

Global Patent Trends 5G and 6G Technology

Trends in patent filing activities in the US and Globally

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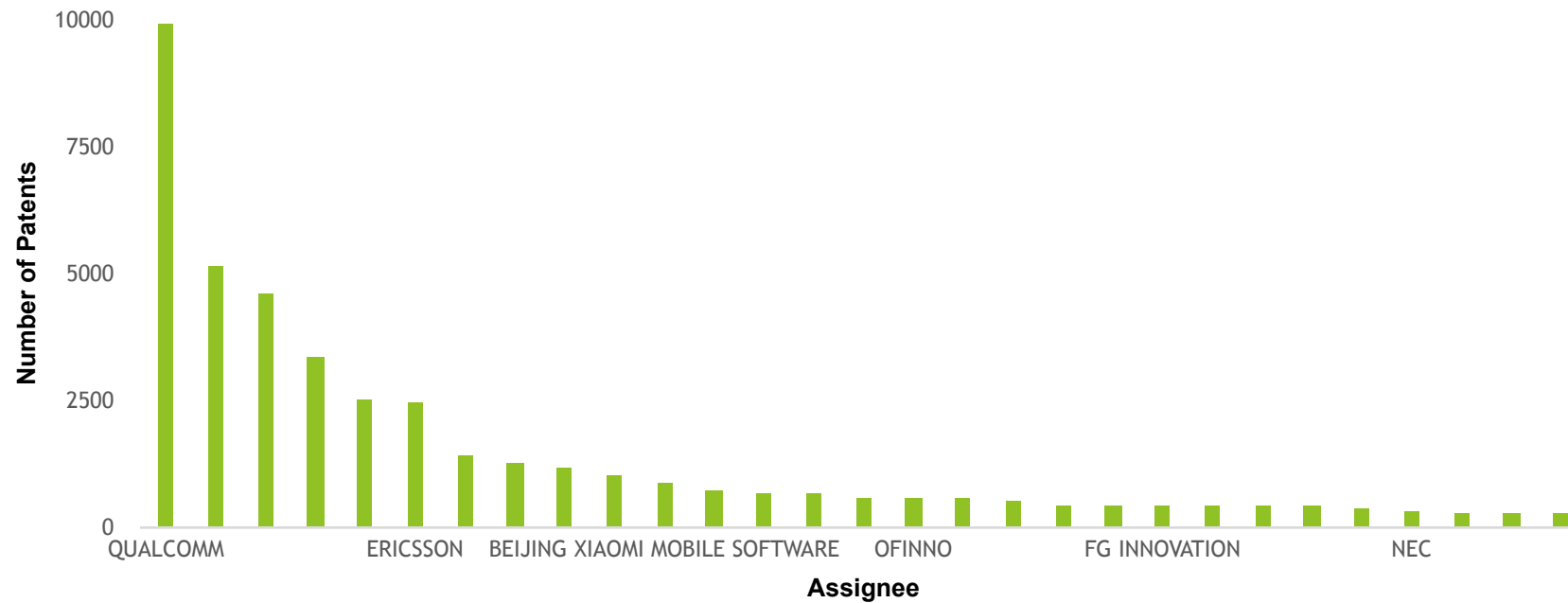
6/28/2023

5G network: Key Technological Domains

5G cellular technology transforms the industries and society with its improved features such as higher transmission speed, lower latency and higher flexibility compared previous wireless standards. The patent filing activities in 5G are analyzed under various key technology divisions, which are as follows:

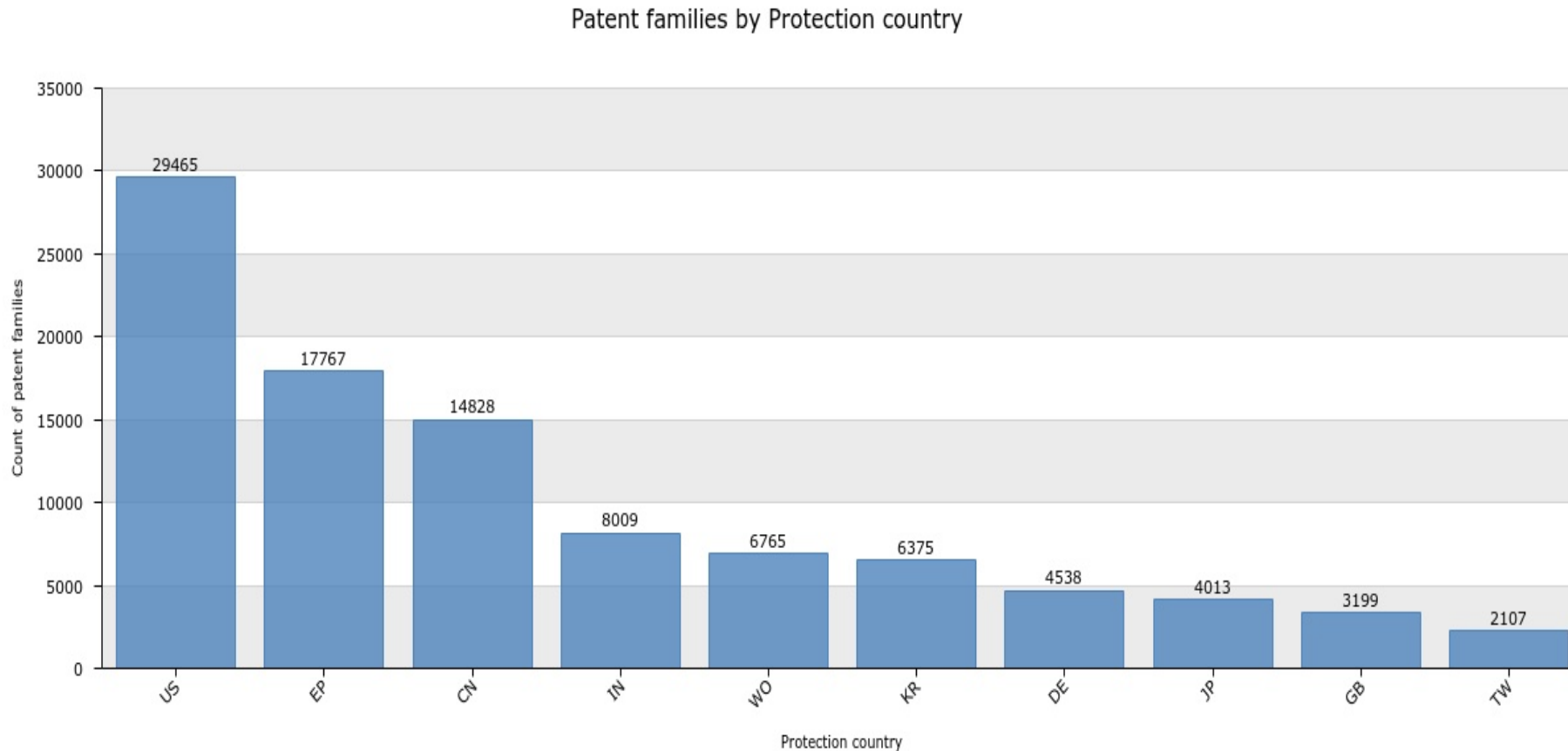
- **Next Generation Radio Access Network (NG-RAN):** basically includes two types of base stations: one operating in the 5G network and other operating in the 4G network or previous generation networks.
- **xHaul Network:** includes fronthaul, midhaul and backhaul.
- **5G core network:** mainly includes Access and Mobility Management Function (AMF) and User Plane Function (UPF), additionally includes UDF (unified data function), PCF (policy control function), AF (application function).
- **Flexible components for network management:** includes segment which can be managed independently or can cover other resources. Further, both traditional and new types of architecture (e.g. separation of control and user data planes) is included.
- **Network services and digital platforms:** provide advanced network services such eMBB (Enhanced Mobile Broadband), URLLC (UltraReliable Low Latency Communication) and mMTC (Massive Machine Type Communications).

Global Patent Families: Assignees (5G)



- It is evident that **Qualcomm** has the **maximum number of patent families (9910)**.

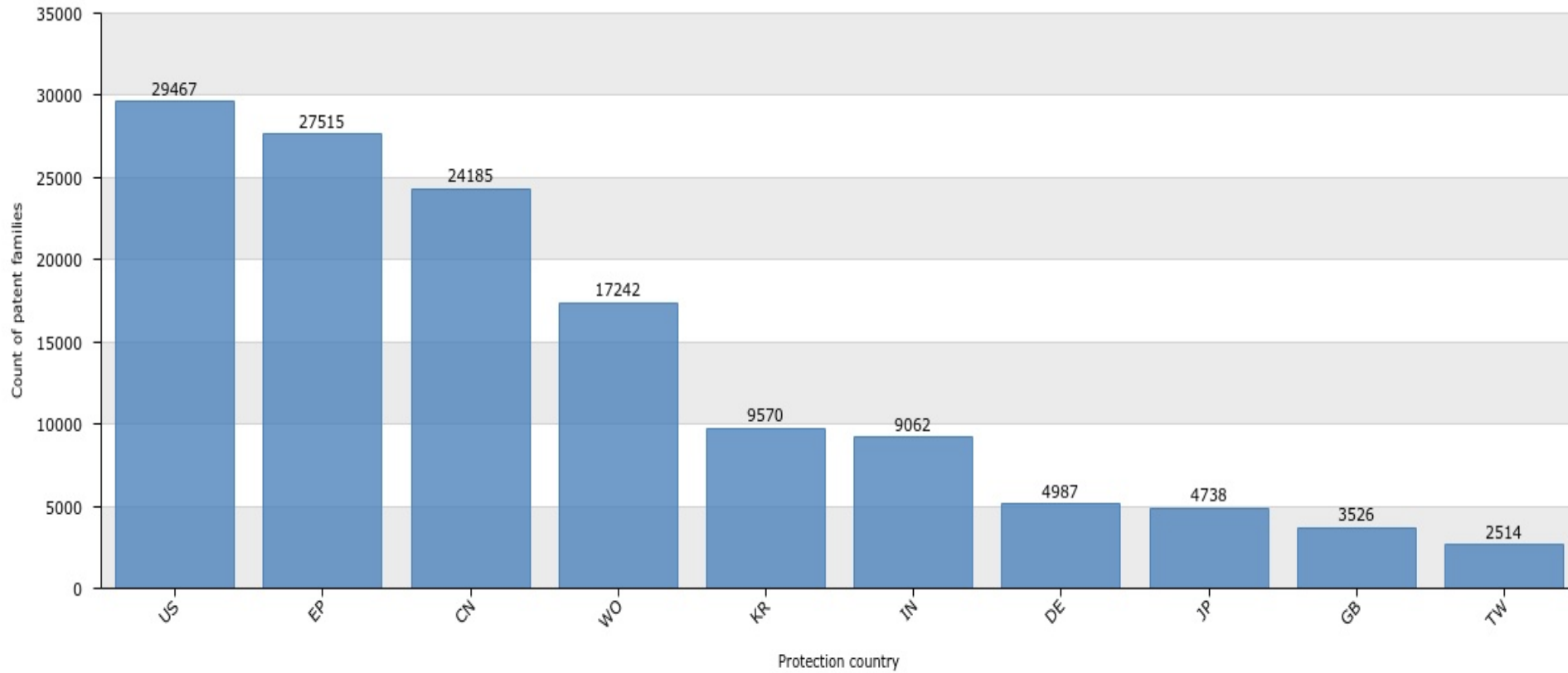
US Patent Families : Top 10 Patent Filing Countries (5G)



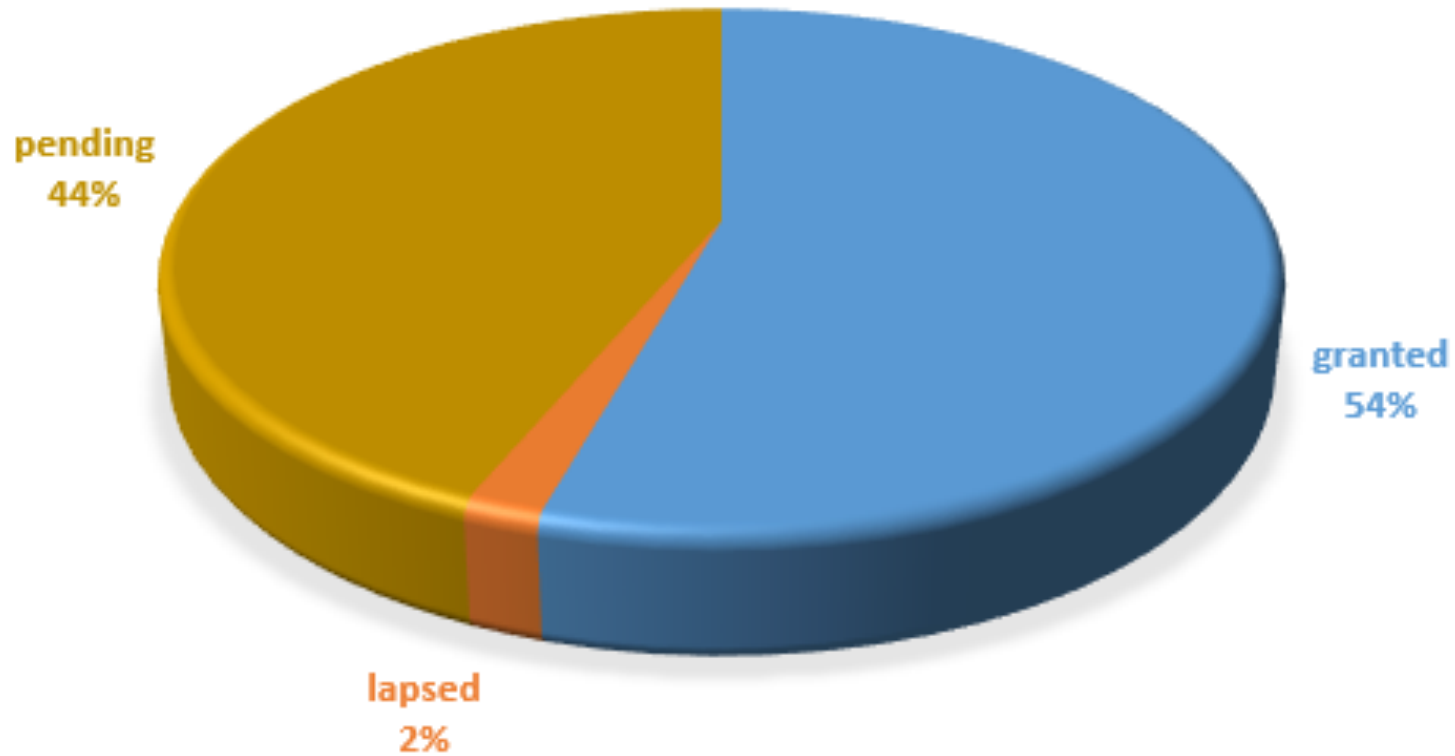
- ❑ The chart shows the **US Patent Families** filing trends in **top 10 countries (US, EP, CN, IN, WO, KR, DE, JP, GB, TW)** contributing in the 5G key technology domains.
- ❑ **US** tops the list with filing of **29465 patent families**, followed by **EP (17767 patent families)** and then by **CN (14828 patent families)**.

Global Patent Families : Top 10 Patent Filing Countries (5G)

Patent families by Protection country

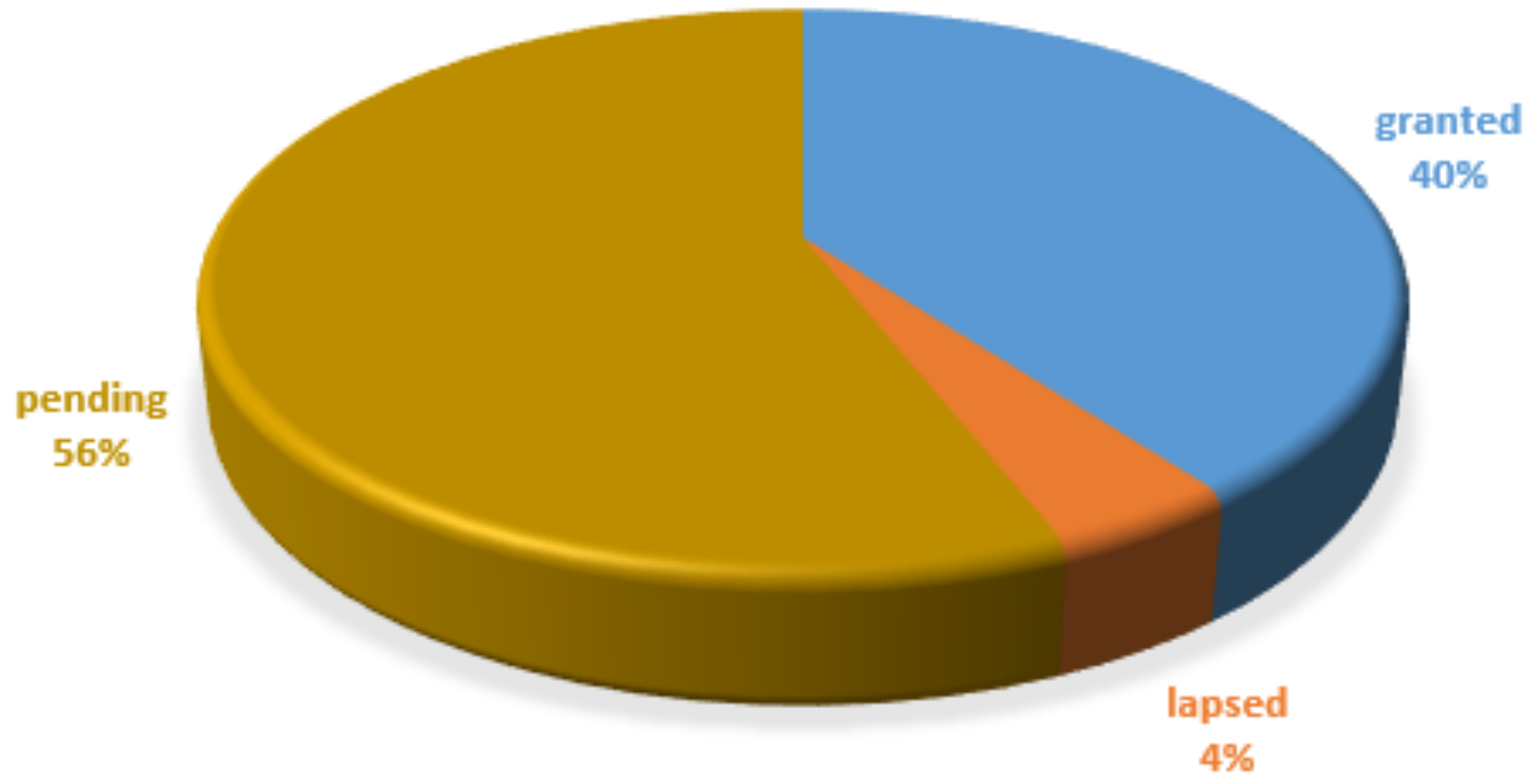


Legal Status: US Patent Documents (5G)



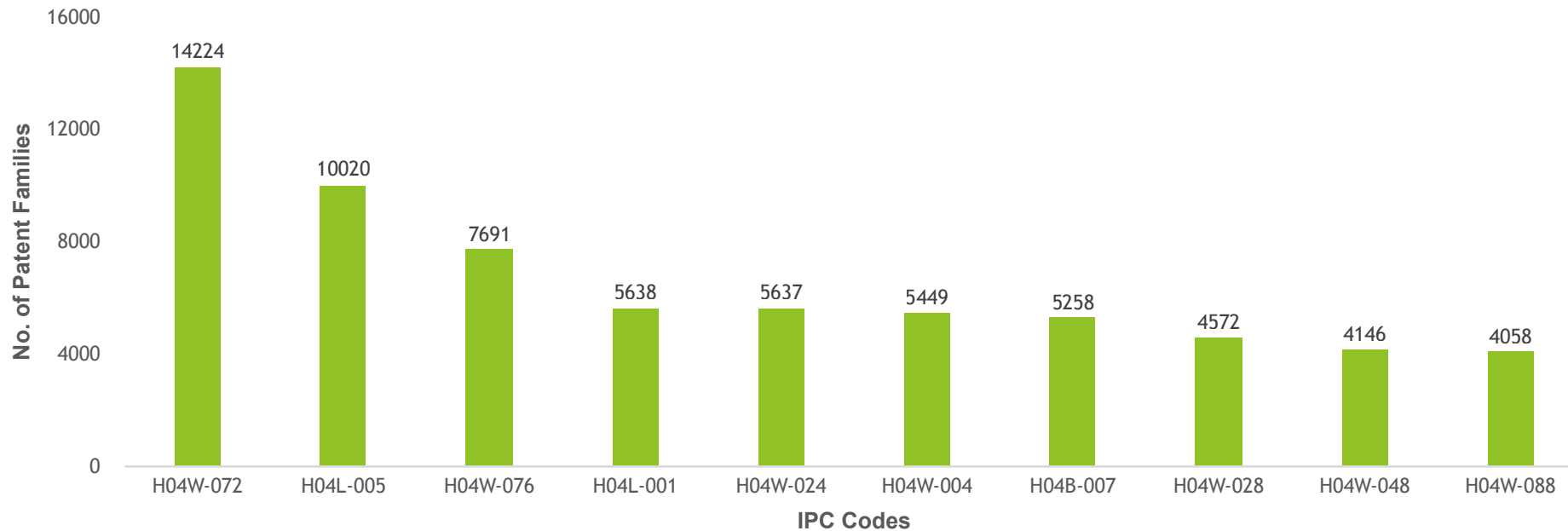
- ❑ The chart shows Legal status of US patent documents for 5G key technological domains.
- ❑ 54% of total US patent documents are granted, 2% are lapsed and 44% are pending.

Legal Status: Global Patent Documents (5G)



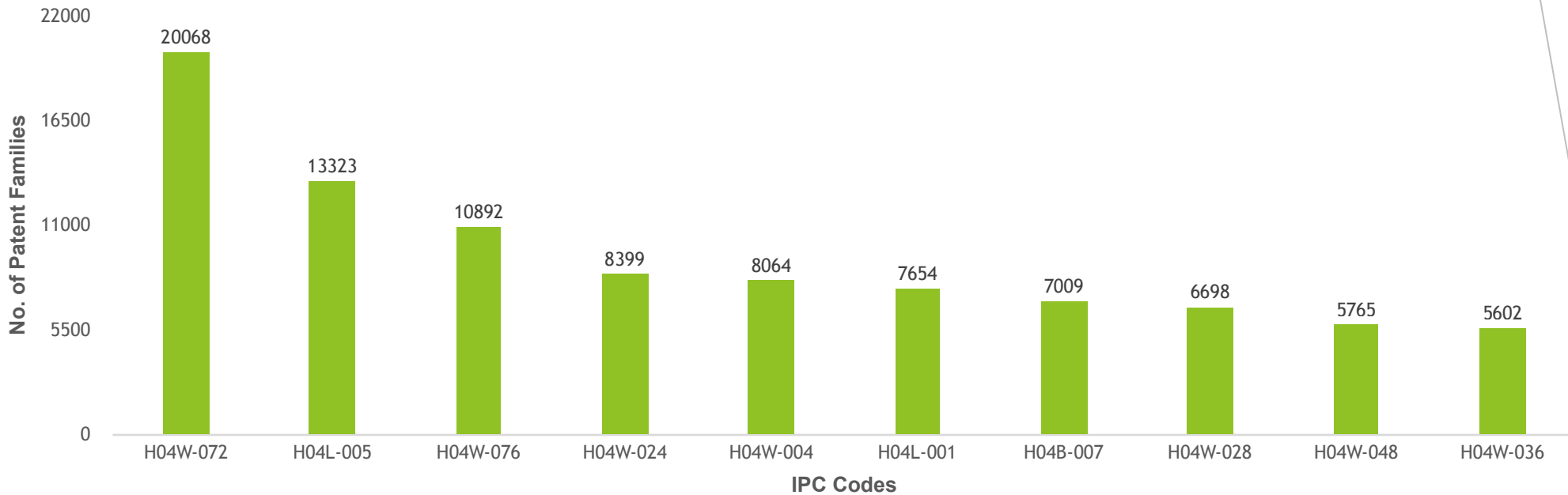
- ❑ The chart shows **Legal status** of global patent documents for 5G key technological domains.
- ❑ **40%** of total global patent documents are **granted**, **4%** are **lapsed** and **56%** are **pending**.

US Patent Families Main IPC Classes (5G)



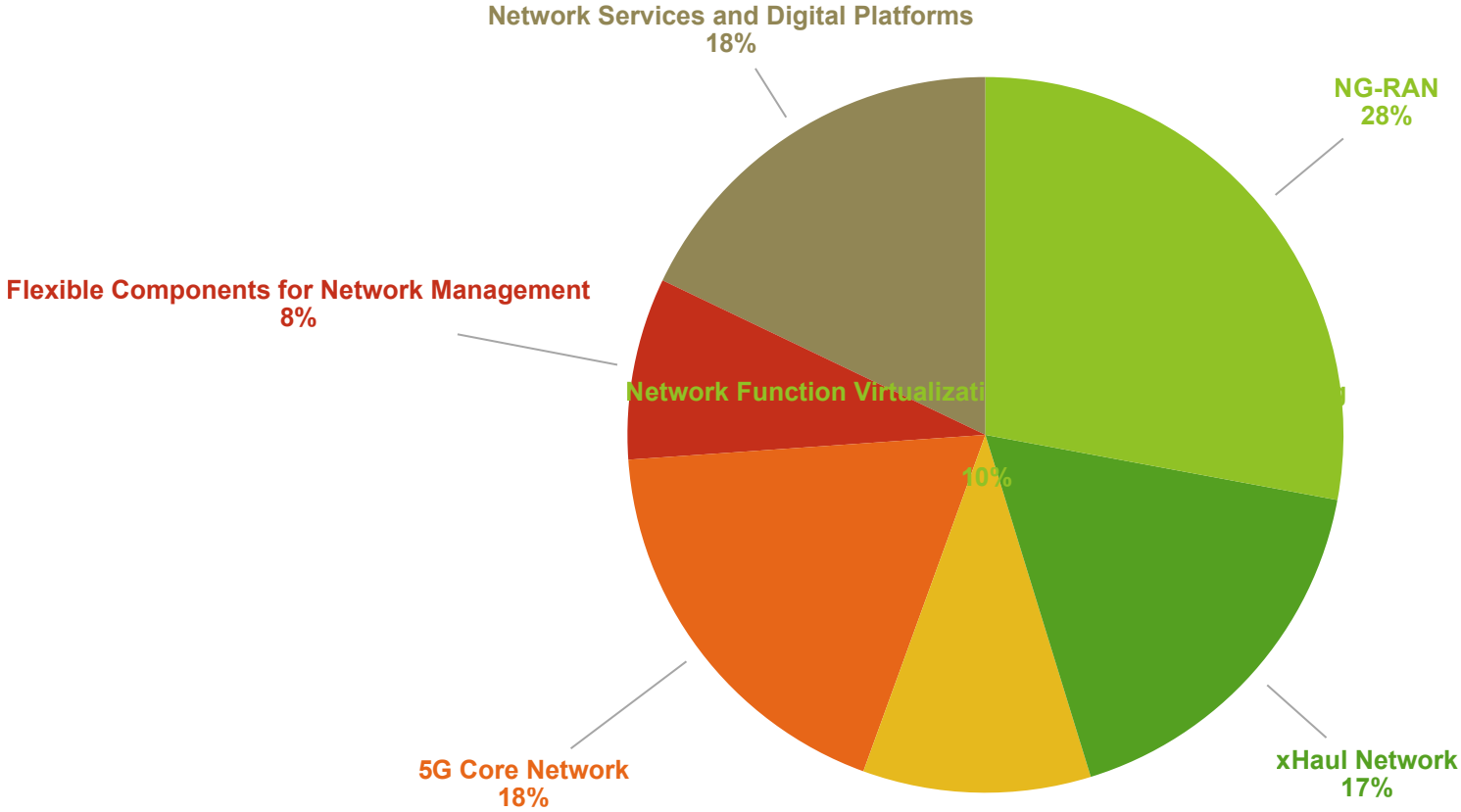
- For US 14224 patent families are categorized under H04W-072 followed by H04L-005 (10020 patent families) and H04W-076 (7691 patent families) for 5G networks.
- Definition of IPC classes:
- H04W72/00: Local resource management
- H04L5/00: Arrangements affording multiple use of the transmission path
- H04B7/00: Radio transmission systems, i.e. using radiation field

Global Patent Families Main IPC Classes (5G)



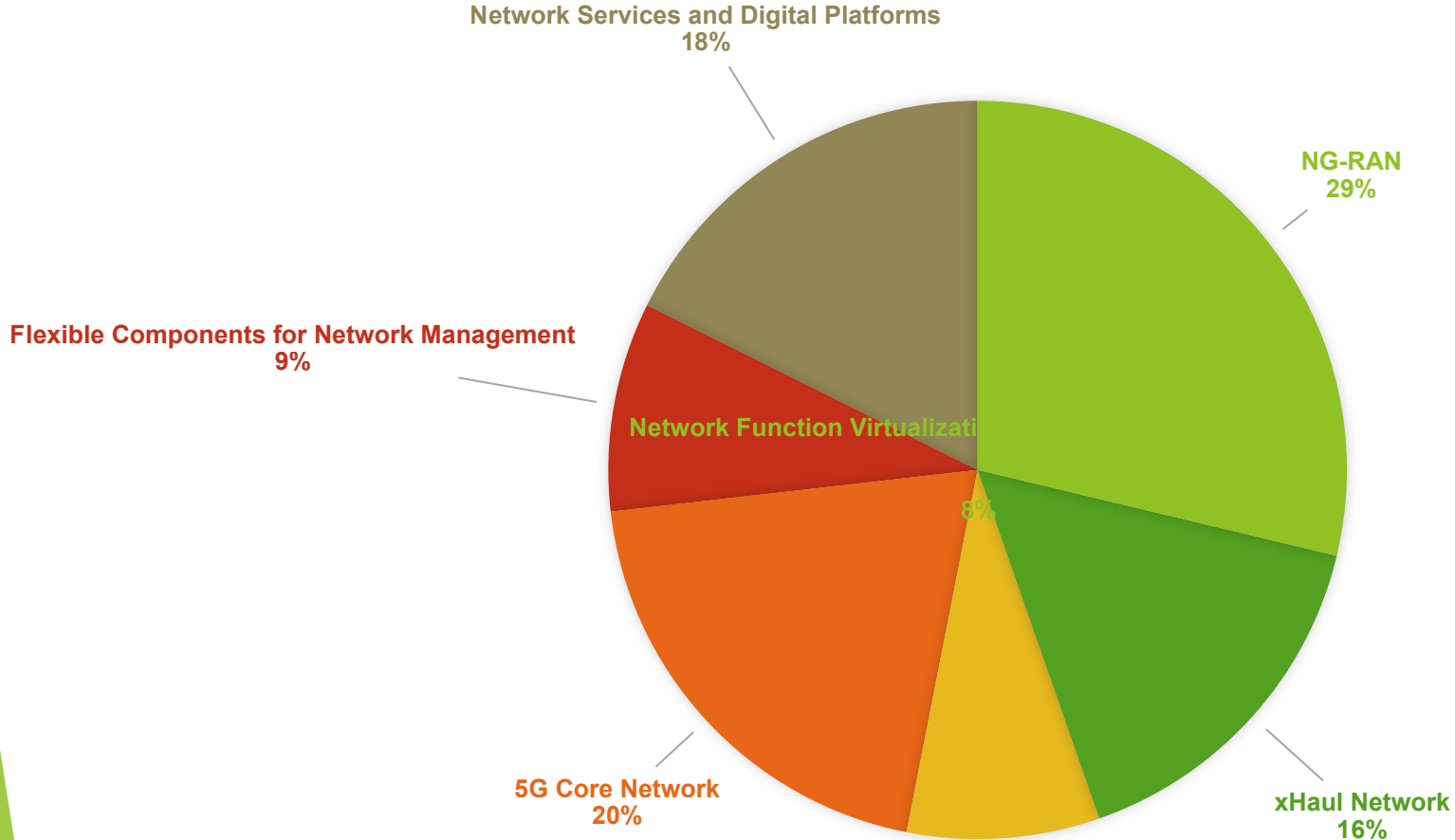
- ❑ For Global Patent Families 20068 are categorized under H04W-072 followed by H04L-005 (13323 patent families) and H04W-076 (10892 patent families) for 5G networks.
- ❑ Definition of IPC classes:
- ❑ H04W72/00: Local resource management
- ❑ H04L5/00: Arrangements affording multiple use of the transmission path
- ❑ H04B7/00: Radio transmission systems, i.e. using radiation field

US Distribution of Patent Families by Key Technological Domains (5G)



- ❑ The chart shows in US, 28% patent families come under Next Generation Radio Access Network (NG-RAN), 17% xHaul network, 10% NFV & Cloud computing, 19% Core network, 08% Flexible components for network management and 18% under Network Services and Digital platforms.

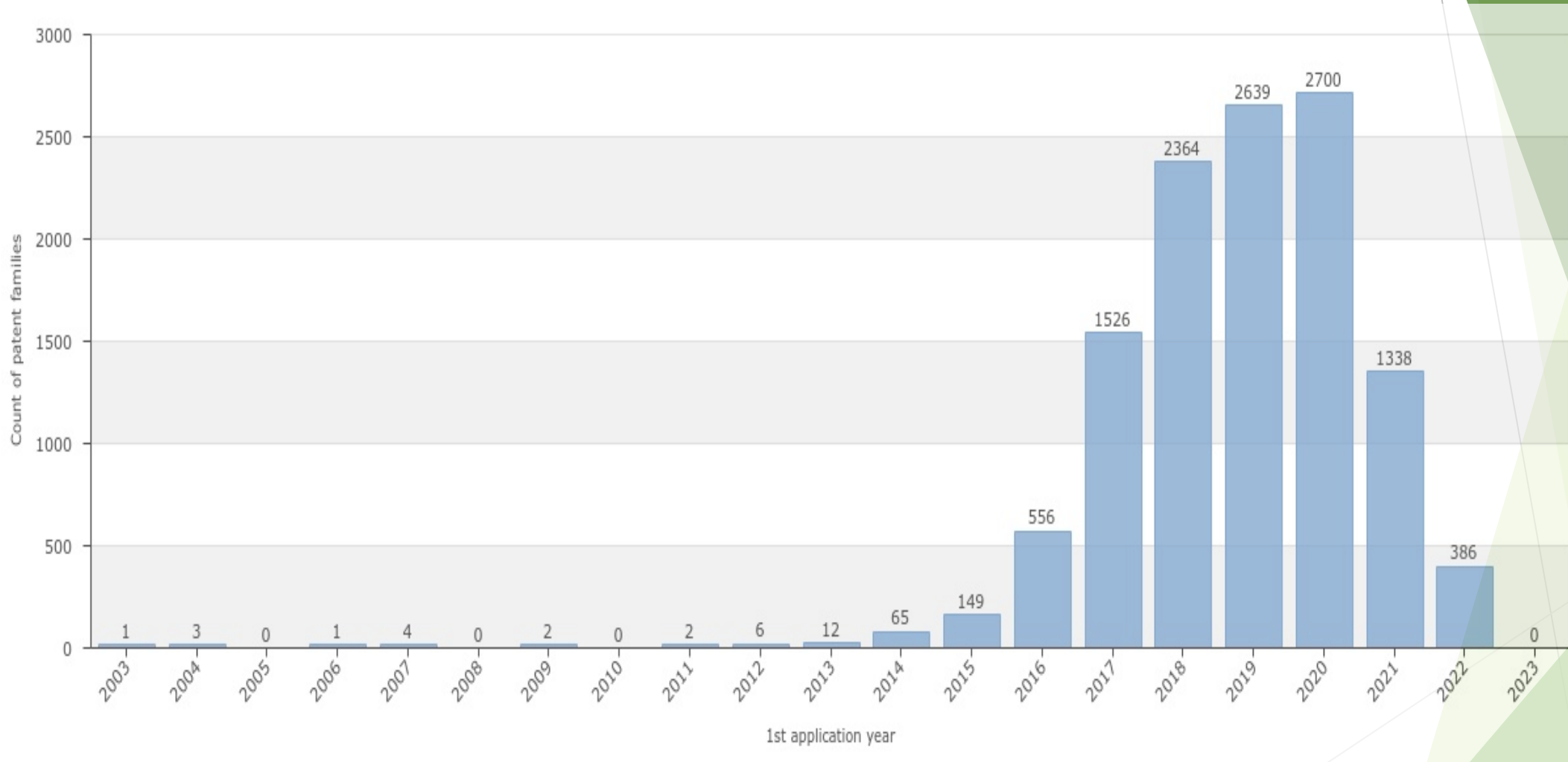
Global Distribution of Patent Families by Key Technological Domains (5G)



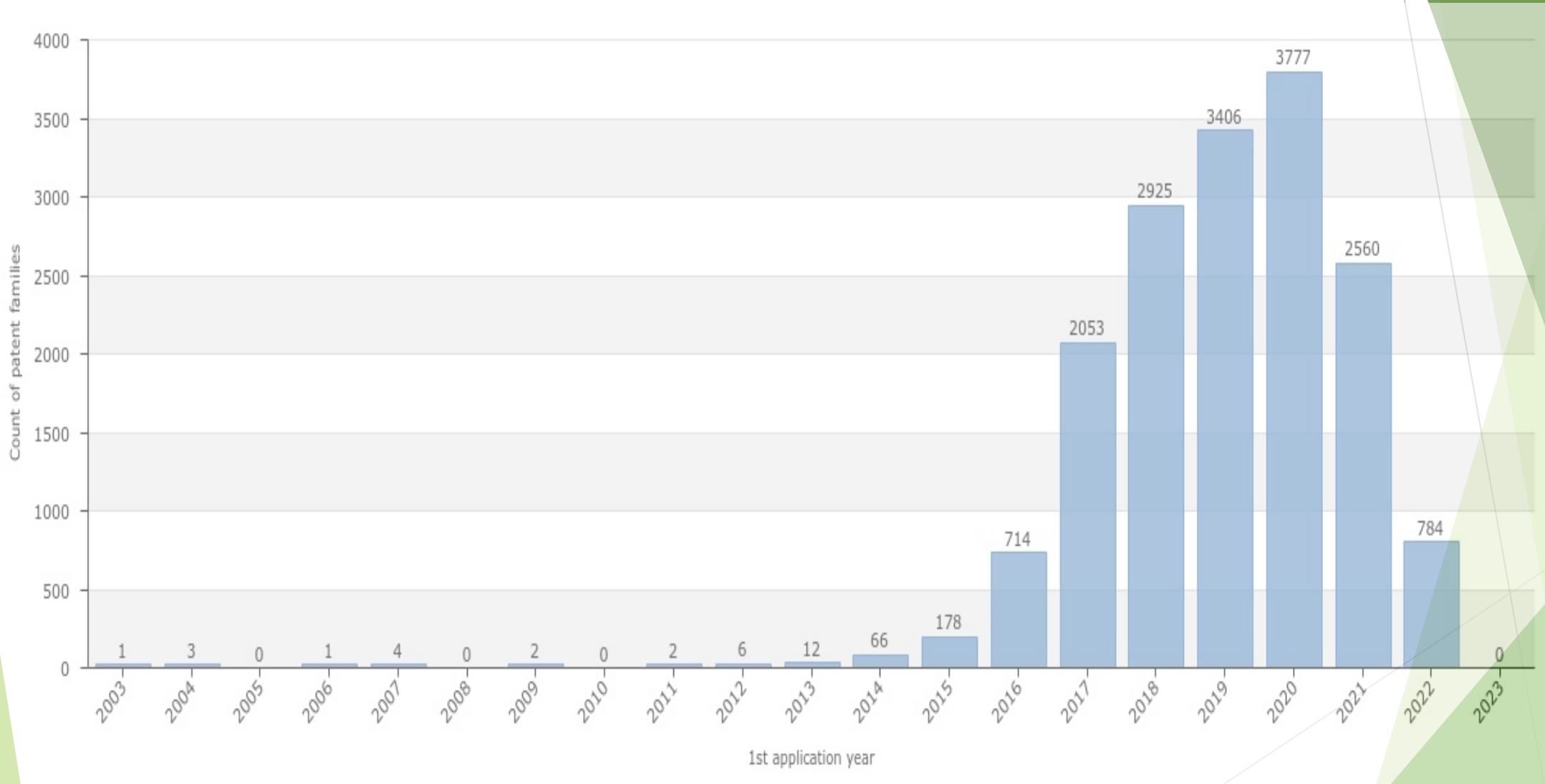
- The chart shows globally, 29% patent families come under Next Generation Radio Access Network (NG-RAN), 16% xHaul network, 8% NFV & Cloud computing, 20% Core network, 09% Flexible components for network management and 18% under Network Services and Digital platforms.

Standard Essential Patents (SEPs) 5G

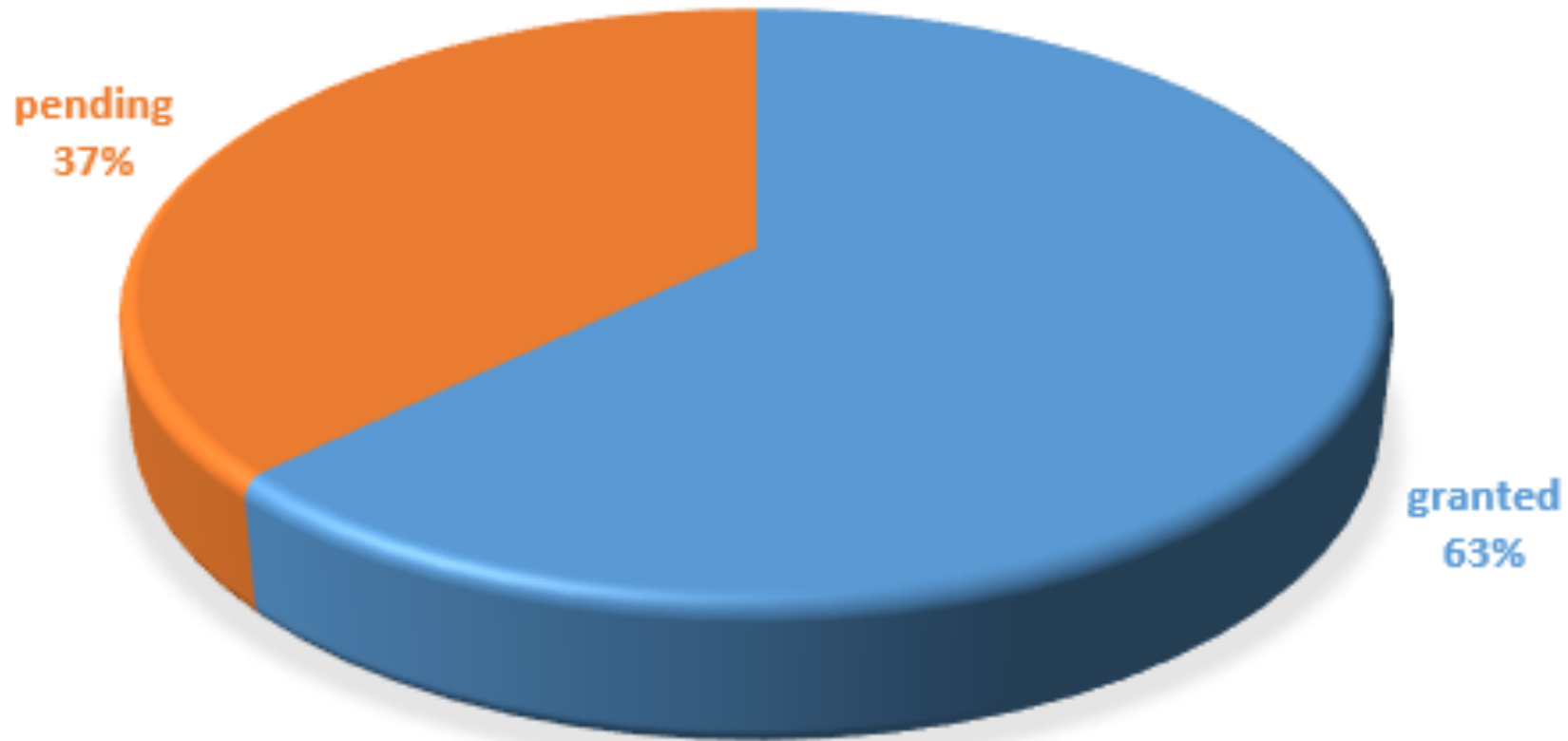
US Standard Essential Patents (SEPs) Filing Trends (5G)



Global Standard Essential Patents (SEPs) Filing Trends (5G)

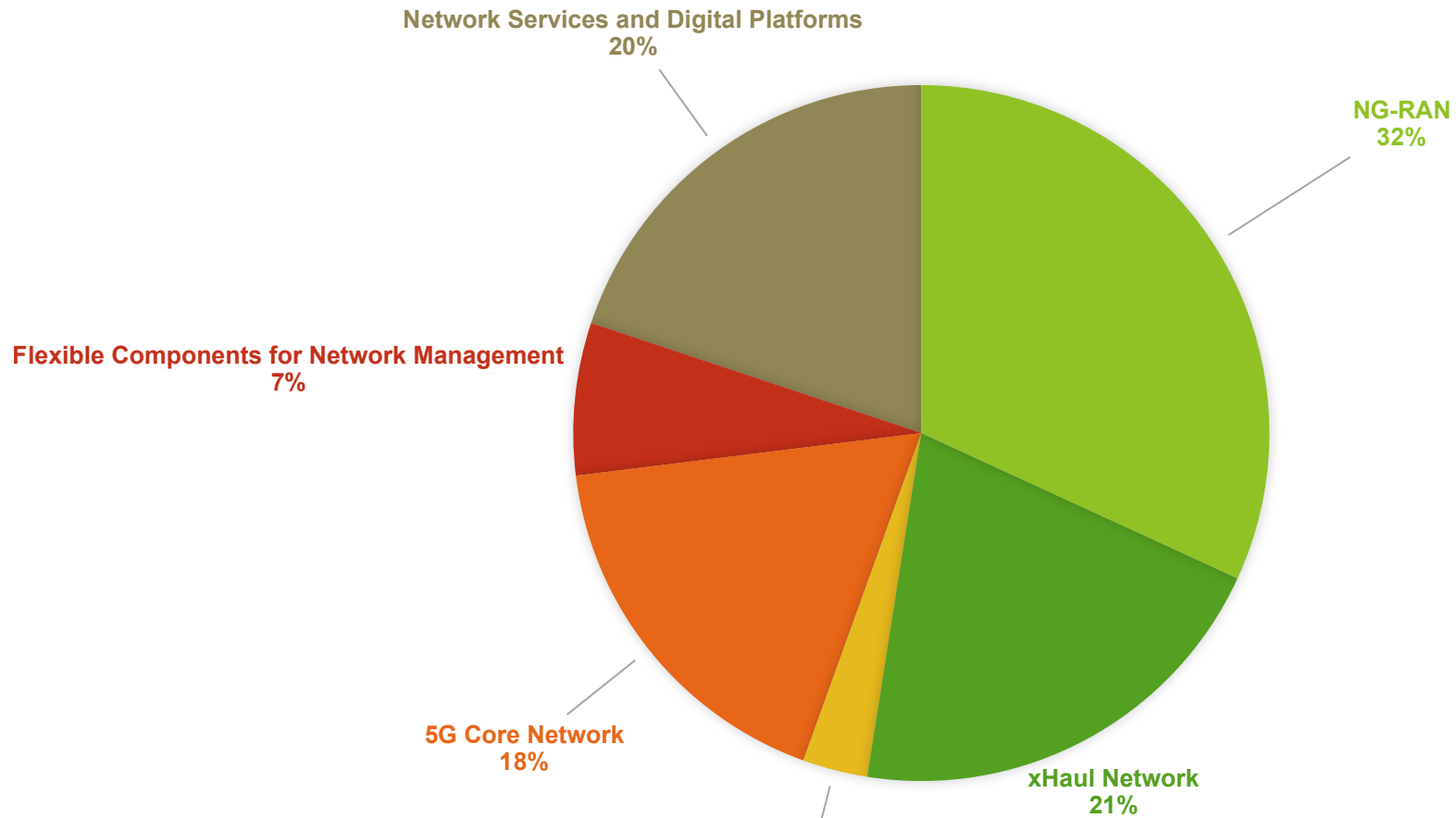


US SEPs Legal Status (5G)



- ❑ The chart shows **Legal status of US Standard Essential Patents** for 5G key technological domains.
- ❑ **63%** of total US Standard Essential Patents are granted, **0.82%** are lapsed and **37%** are pending.

US Distribution of SEPs by Key Technological Domains (5G)



- The chart shows in US, 32% SEP families come under Next Generation Radio Access Network (NG-RAN), 21% xHaul network, 03% NFV & Cloud computing, 17% Core network, 07% Flexible components for network management and 20% under Network Services and Digital platforms.

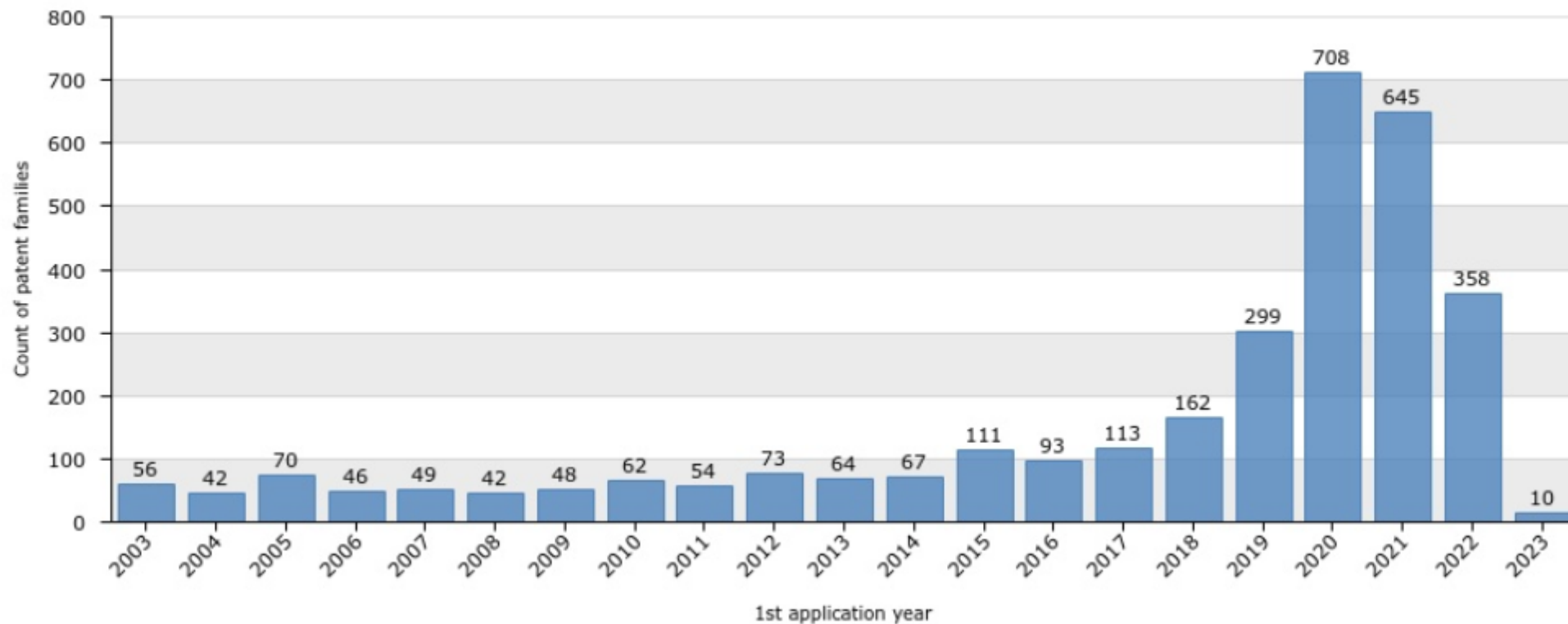
6G network: Key Technological Domains

Introduction

- ❑ **6G frequency bands** (terahertz & sub-terahertz band): provides ultra fast transmission speed and large capacity to the network.
- ❑ **Artificial Intelligence (AI) & Machine Learning (ML)**
- ❑ **Blockchain & Distributed Ledger technology**: proved cyber security and data encryption.
- ❑ **Quantum Communication**: provides ultra security and resilience.
- ❑ **Reconfigurable intelligent surfaces (RISs)**: provide enhanced capacity and coverage of wireless networks by smartly reconfiguring the wireless propagation environment.
- ❑ **Energy Harvesting**: work towards providing the ultra low power consumption devices.
- ❑ **Visible Light Communication (VLC)**: provides a high performance, highly flexible communication network which can be used in stringent 6G conditions.
- ❑ **Non-terrestrial networks (NTN)**: work towards the global wireless coverage.
- ❑ **Orbital angular momentum (OAM)**: work towards potentially increasing the system capacity with lesser hardware complexity.
- ❑ **General 6G communication**

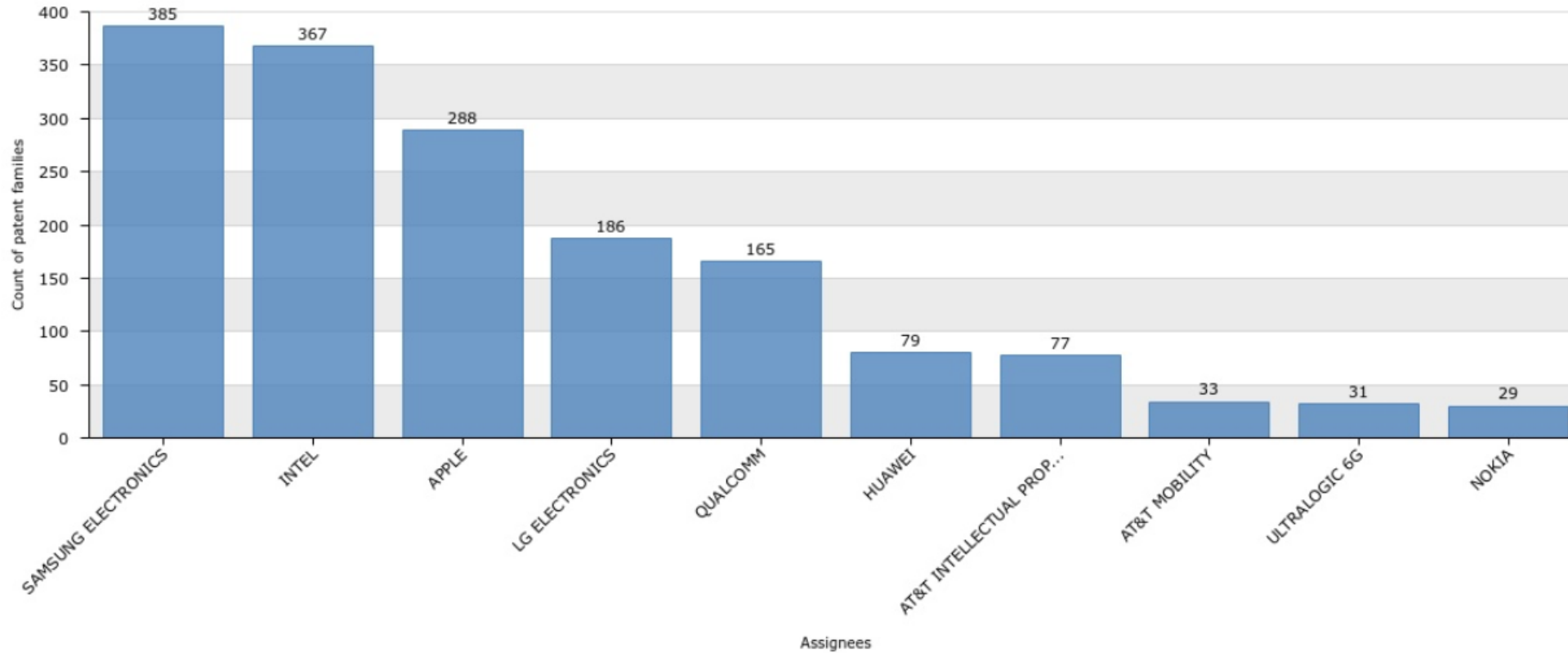
US Patent Filing Trends (6G)

1st application year



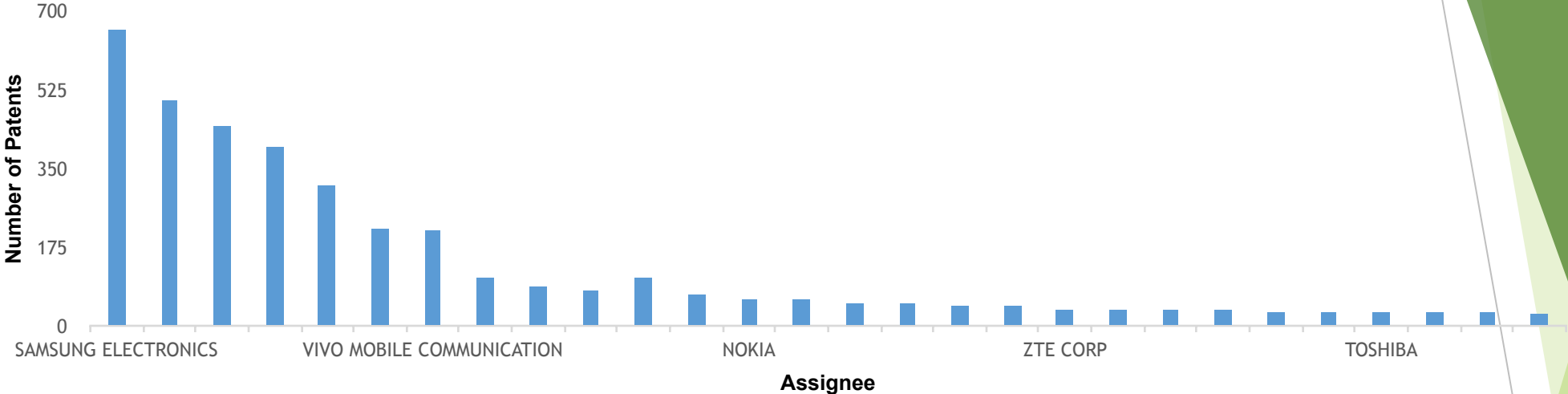
US Patent Families : Top 10 Assignees (6G)

Patent families by Assignees



- ❑ The chart shows the number of records by the Country of the Applicant/Assignee.
- ❑ It is evident that **Samsung Electronics** has the maximum number of patent families (**385**) followed by the **Intel (367)** and **Apple (28)**.
- ❑ **AT & T Mobility**, **Ultra logic 6G** show patent holding with each having a patent count of **33** and **31** respectively.

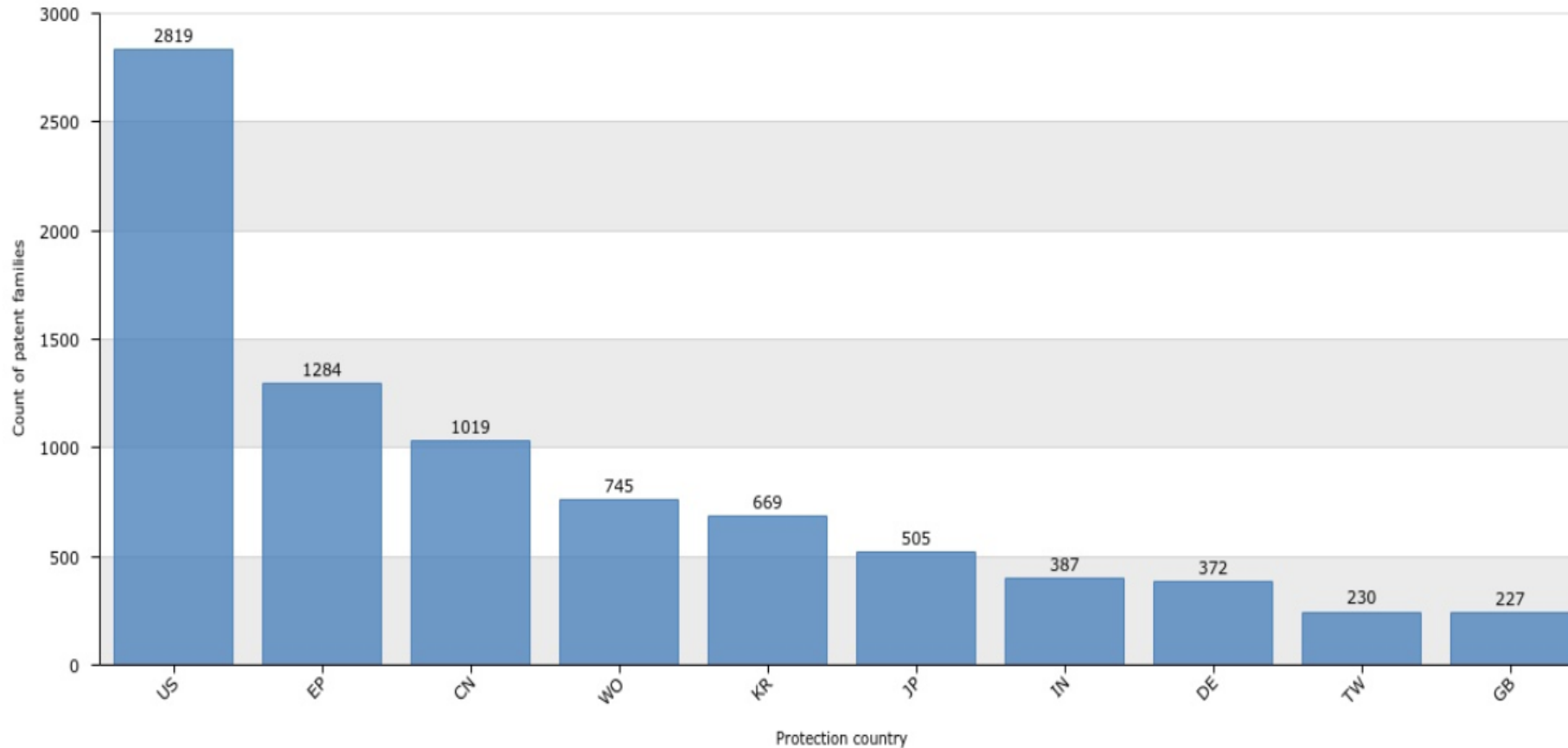
Global Patent Families: Assignees (6G)



It is evident that Samsung Electronics has the maximum number of patent families (662)

US Patent Families :Top 10 Patent Filing Countries (6G)

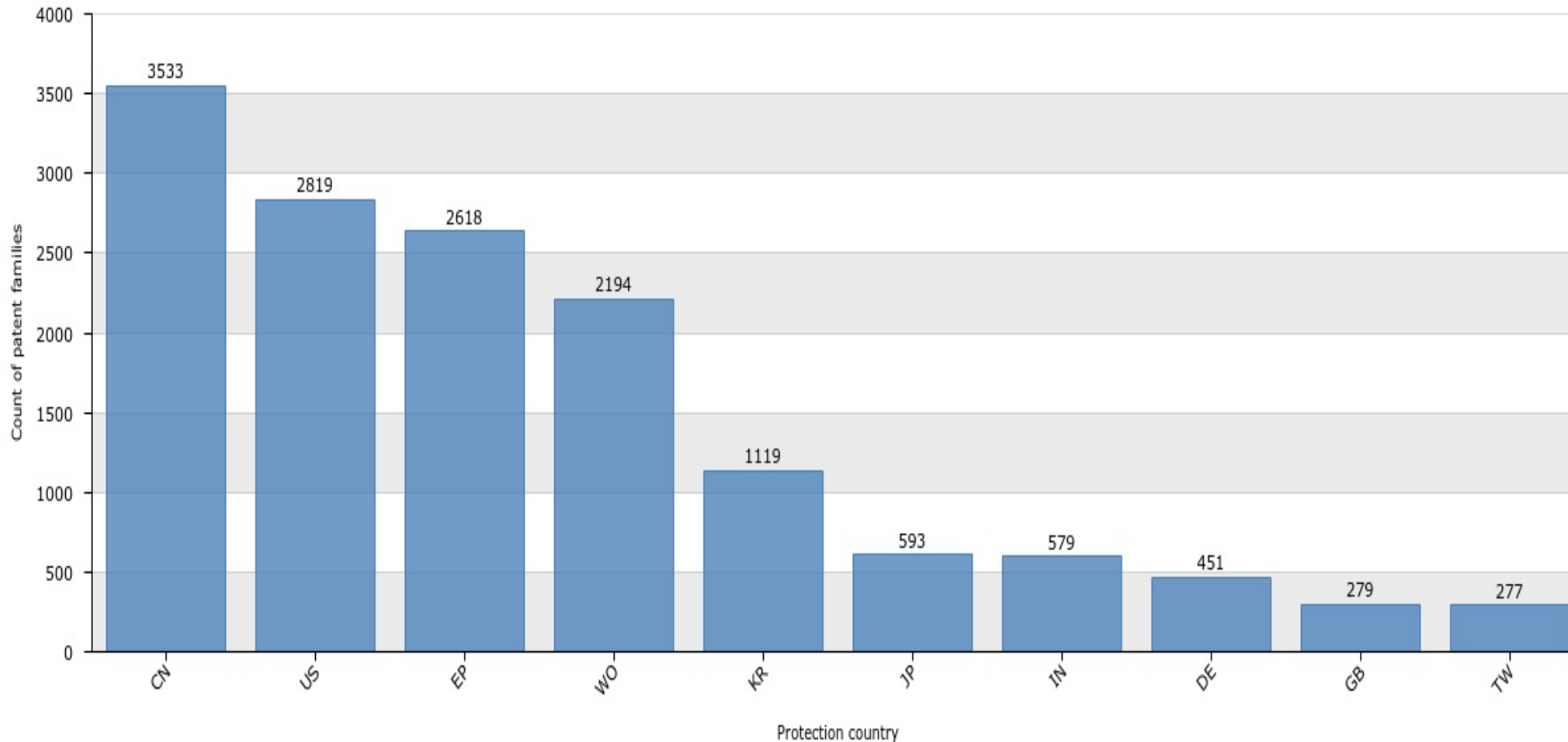
Patent families by Protection country



- ❑ The chart shows the filing trends in the technology space for top 10 countries (US, EP, CN WO, KR, JP, IN, DE, TW, GB) contributing in this domain.
- ❑ US tops the list with filing of 2819 patent families, followed by EP (1284 patent families) and then by CN 1019 patent families).

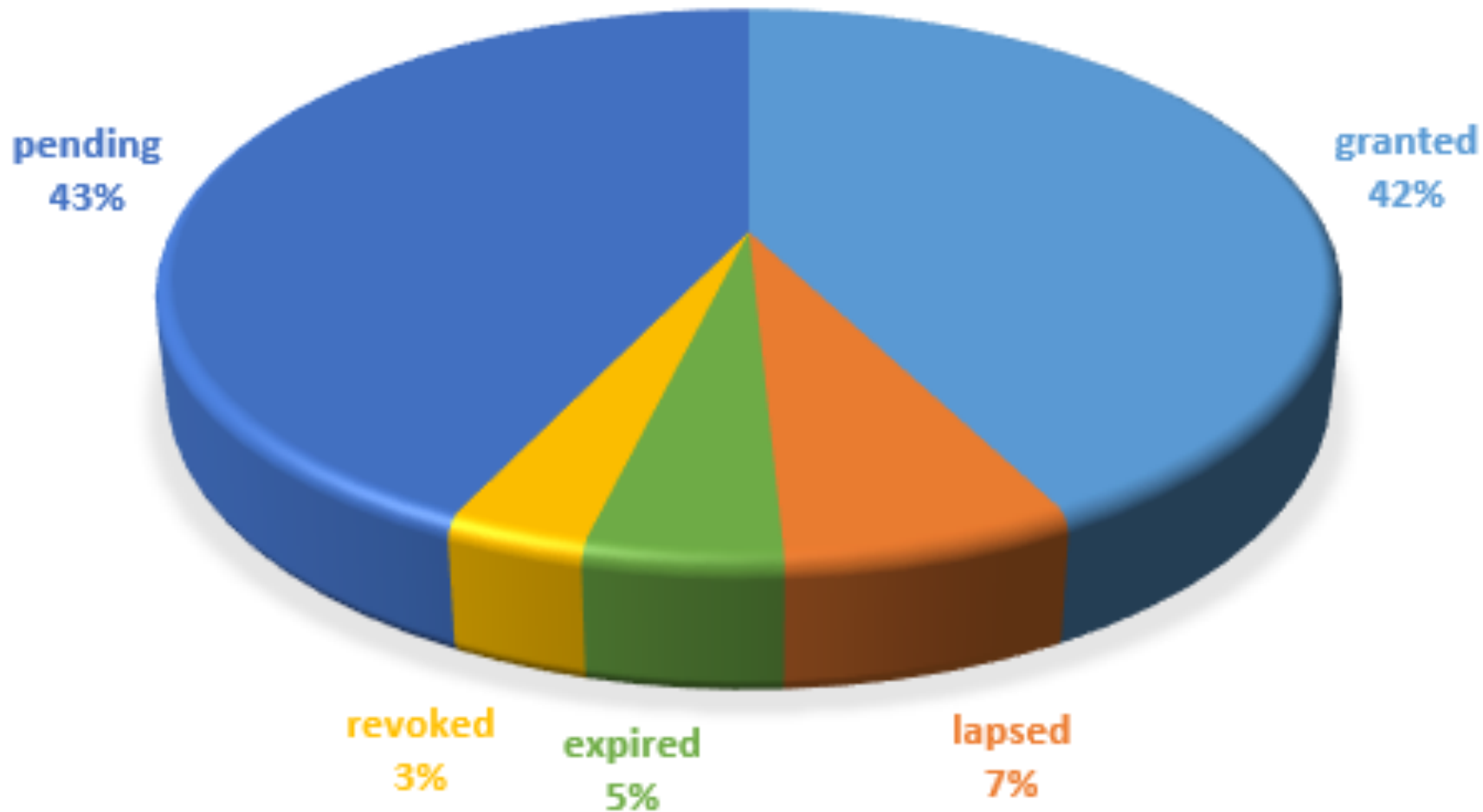
Global Patent Families: Top 10 Patent Filing Countries (6G)

Patent families by Protection country



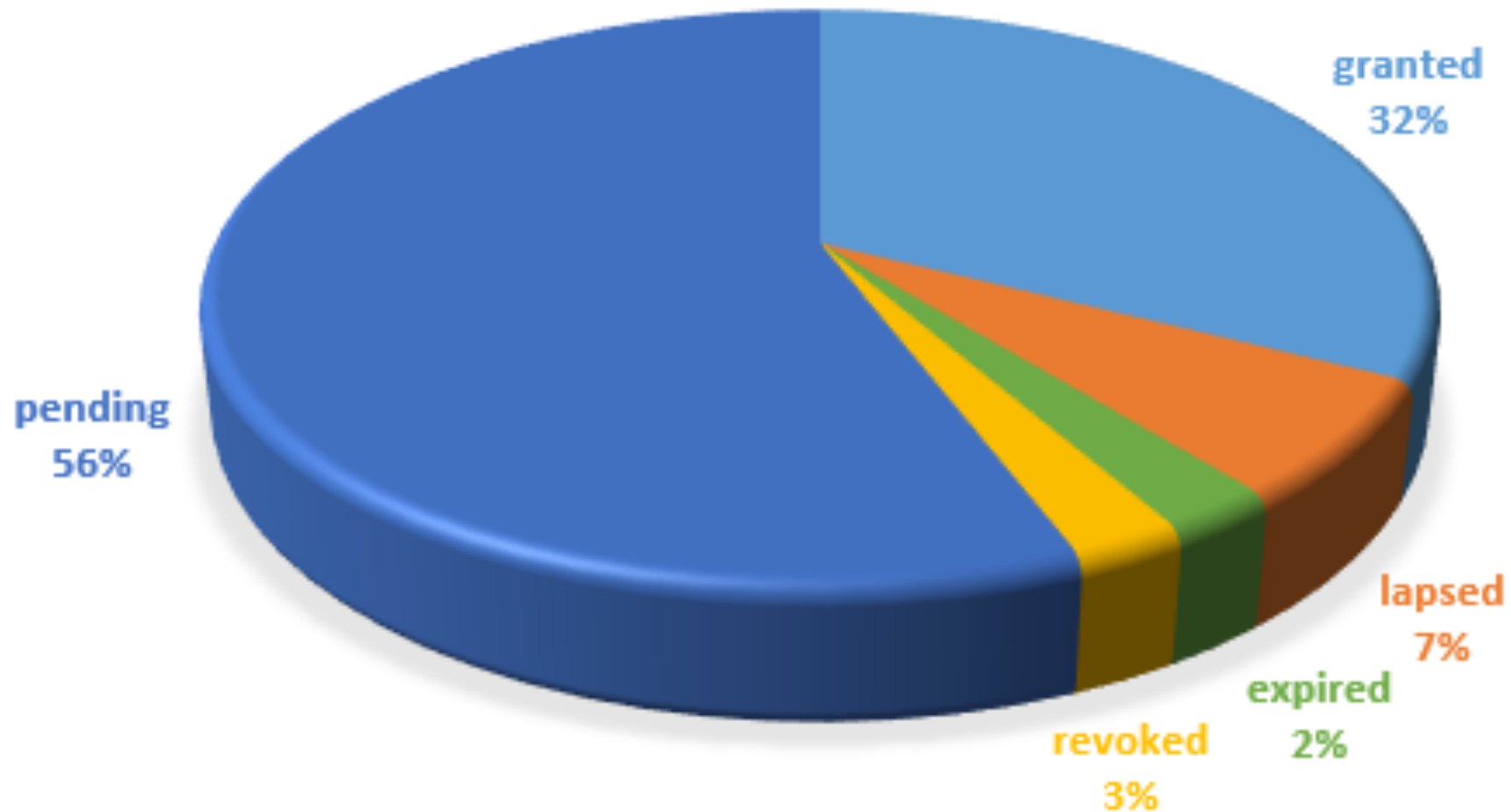
- ❑ The chart shows the filing trends in the technology space for top 10 countries (CN, US, EP, WO, KR, JP, IN, DE, GB, TW) contributing in this domain.
- ❑ **China tops the list with filing of 3533 patent families, followed by US (2819 patent families) and then by EP 2618 patent families).**

Legal Status: US Patent Documents (6G)



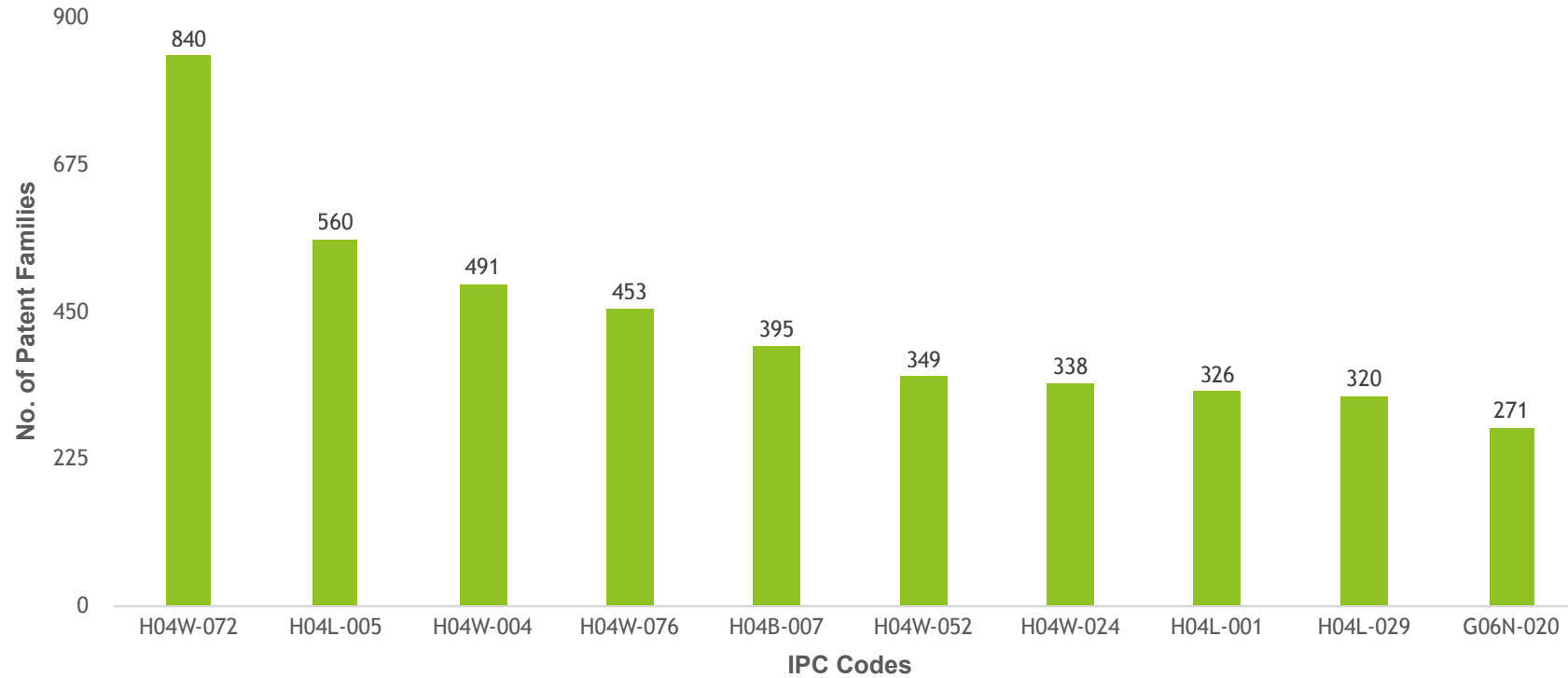
- ❑ The chart shows **Legal status** of US patent documents for 6G key technological domains.
- ❑ 42% of total US patent documents are **granted**, 7% are **lapsed** and 43% are **pending**.

Legal Status: Global Patent Documents (6G)



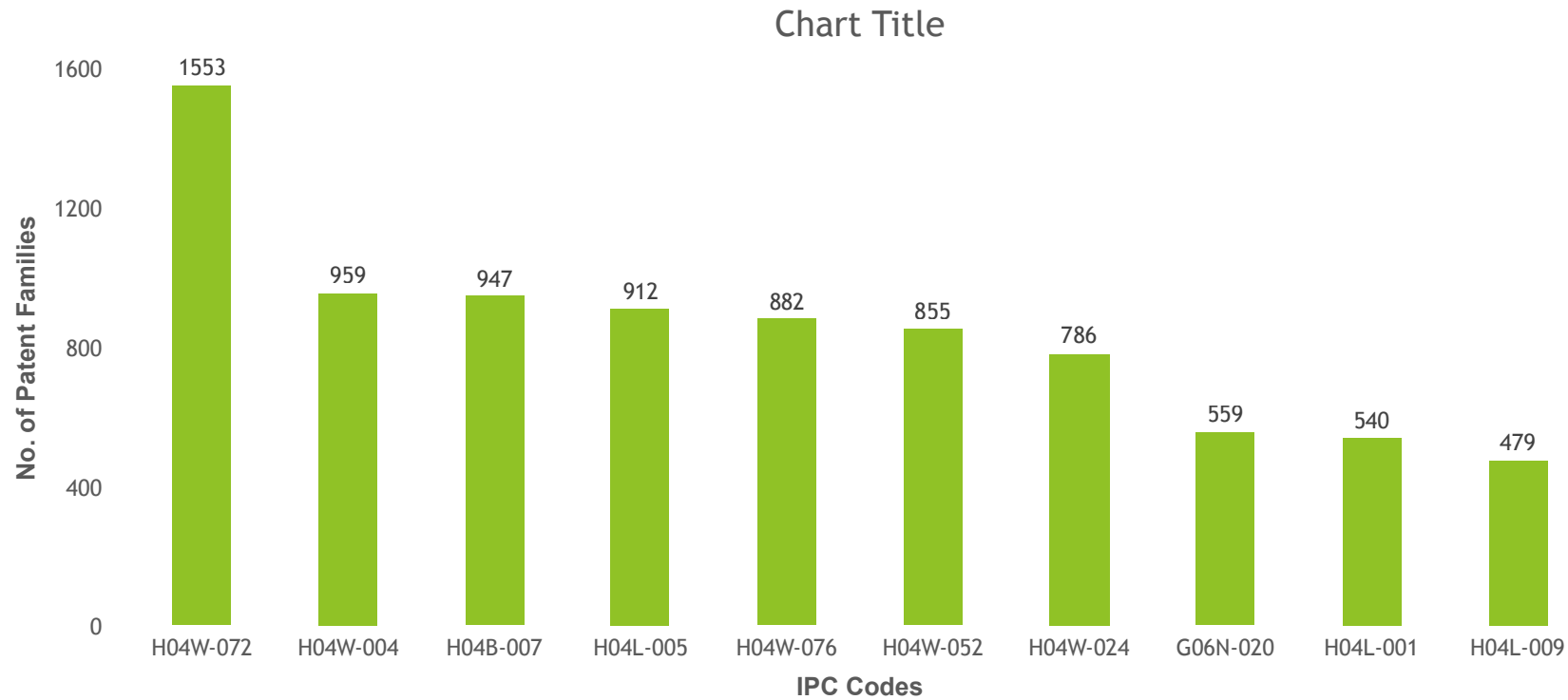
- ❑ The chart shows **Legal status** of **global patent documents** for 6G key technological domains.
- ❑ **32%** of total global patent documents are **granted**, **7%** are **lapsed** and **56%** are **pending**.

US Patent families : Main IPC Classes (6G)



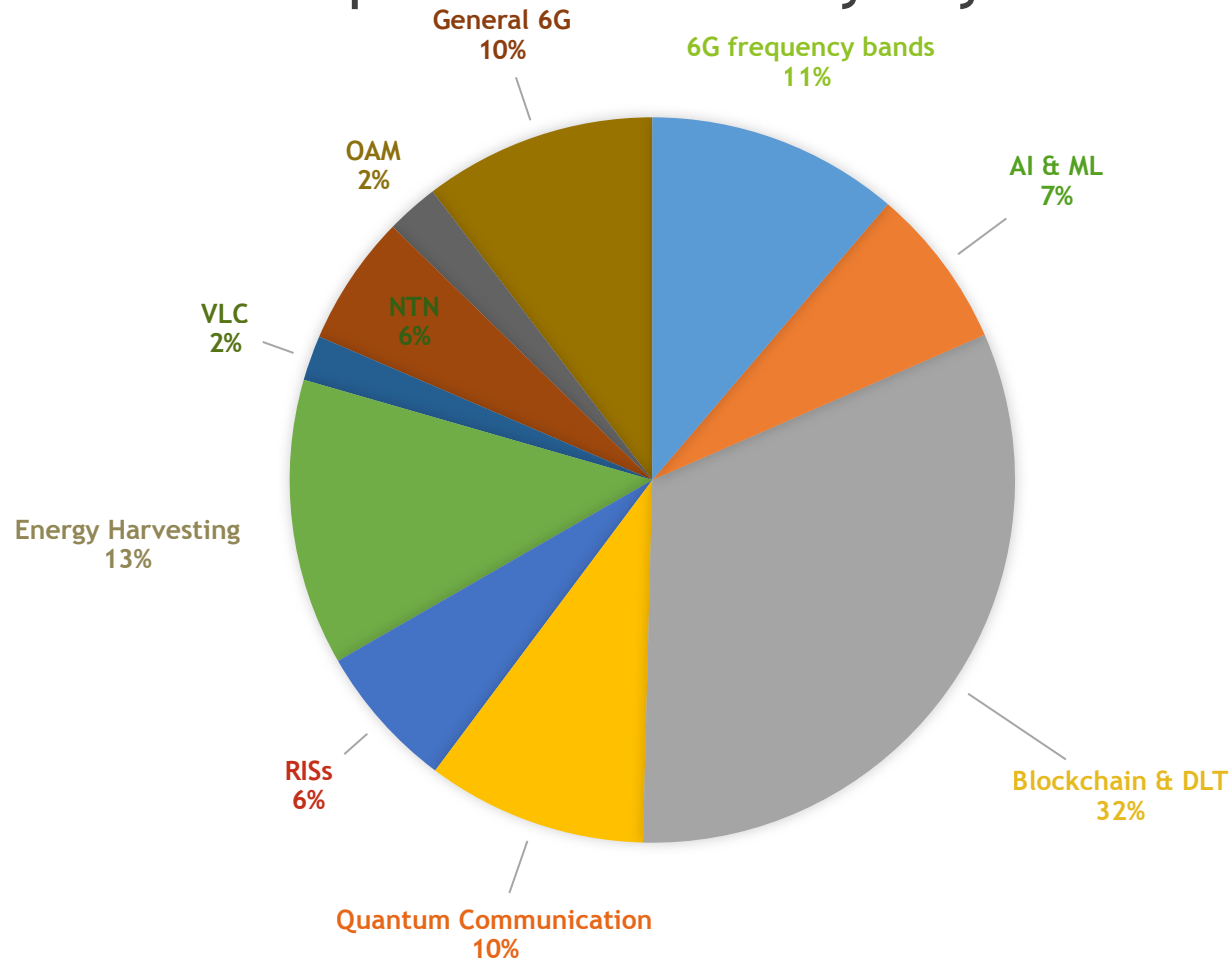
- ❑ **840** of patent families from 6G technology are categorized under **H04W-072** followed by **H04L-005** with **560** and **H04W-004** with **491**
- ❑ Definition of IPC classes:
- ❑ **H04W72/00**: Local resource management
- ❑ **H04L5/00**: Arrangements affording multiple use of the transmission path
- ❑ **H04W4/00**: Services specially adapted for wireless communication networks; Facilities therefor

Global Patent families: Main IPC Classes (6G)



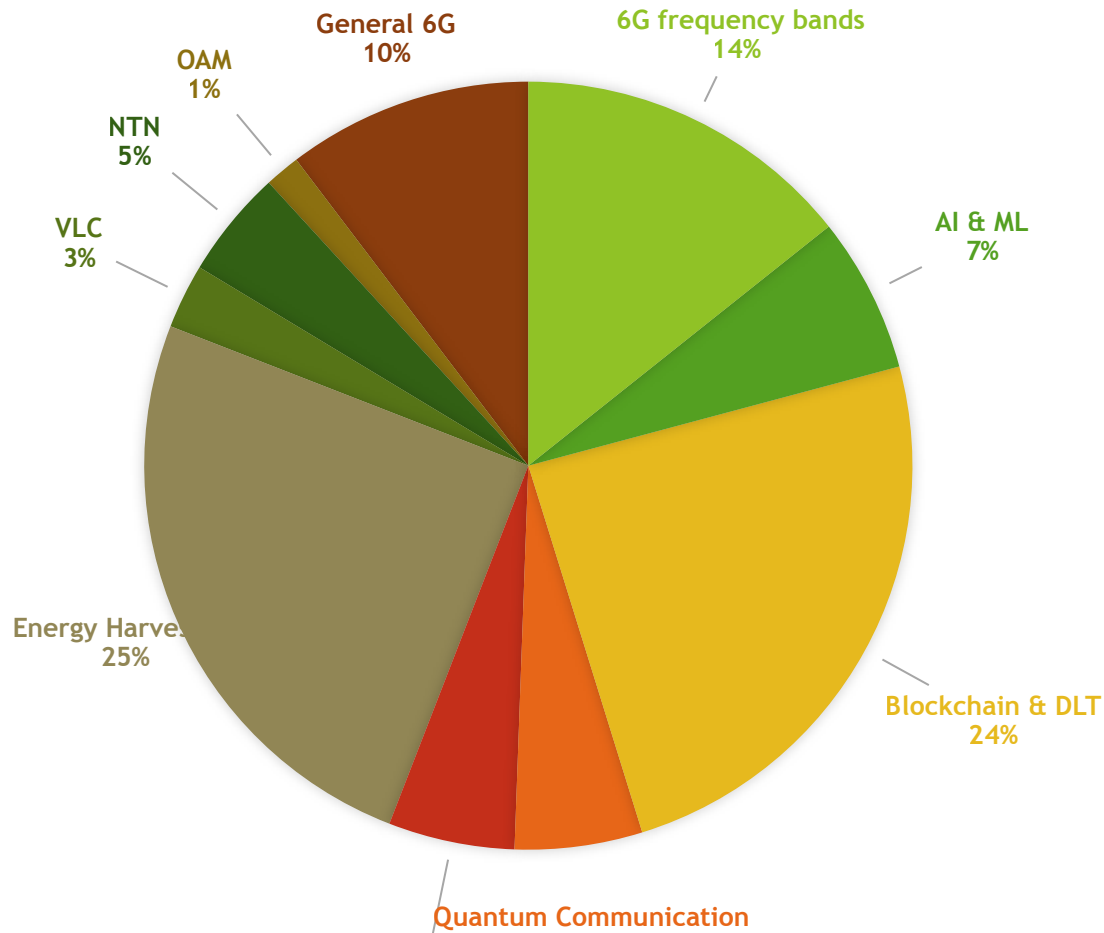
- ❑ 1553 of patent families from 6G technology are categorized under H04W-072 followed by H04W-004 with 959 and H04B-007 with 947
- ❑ Definition of IPC classes:
- ❑ H04W72/00: Local resource management
- ❑ H04W4/00: Services specially adapted for wireless communication networks; Facilities therefor
- ❑ H04B7/00: Radio transmission systems, i.e. using radiation field

US Distribution of patent families by key technological domains (6G)



- ❑ The chart shows in US, (32%) patent families come under **Blockchain** which is highest among all, (13%) patent families under **Energy Harvesting**,
- ❑ (11%) patent families under **6G frequency bands**, (10%) patent families **Quantum Communication** and **general 6G** each for transmitting the signal.
- ❑ (07%) patent families under **AI & ML** and **RISs** each, (06%) patent families use **NTN**.
- ❑ (02%) patent families use **VLC** and **OAM** which is the least patent families among all.

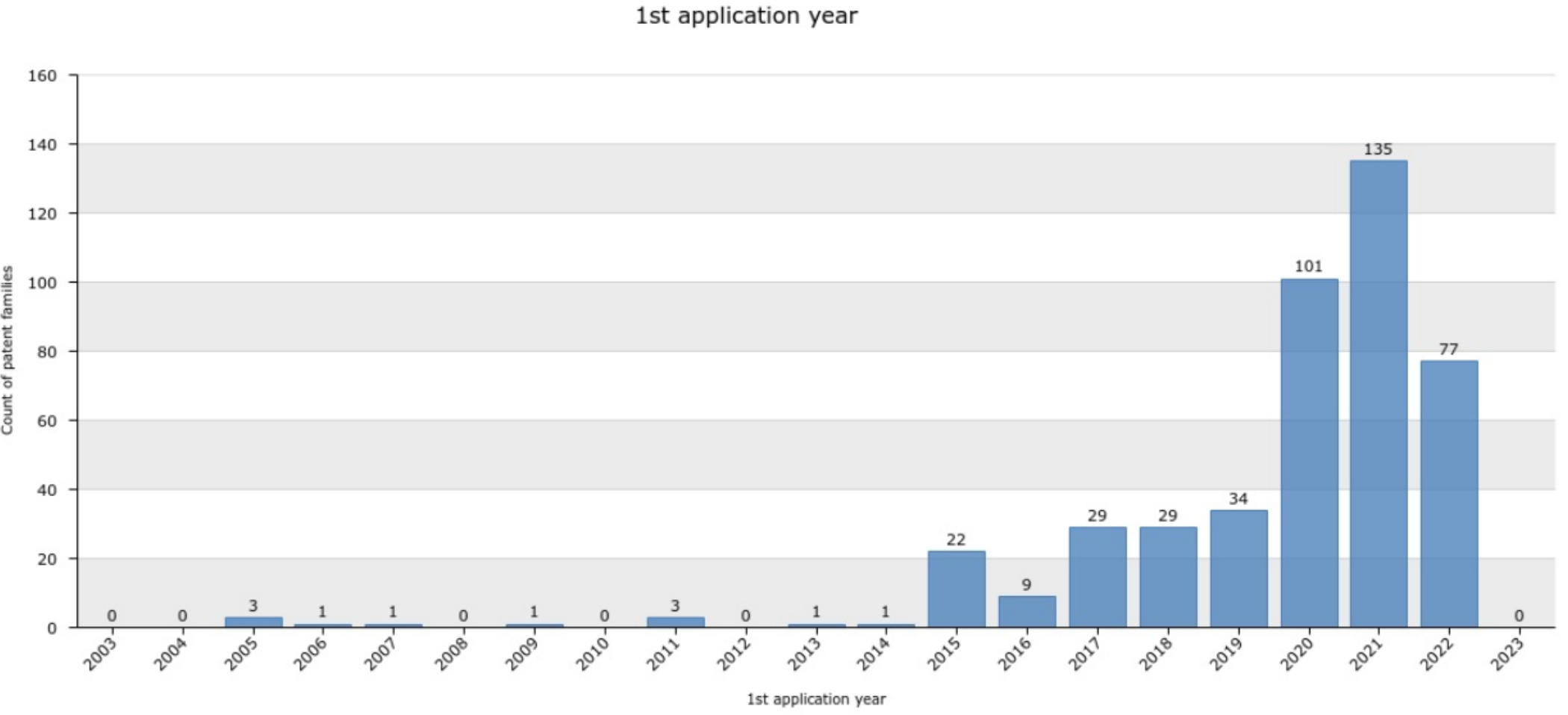
Global Distribution of patent families by key technological domains (6G)



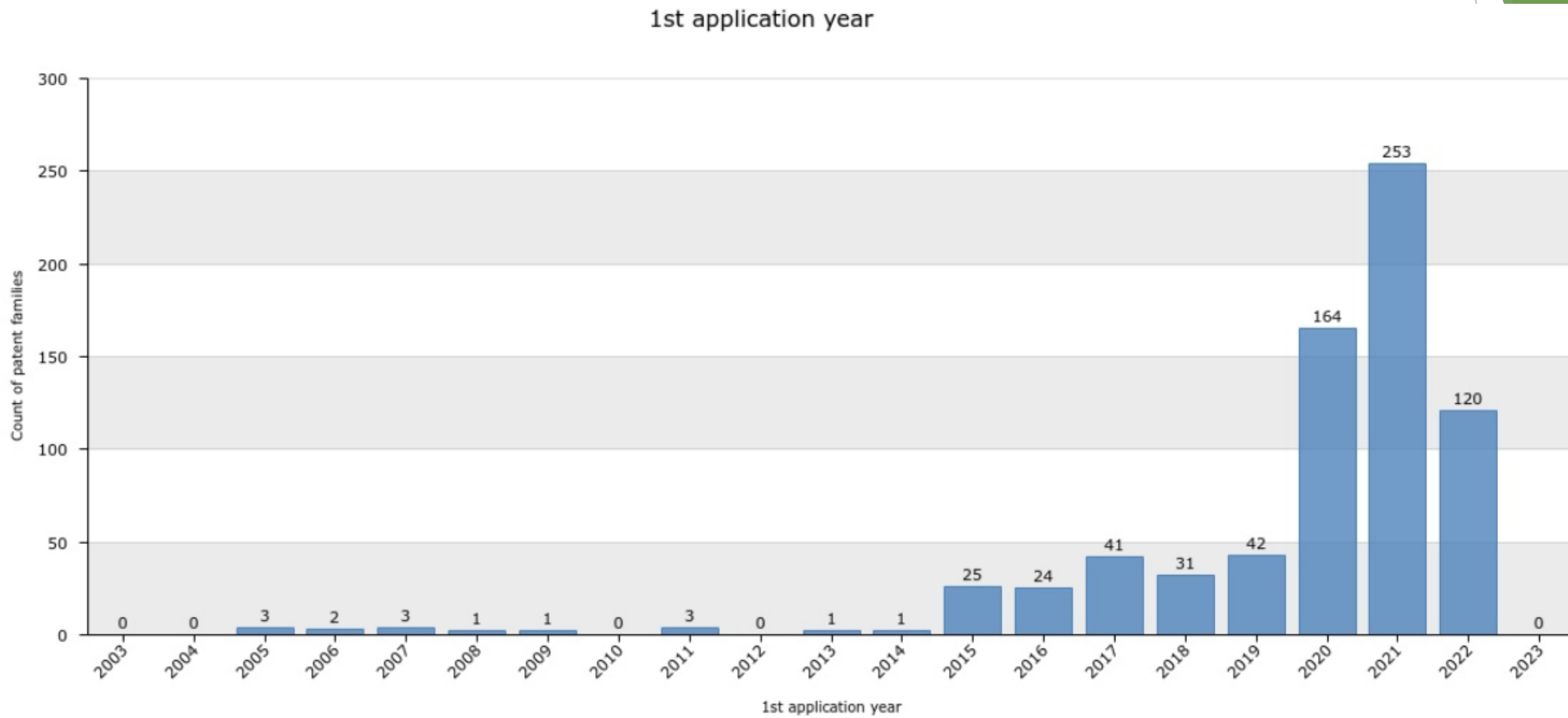
- ❑ The chart shows globally, (25%) patent families come under Energy Harvesting which is highest among all, (24%) families under Blockchain.
- ❑ Out of which (14%) patent families come under 6G frequency bands and (10%) patent families under general 6G for transmitting the signal.
- ❑ (07%) patent families under AI & ML and (05%) patent families RISs and Quantum Communication each.
- ❑ (5%) patent families under NTN, (03%) patent families VLC and (02%) patent families under OAM which is the least patent families among all.

Standard Essential Patents (SEPs) 6G

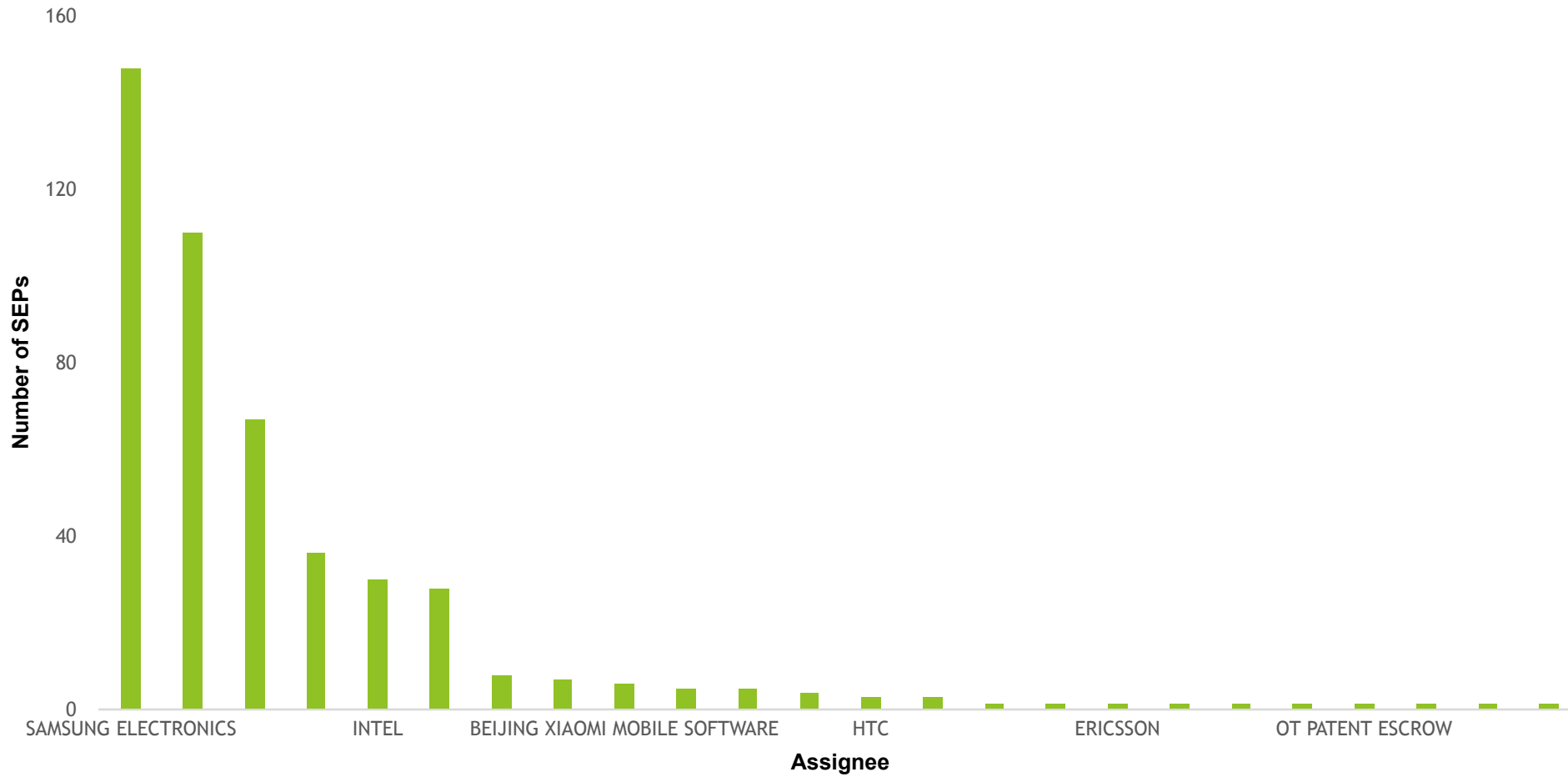
US Standard Essential Patents (SEPs) Filing Trends (6G)



Global Standard Essential Patents (SEPs) Filing Trends (6G)

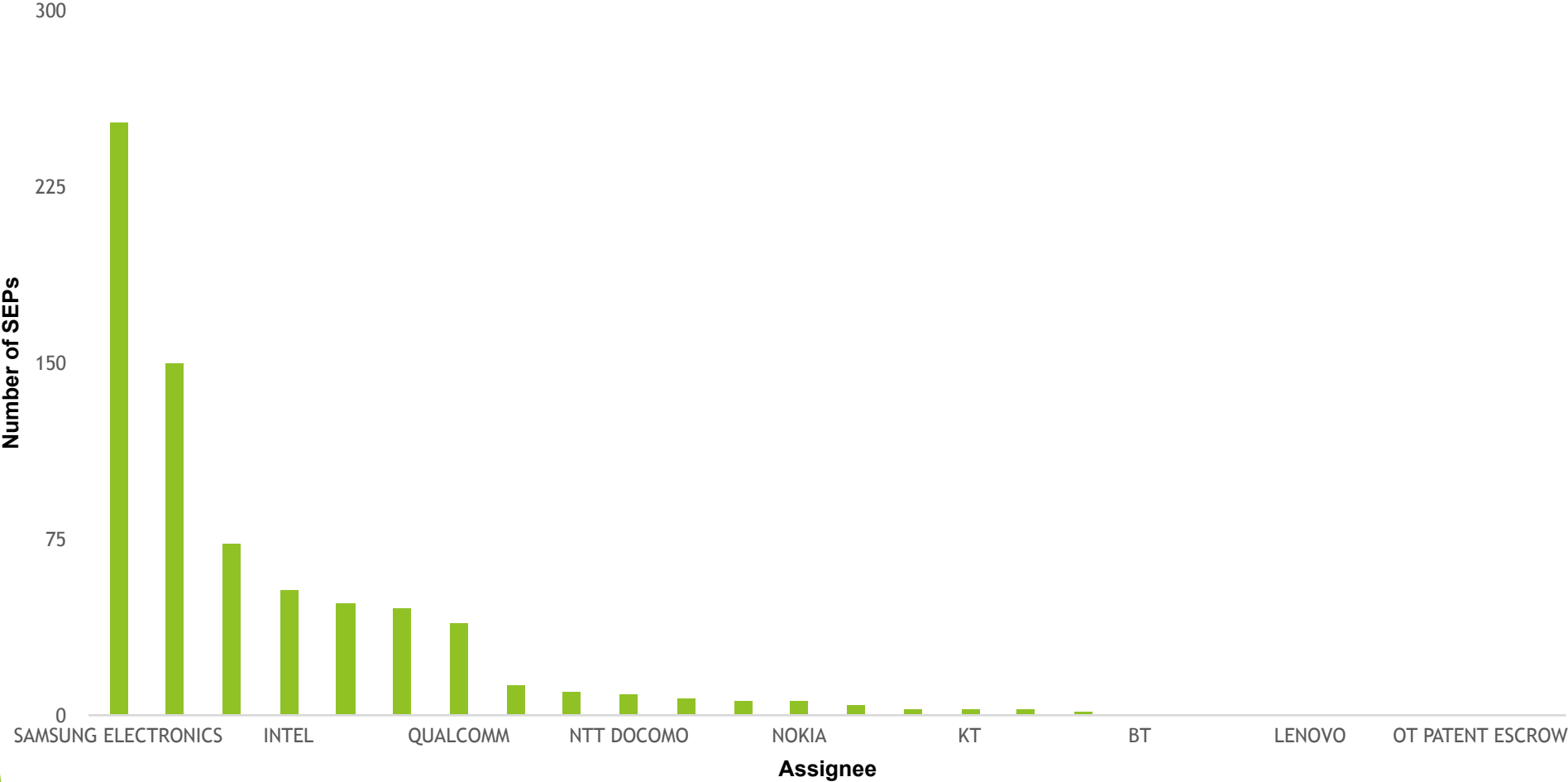


US (SEPs) Families: Assignees (6G)



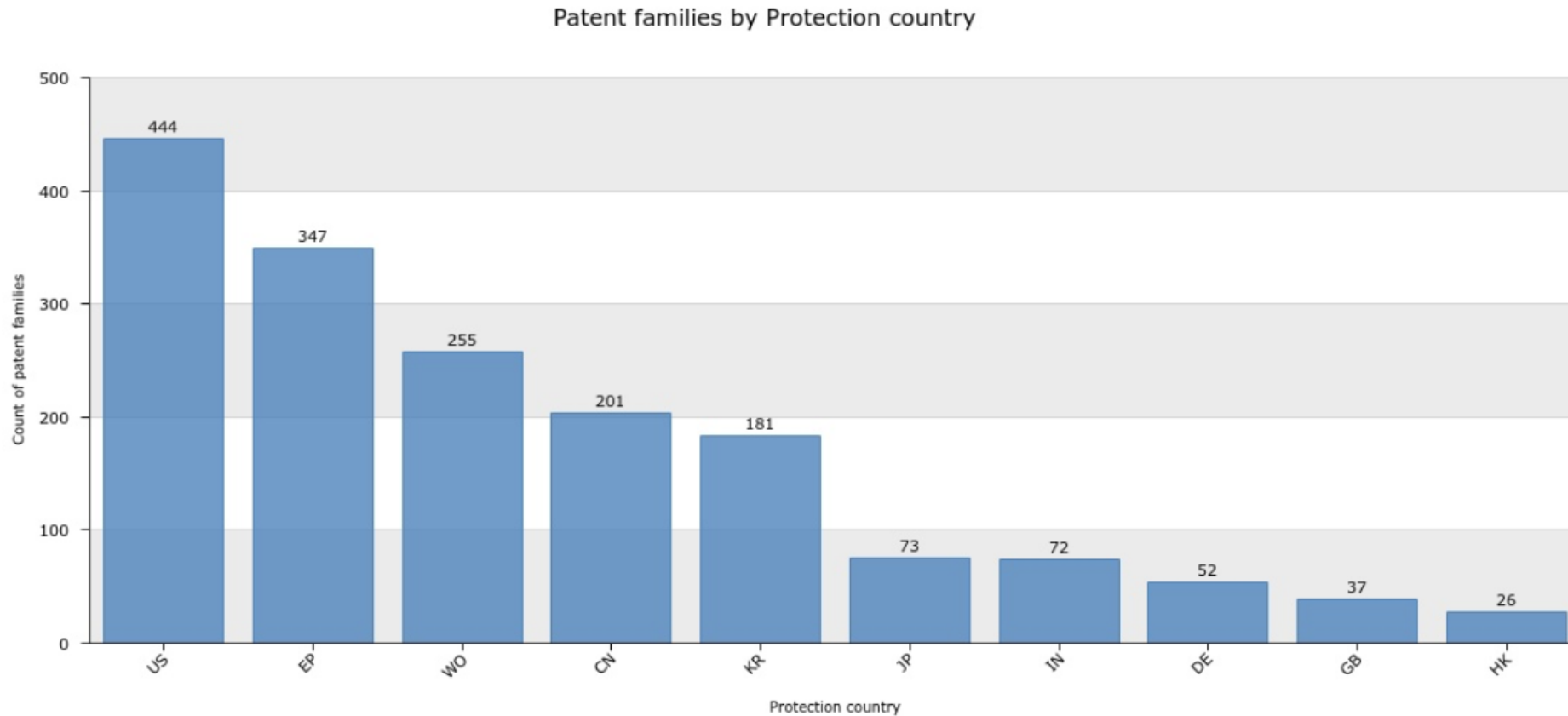
It is evident that **Samsung Electronics** has the maximum number of SEP families (148).

Global (SEPs) Families: Assignees (6G)



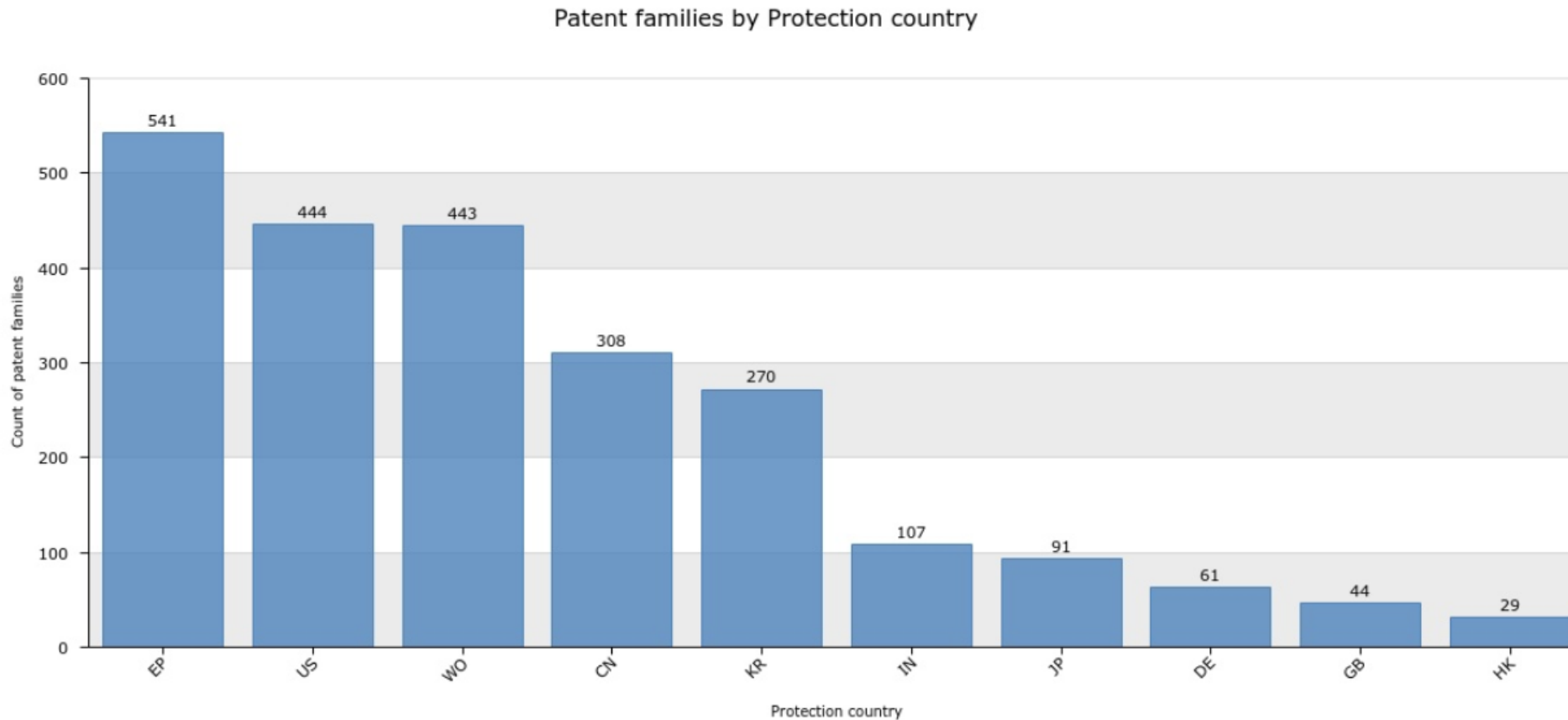
It is evident that Samsung Electronics has the maximum number of SEP families (252)

US (SEPs) Families :Top 10 Patent Filing Countries (6G)



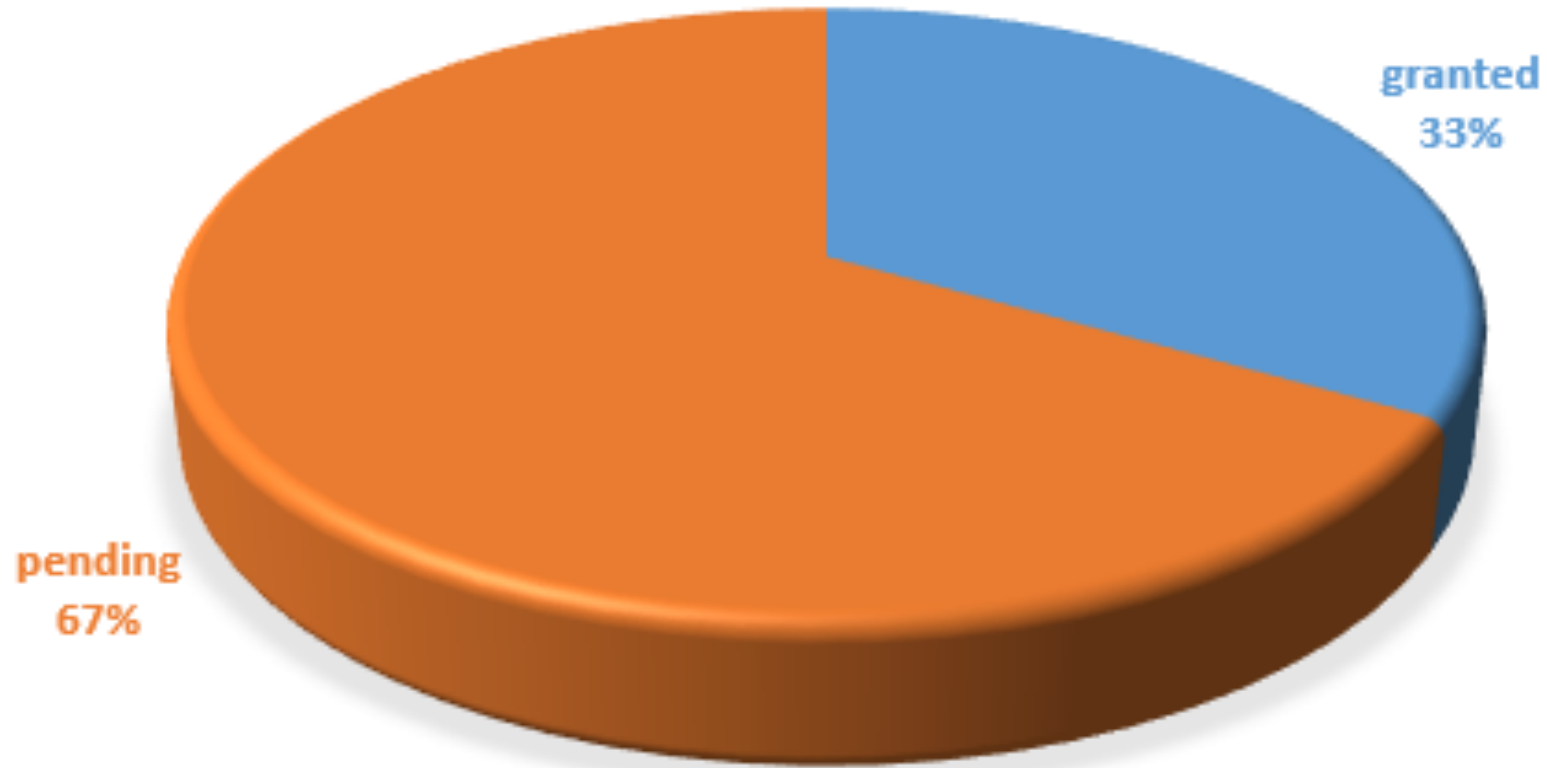
- ❑ The chart shows the **SEP** filing trends in the technology space for **top 10 countries (US, EP, WO, CN, KR, JP, IN, DE, GB, HK)** contributing in this domain.
- ❑ **US** tops the list with filing of **444 SEP** families, followed by **EP (347)** and then by **WO (255)**.

Global (SEPs) Families: Top 10 Patent Filing Countries (6G)



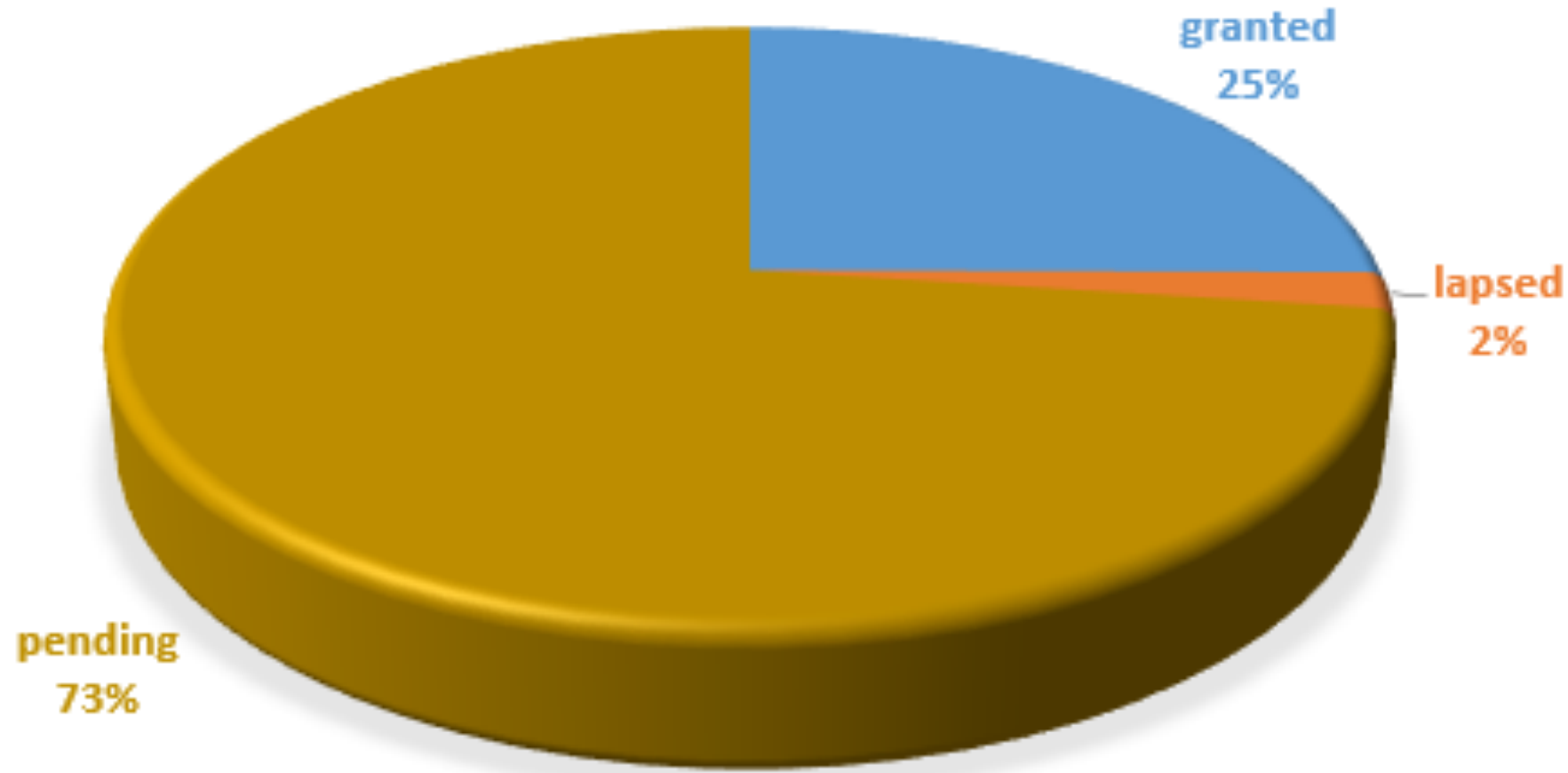
- ❑ The chart shows the SEP filing trends in the technology space for top 10 countries (EP, US, WO, CN, KR, IN, JP, DE, GB, HK) contributing in this domain.
- ❑ EP tops the list with filing of 541 SEP families, followed by US (444) and then by WO (443).

Legal Status: US (SEPs) Documents (6G)



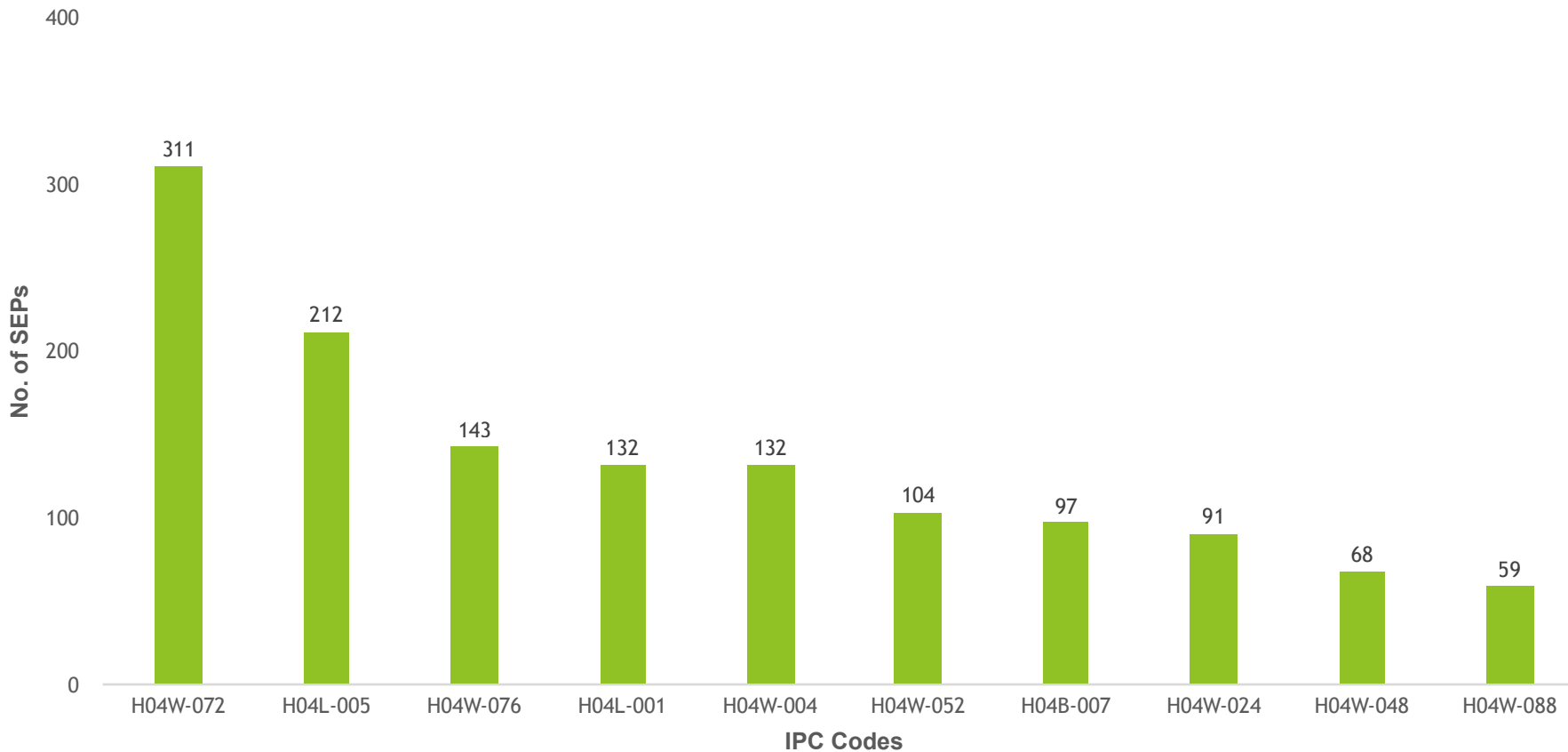
- ❑ The chart shows **Legal status of US SEP documents** for 6G key technological domains.
- ❑ **33.0%** of total US patent documents are **granted** and **67%** are **pending**.

Legal Status: Global (SEPs) Documents (6G)



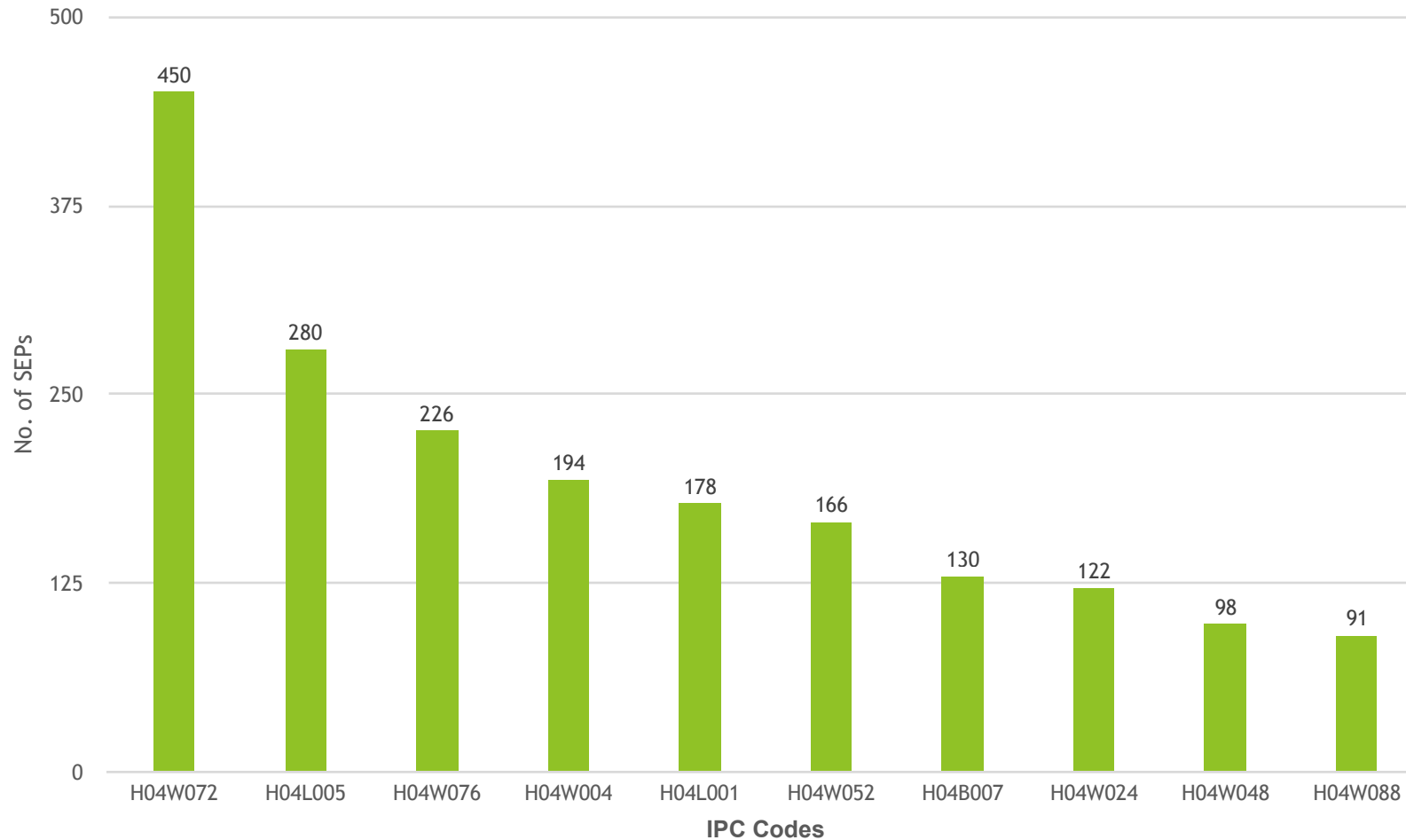
- ❑ The chart shows **Legal status** of **global SEP documents** for 6G key technological domains.
- ❑ **25%** of total global patent documents are **granted**, **2%** are **lapsed** and **73%** are **pending**.

US (SEPs) Families: Main IPC Classes (6G)



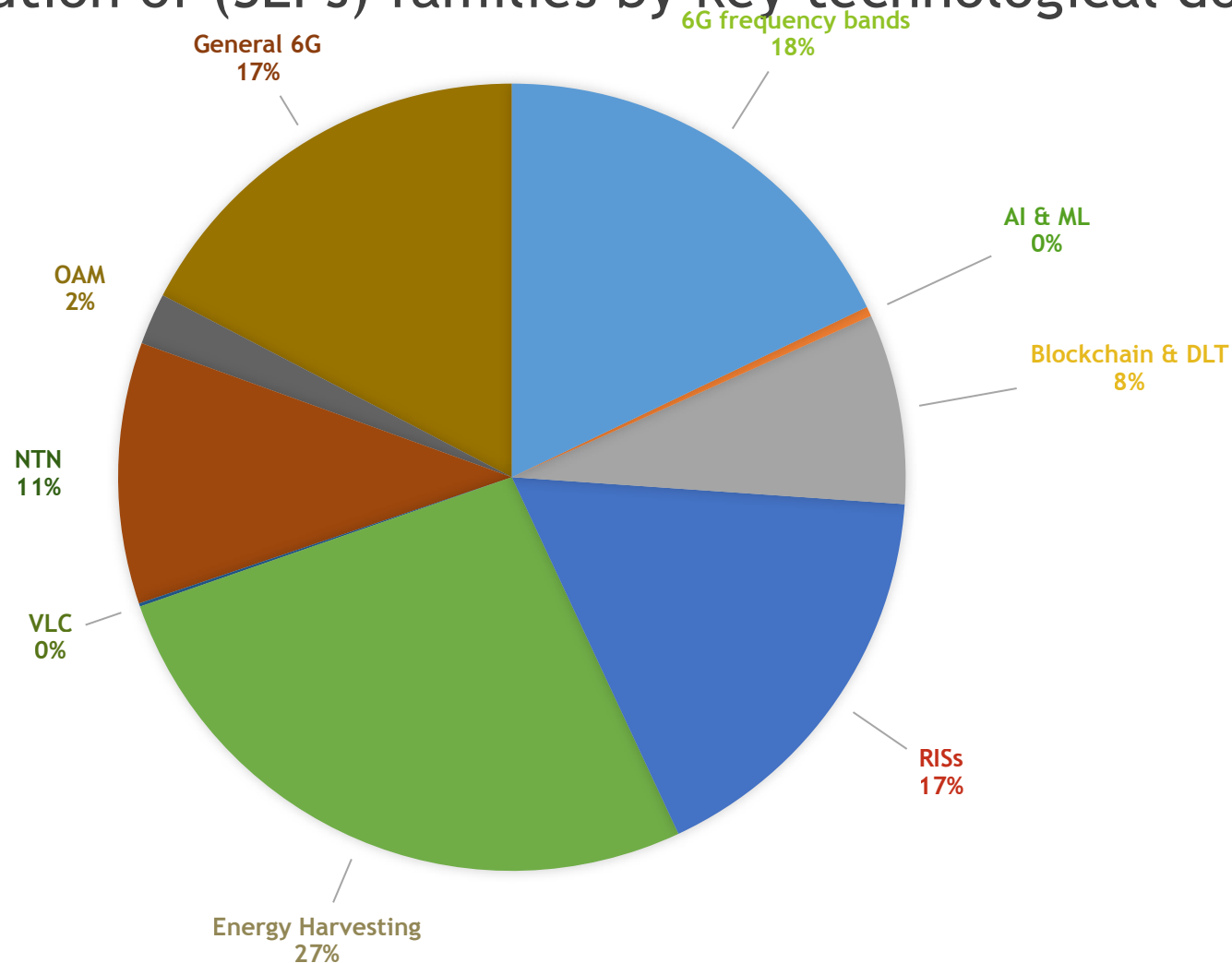
- ❑ **311 of SEP families from 6G technology are categorized under H04W-072 followed by H04L-005 with 212 and H04W-076 with 143.**
- ❑ Definition of IPC classes:
- ❑ **H04W72/00: Local resource management**
- ❑ **H04L5/00: Arrangements affording multiple use of the transmission path**
- ❑ **H04W76/00 : Connection management**

Global (SEPs) families: Main IPC Classes (6G)



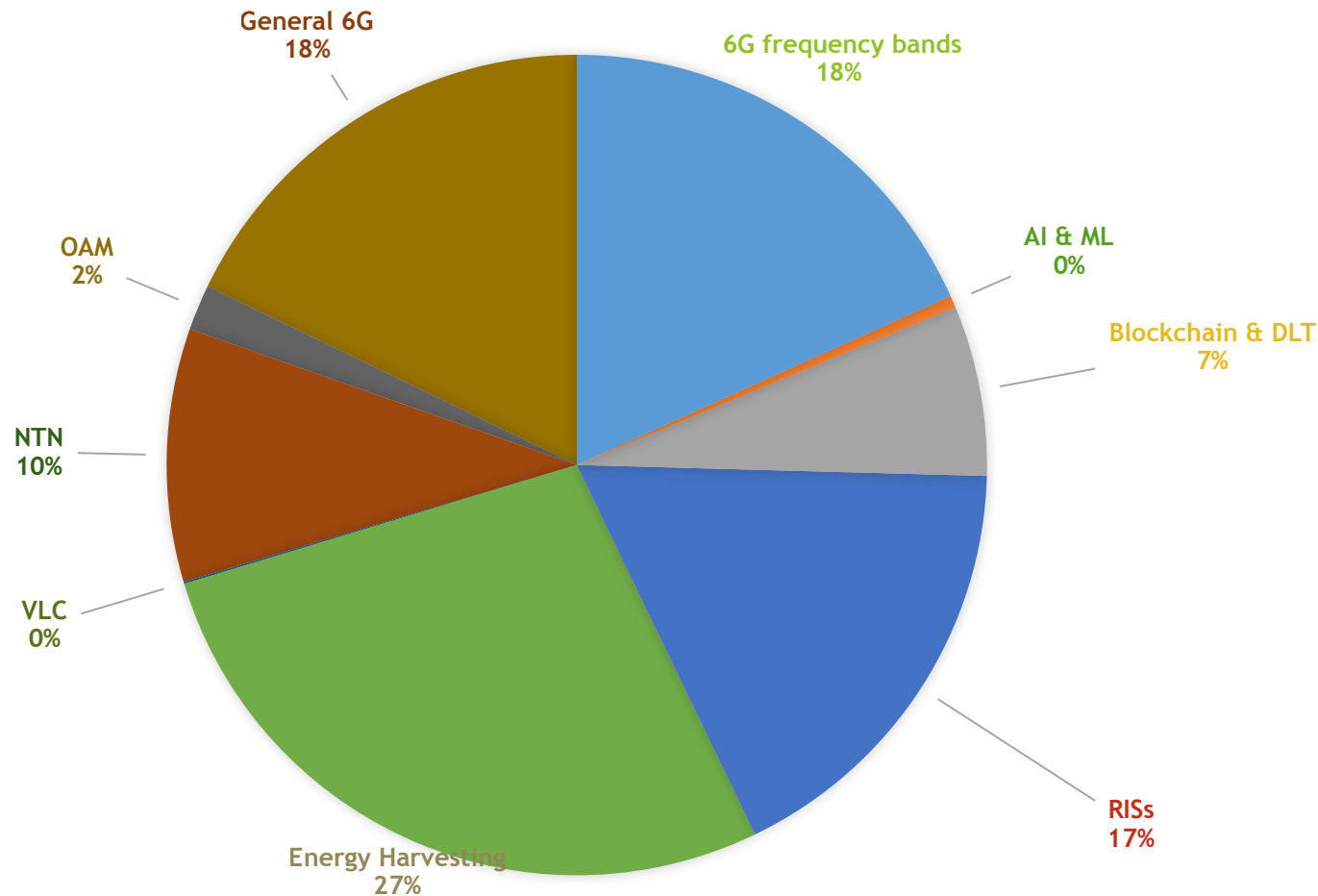
- ❑ 450 of SEP families from 6G technology are categorized under H04W072 followed by H04L005 with 280 and H04W076 with 226.
- ❑ Definition of IPC classes:
- ❑ H04W72/00: Local resource management
- ❑ H04L5/00: Arrangements affording multiple use of the transmission path
- ❑ H04W76/00 : Connection management

US Distribution of (SEPs) families by key technological domains (6G)



- ❑ The chart shows in US, (27%) SEP families come under Energy Harvesting which is highest among all, (18%) SEP families use 6G frequency bands.
- ❑ Out of which (17%) SEP families under general 6G and RISs each.
- ❑ (11%) SEP families under NTN, (8%) under families use Blockchain.
- ❑ (2%) SEP families use OAM, (0%) patent families under VLC, AI and Quantum Communication each.

Global Distribution of (SEPs) families by key technological domains (6G)



- ❑ The chart shows globally, (27%) SEP families come under Energy Harvesting which is highest among all, (18%) SEP families under 6G frequency bands and general 6G each.
- ❑ (17%) SEP families under RISs, (10%) SEP families use NTN and (7%) families under Blockchain.
- ❑ (2%) SEP families under OAM, (1%) SEP families use AI, (0%) patent families use VLC and Quantum Communication.

Thank you very much!!



Robert L. Scott

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