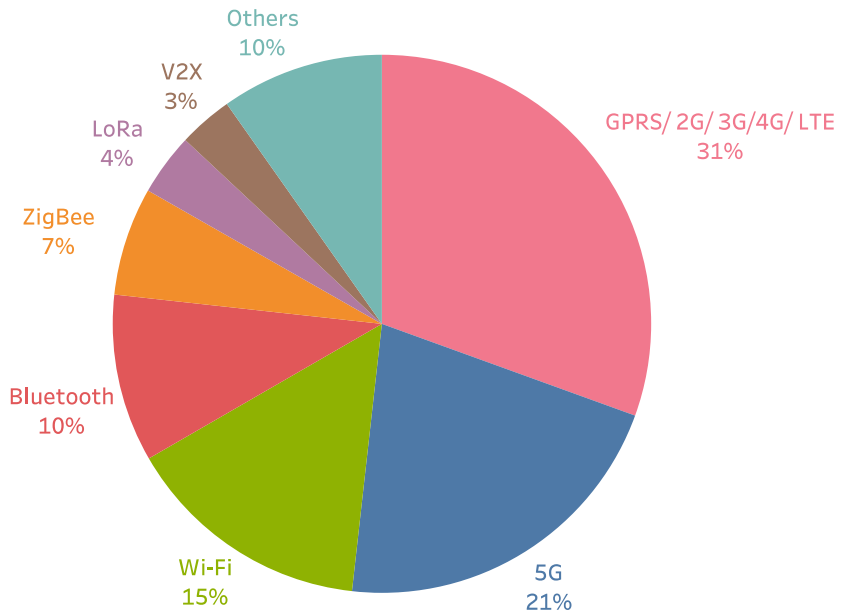
This category deals with patents/applications pertaining to components being incorporated in the Edge Computing. Below representation shows sub-categories, such as, Edge Server/ Edge Node, Base Station, End User Devices and others.




As evident from the chart, maximum number of patents/applications are falling under Edge Server/ Edge Node (48%) followed by Base Station (34%) and End User Devices (6%).

### 6.2.2. Bifurcation of Patents/Applications Pertaining to 'Technology'

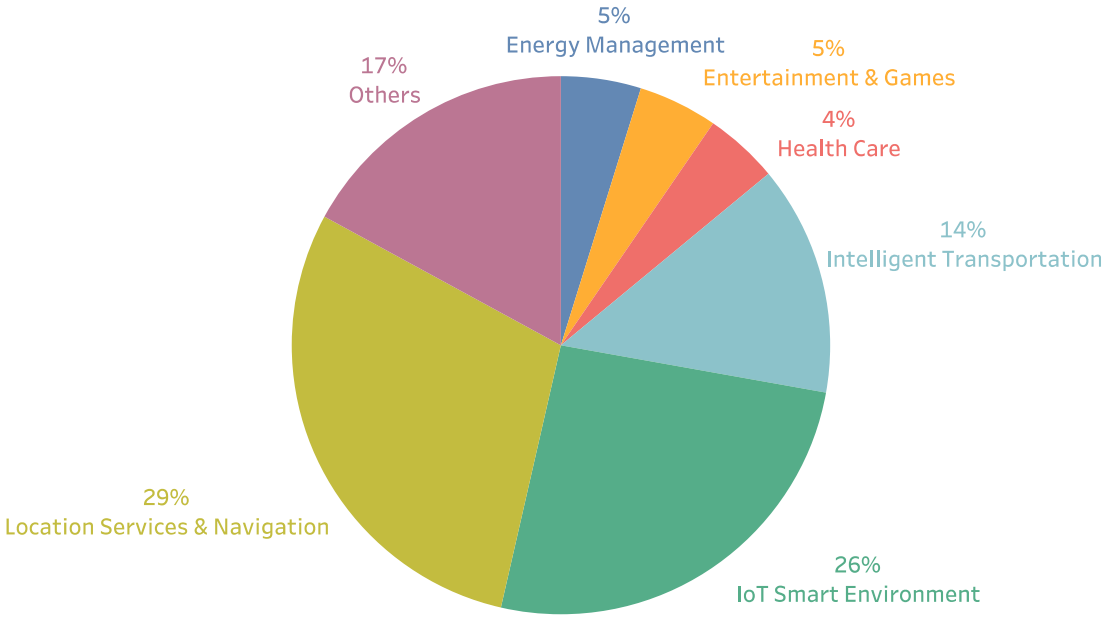
This category deals with patents/applications pertaining to Technology being incorporated in Edge Computing Technology. Below representation shows sub-categories such as GPRS/ 2G/3G/4g/LTE, 5G, Wi-Fi, Bluetooth, ZigBee, LoRa, V2X and others.




As evident from the chart, maximum number of patents/applications are falling under GPRS/ 2G/ 3G/4G/LTE (31%) followed by 5G (21%) and Wi-Fi (15%).

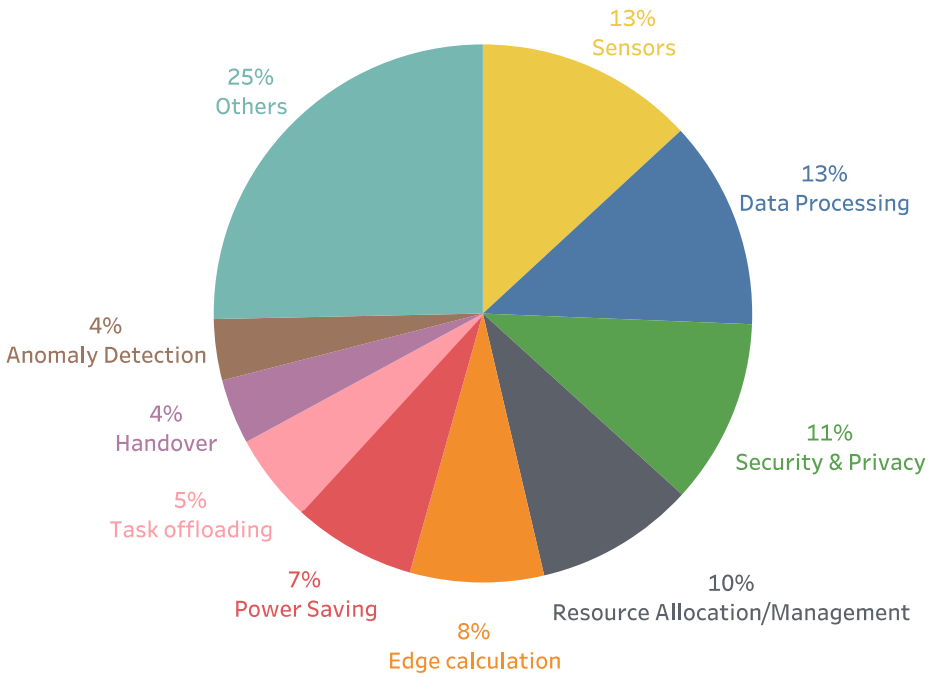
### 6.2.3. Bifurcation of Patents/Applications Pertaining to 'Applications'

This category deals with patents/applications pertaining to applications based on Edge Computing Technology. Below representation shows sub-categories such as Location Services &Navigation, IoT Smart Environment, Intelligent Transportation, Energy Management, Entertainment & Games, Health Care and others.




As evident from the chart, maximum number of patents/applications are falling under the category of Location Services &Navigation (29%) followed by IoT Smart Environment (26%), and Intelligent Transportation (14%).

### 6.2.4. Bifurcation of Patents/Applications Pertaining to 'Miscellaneous'




As evident from the chart, maximum number of patents/applications are falling under the category of Sensors (13%), Data Processing (13%) followed by Security and Privacy (11%), and Resource Allocation/ Management (10%).

# 7. Conclusion

- The report explores the patent landscape of innovations relating to edge computing technology.
- A set of 624 patent families (that bifurcates to a total of 1151 individual patents/applications) filed in the Edge Computing domain were analyzed.
- As inferred from the analyzed dataset, there is a rise in patent filing activities in Edge Computing domain. The year 2018 had witnessed maximum number of patent application filings.
- The technology is dominated by Chinese applicants, making up more than 50% of the total families captured within the report. China (374 patent applications) registers itself as the country with most numbers of innovation followed by USA (115 patent applications).
- Globally, the top players within this technology are Intel with 31 patent families, followed by Nokia (27 patent families). Other applicants that have significant numbers of patent application are Huawei, NEC, ZTE, Jinan Inspur High & New Technology, and Qualcomm.
- From of analyzed dataset, Inventors Wen Hong, Sabella, and GuimBernatFrancesc are the leading innovators in Edge Computing domain. Iwai Takanori, Yu Zhilou, Smith Ned M, Lu Wei and Chen Qianbin also have significant contributions.
- Patent publications particularly have focus on Edge Server/ Edge Node (272), Base Station (194), End User Devices (36), GPRS/ 2G/ 3G/4G/ LTE(197), 5G (137), Wi-Fi (96), Bluetooth (65), ZigBee (42), LoRa (24), V2X (21), Sensors (157), Data Processing (150), Security & Privacy (133) Resource Allocation/Resource Management (115), Edge calculation (96), Power Saving (89), Task offloading (63), Handover (47), Anomaly Detection (44), IoT Smart Environment (151), Location Services (109), Intelligent Transportation (81), Navigation (63), Energy Management (28), Entertainment & Games (28), Health Care (26) and Others (530).
- Based on the available patent data, significant growth and further IP certainty in edge computing technology is expected in the coming years. Further monitoring of the patent landscape will allow the field to be fully appreciated.

# 8. References & Credits

[1] A Beginner's Guide to Edge Computing

[2] What Is Edge Computing?

[3] The Benefits and Potential of Edge Computing

[4] Top 5 Benefits Of Edge Computing

[5]The Future ofEdge Computing

[6]Risks & Benefits of Edge Computing

[7] Edge Computing-IBM

[8] Icons Courtesy: Flat Icon

# Disclaimer

IIPRD has prepared this sample report, wherein contents of the report is based on internal evaluation of Patent Literature (Patents or Patent Applications) as retrieved from Patent Databases that are believed to be reliable by IIPRD. Being a sample report, complete list of patent documents retrieved/analyzed is not disclosed herein; however, it can be made available on request,subject to IIPRD terms and conditions being met.. IIPRD disclaims all warranties as to the accuracy, completeness or adequacy of the report. For preparing the report, patent literature searches(based on the keywords, IPC/CPC, etc.) were conducted and a dataset was retrieved, the dataset was then analyzed.The searching and analysisis subject to individual/researcher'sdiscretion, neither IIPRD nor its affiliates, any of its proprietors, and employees (together, "personnel") are responsible for the authenticity of the data. The purpose of this report is not to formulateany sort of legal advice.

Delhi | Noida | Mumbai | Pune | Bengaluru | Hyderabad | Indore | Jalandhar | Chennai
US | Bangladesh | Myanmar | Vietnam | Nepal | Malaysia | Sri Lanka

## ABOUT IIPRD

IIPRD is a premier Intellectual Property Consulting and Commercialization/Licensing Firm with a diversified business practice providing services in the domain of Commercialization, Valuation, Licensing, Transfer of Technology and Due-Diligence of Intellectual Property Assets along with providing complete IP and Patent Analytics and Litigation Support Services to International Corporates and Global IP Law Firms.


Contact Person

Tarun Khurana

iiprd@iiprd.com, info@khuranaandkhurana.com

Contact No.: +91-120-4296878, 2399113, 2399010

Contact Details

Noida (NCR) Office – Head Office

E-13, UPSIDC Site – IV, Behind Grand Venice, Greater Noida, 201308


Visit us at

www.iiprd.com | www.khuranaandkhurana.com