PROSPECTS 5.0

PROSPECTS 5.0 Industry 5.0 Wiki August 2025 Patent Analysis

Industry 5.0 – Digitalization, Automation Technologies in Manufacturing and Industry 5.0 Readiness Analysis Tools

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Scope & Methodology

Search Database: Orbit Intelligence

Date Range: 2022-07-31 to 2025-07-31

Selected CPC Classes:

- **General Automation and Control Systems: G05B** Control or regulating systems in general
- **Industrial Robots: B25J** Manipulators; Chambers provided with manipulation devices
- **Digitalization and Smart Manufacturing Systems: G06F** Electric digital data processing
- **IoT-Based Manufacturing and Sensor Technologies: G08C** Transmission systems for measured values (especially wireless sensor systems) and **H04L 67/10** Network arrangements supporting industrial automation
- **Machine-to-Machine Communication / Data Integration: H04L 29/08** Network protocols for industrial automation and machine-to-machine communication
- **Production Line Management / Flexible Manufacturing Systems (FMS): B23Q 11/00** Arrangements for monitoring or indicating the functioning of machines (e.g., automated production lines) and **B65G** Conveying, packaging, or storage apparatus (e.g., automated handling systems)
- **Artificial Intelligence in Manufacturing and Decision Support: G06N** Computer systems based on specific computational models

Search Query Used: ((((Manufactur+ OR Producing OR Production) AND (robot OR cobot OR (digital W twin) OR (predictive W maintenance)))/TI/AB/CLMS/OBJ/KEYW AND ((G05B OR B25J OR G06F OR G08C OR H04L-067/10 OR G16Y OR H04L-029/08 OR B23Q-011/00 OR G06N OR B65G))/IPC/CPC) AND (EPD=2022-07-31:2025-07-31)) → **37110 Results**

Note: 2025 results may not reflect real case due to data incompleteness, as filings for the current year are still ongoing and not yet fully recorded.

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1. INTRODUCTION

The PROSPECTS 5.0 project is dedicated to analysing how European industries are adopting the core principles of Industry 5.0: **human-centricity, sustainability, and resiliency**. A key part of this analysis involves understanding the technological landscape that underpins this industrial evolution.

This patent report contributes directly to that goal by examining innovation trends and key players in critical Industry 5.0 domains, such as **digitalization and automation technologies in manufacturing**. By mapping the intellectual property landscape, this analysis provides essential insights for policymakers and industry stakeholders, supporting the project's mission to facilitate a successful and informed transition to Industry 5.0.

In the initial patent analysis[1] conducted within the scope of the PROSPECTS 5.0 project, a very broad review was carried out, encompassing all keywords and CPC codes evocative of Industry 5.0. Unlike that earlier approach, this patent analysis adopts a more focused methodology, utilising a patent pool from which patents only partially related to manufacturing activities have been excluded. This ensures a more targeted and relevant evaluation of patents directly pertaining to production processes.

[1] https://wiki.prospects5-0.eu/wp-content/uploads/2024/12/PROSPECTS-5-0_December-2024-Patent-Analysis.pdf

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2. PLAYERS ANALYSIS

2.1. Key Players

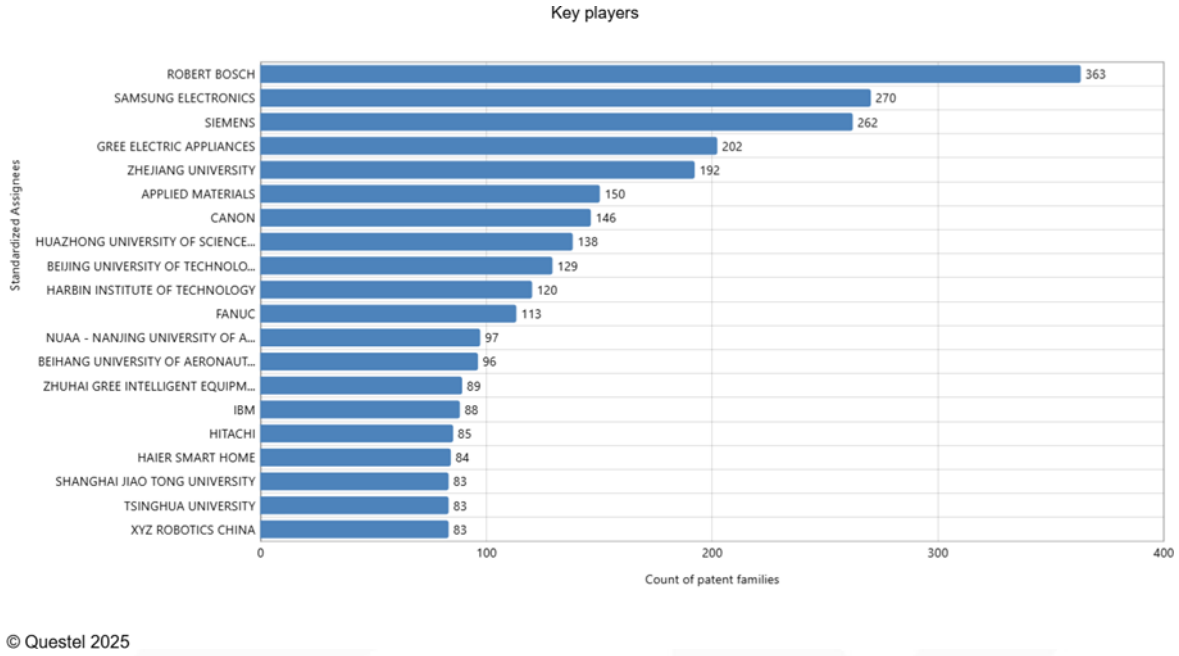

Figure 1 Key Players

The "Key players" chart (Figure 1) presents a comparative analysis of leading patent holders based on the number of patent families. ROBERT BOSCH emerges as the most prominent assignee, with a total of 363 patent families, significantly ahead of other players. SAMSUNG ELECTRONICS and SIEMENS follow with 270 and 262 patent families, respectively, indicating their substantial involvement in innovation within the analyzed domain. GREE ELECTRIC APPLIANCES and ZHEJIANG UNIVERSITY also hold strong positions, reflecting both corporate and academic engagement.

Notably, the presence of multiple universities among the top assignees including ZHEJIANG UNIVERSITY, HUAZHONG UNIVERSITY OF SCIENCE AND TECHNOLOGY, and BEIJING UNIVERSITY OF TECHNOLOGY illustrates the important role of academic institutions in driving technological development. Canon, Applied Materials, and FANUC represent additional industry leaders contributing to the innovation landscape.

Overall, the distribution suggests a healthy mix of industrial and academic contributions to patent activity, with notable concentration among a few dominant players. The graph highlights the competitive and collaborative dynamics of innovation across corporations and research institutions.

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2.2. Key Players by Legal Status

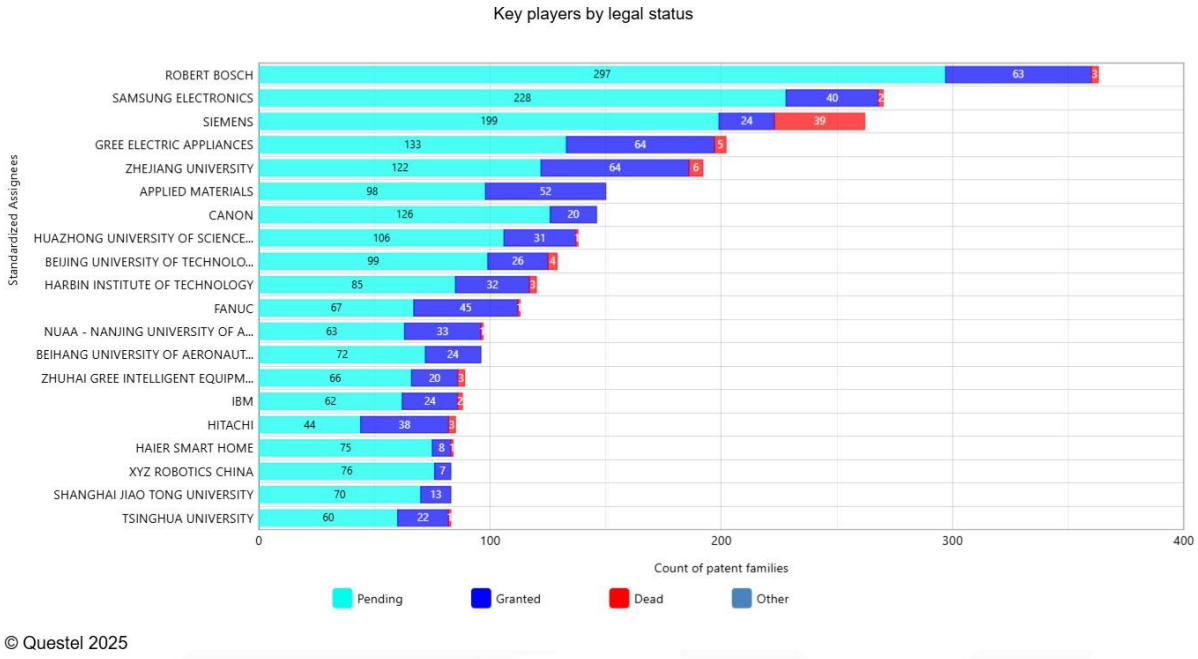

Figure 2 Key Players by Legal Status

Figure 2 provides a detailed overview of the legal status distribution of patent portfolios held by leading assignees. The status categories include pending (cyan), granted (blue), dead (red), and other (gray-blue), illustrating not only the volume but also the maturity and maintenance of patent assets among top organizations.

ROBERT BOSCH leads with a highly active portfolio comprising 297 pending applications and 63 granted families, with a very small number of dead or other-status families. This indicates a strong ongoing investment in innovation and a forward-looking patent strategy. SAMSUNG ELECTRONICS follows with 228 pending and 40 granted families, further supporting its position as a technology driven innovator with a focus on maintaining a growing pipeline of applications.

Some companies, such as SIEMENS, show a more balanced portfolio with 199 pending, 24 granted, and a relatively higher number of dead patents (39), suggesting both a history of innovation and ongoing pruning of older or less valuable assets. On the other hand, GREE ELECTRIC APPLIANCES and ZHEJIANG UNIVERSITY both exhibit a large number of pending families and a notable proportion of granted patents, reflecting an aggressive and maturing patent strategy, particularly among Chinese players.

Academic institutions such as HUAZHONG UNIVERSITY OF SCIENCE AND TECHNOLOGY, BEIJING UNIVERSITY OF TECHNOLOGY, and HARBIN INSTITUTE OF TECHNOLOGY are also visible in the landscape, with portfolios predominantly composed of pending applications. This reflects the universities' growing role in upstream research and early-stage innovation, with fewer patents reaching granted or expired status compared to industry players. Overall, the graph underscores varied strategies across assignees ranging from sustained application growth to portfolio consolidation depending on organizational focus and lifecycle management priorities.

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2.3. Investment Trend for Key Players

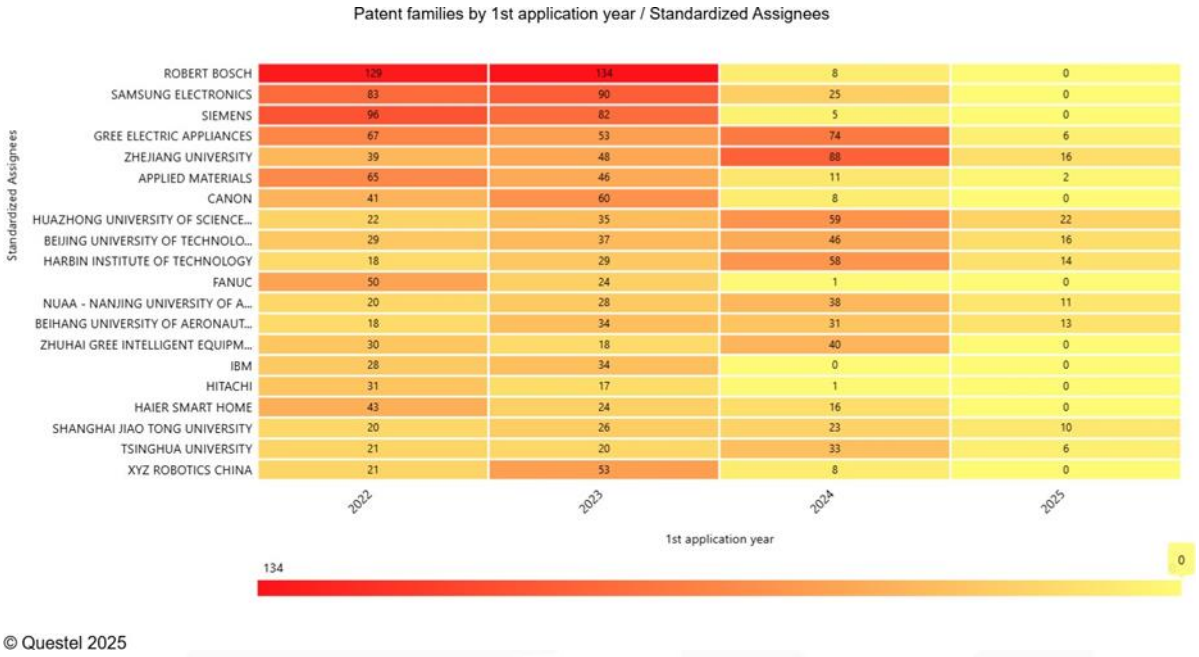

Figure 3 Investment Trend for Key Players

This heatmap visualizes the filing activity of leading organizations over the last four years. The data highlights a strong peak in patent filings during 2022 and 2023, particularly for companies like **ROBERT BOSCH, SAMSUNG ELECTRONICS**, and **SIEMENS**, which show intense red and orange tones indicating high volumes of first filings. ROBERT BOSCH stands out with the highest number of filings in both 2022 (129) and 2023 (134), demonstrating consistent investment in innovation. Similarly, Chinese players such as **ZHEJIANG UNIVERSITY** and **GREE ELECTRIC APPLIANCES** increased their activity significantly in 2023 and maintained momentum into 2024.

In contrast, 2025 shows limited activity across all entities so far, which could be attributed to either the recency of the year or a temporary slowdown. Nevertheless, companies like **HUAZHONG UNIVERSITY OF SCIENCE AND TECHNOLOGY, HARBİN INSTITUTE OF TECHNOLOGY**, and **BEIJING UNIVERSITY OF TECHNOLOGY** still exhibit ongoing patenting efforts in 2024 and 2025, suggesting continued research output from academic institutions. Overall, the chart reflects strong recent patent investment from both industrial and academic players, with notable leadership from German, Korean, and Chinese organizations. The trend suggests a sustained innovation trajectory, especially from companies with high volume filings across multiple consecutive years.

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2.4. Key Inventions by Players

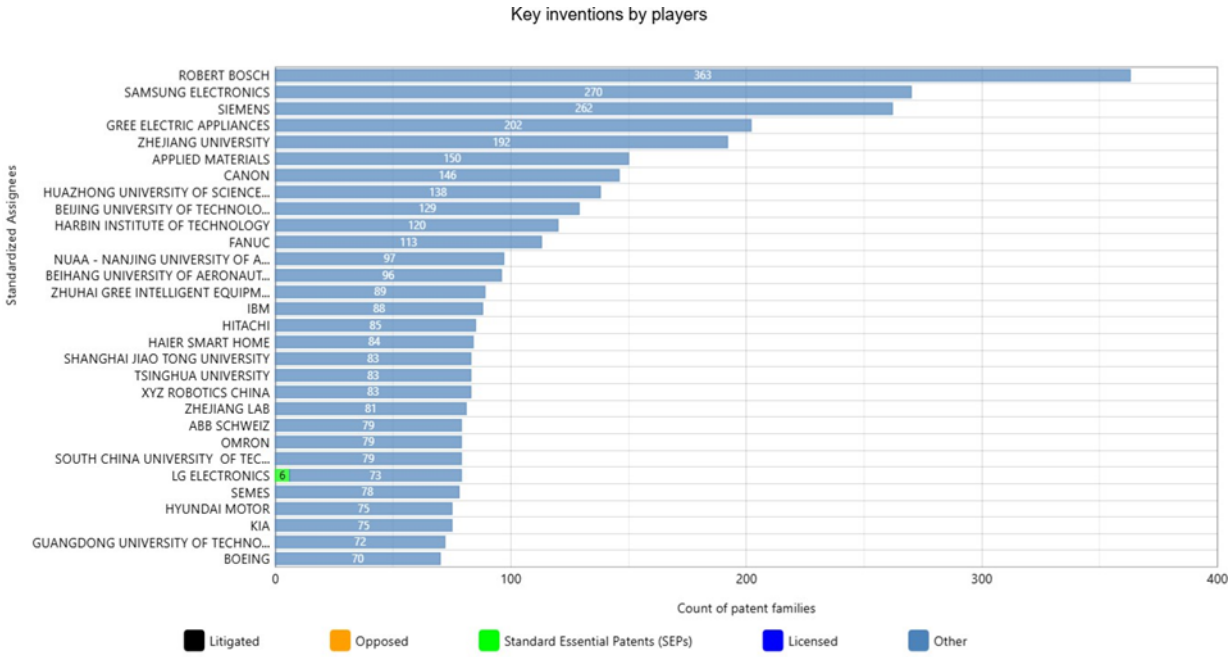

Figure 4 Key Inventions by Players

"**Key inventions by players** (Figure 4)" highlights the top 30 assignees based on the count of patent families, while also distinguishing patents that are litigated, opposed, licensed, or classified as Standard Essential Patents (SEPs) (APPENDIX). Among these, **LG Electronics** stands out with **6 SEPs marked in green indicating potentially critical patents that are essential to industry standards and thus may hold strategic importance**.

Robert Bosch, Samsung Electronics, and **Siemens** lead the chart with the largest patent portfolios, while several universities and Asian tech firms also rank prominently, reflecting a diverse innovation ecosystem. The majority of patent families fall under the "other" category, suggesting they are neither currently licensed nor involved in litigation or standard-setting.

Given the **significance of SEPs in enabling interoperability and compliance across industries, the LG Electronics portfolio deserves closer examination**. Accordingly, a detailed list of these SEP patents is provided for further analysis

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3. MARKET ANALYSIS

3.1. Markets & Competitors Location

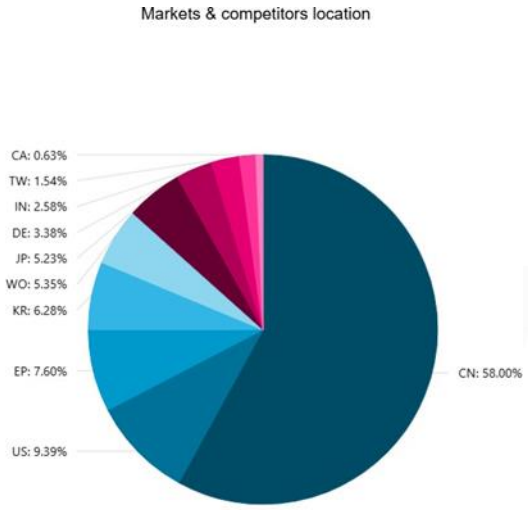

Figure 5 Markets & Competitors Location

"**Markets & competitors' location** (Figure 5)" illustrates the geographical distribution of patent filings, providing insight into the primary jurisdictions where companies are seeking protection and, by extension, where competitive activity is concentrated. **China (CN)** overwhelmingly leads with **58%** of the filings, indicating a dominant position in terms of both innovation output and market focus. This suggests that China is not only a key innovation hub but also a critical market for competitors in this field.

Following China, the **United States (US)** accounts for **9.39%**, and the **European Patent Office (EP)** follows with **7.60%** of the filings. Other notable jurisdictions include **South Korea (KR)** with **6.28%**, **World Intellectual Property Organization (WO)** filings at **5.35%**, and **Japan (JP)** at **5.23%**. These figures reflect strong patenting efforts in other major global economies, albeit at significantly lower volumes compared to China.

Smaller shares are observed in countries like **Germany (DE), India (IN), Taiwan (TW),** and **Canada (CA),** each representing less than 4% of the total. The chart demonstrates a strong regional focus in Asia, especially China, while also highlighting the importance of global protection strategies in the US and Europe for companies aiming to secure international markets.

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3.2. Priority Country

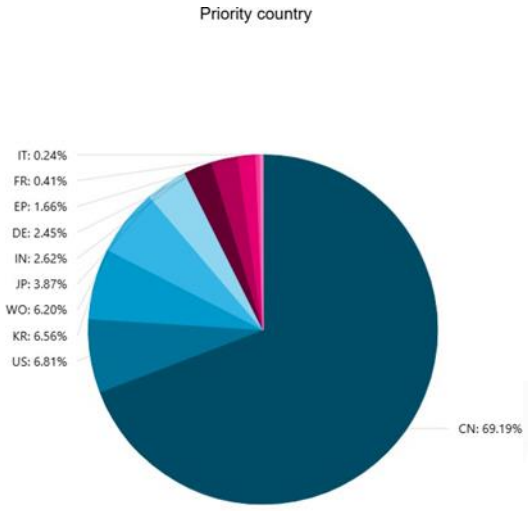

Figure 6 Priority Country

The pie chart titled "**Priority country** (Figure 6)" illustrates the geographical origin of the first filings in patent families. **China (CN)** is the clear leader, accounting for **69.19%** of all priority applications. This dominant share indicates that a substantial portion of innovations in the analyzed domain are initially filed in China, highlighting the country's pivotal role as a global innovation hub and its strong domestic patenting activity.

Other countries play comparatively minor roles. The **United States (US)** follows with **6.81%**, and **South Korea (KR)** with **6.56%**, indicating their importance as secondary innovation centers. International filings via **WO (PCT)** represent **6.20%**, suggesting a strategic approach to global protection by some applicants. Countries like **Japan (JP), India (IN)**, and **Germany (DE)** also appear in the breakdown, albeit with smaller shares. Overall, the chart underscores China's central position in setting the initial patenting direction in this technological field.

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3.3. Patent Families by Standardized Assignees / Publication Country

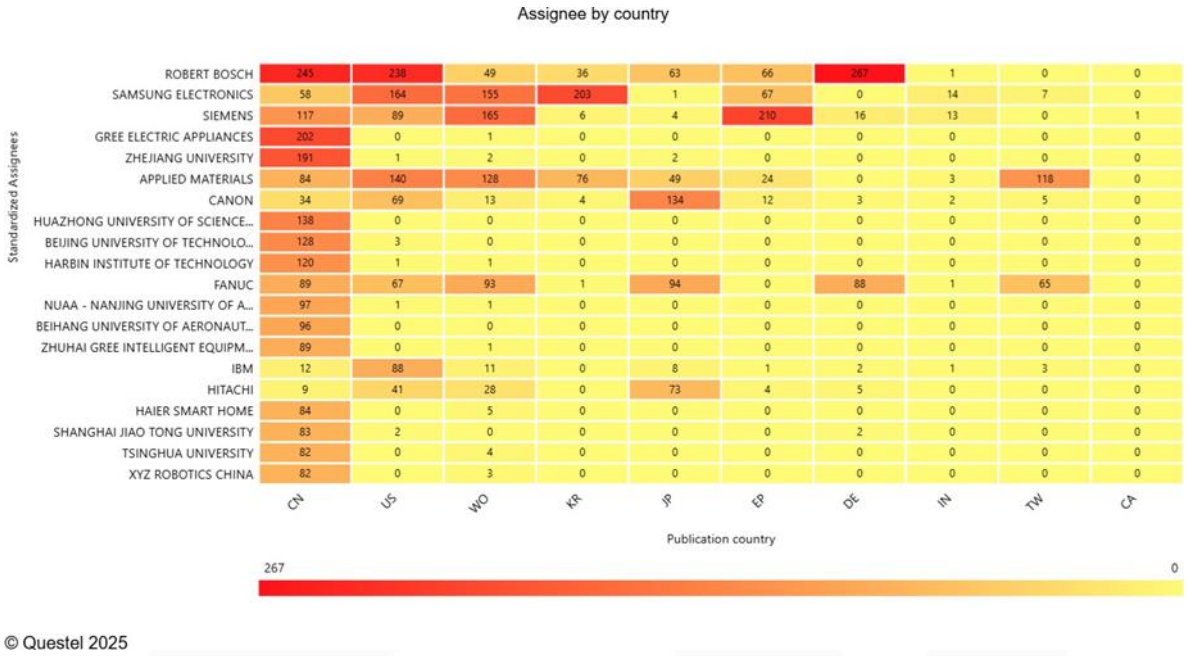

Figure 7 Patent Families by Standardized Assignees / Publication Country

"**Assignee by country** (Figure 7)" highlights the geographical distribution of patent publications across major jurisdictions for leading assignees. It reveals that **Robert Bosch, Siemens**, and **Samsung Electronics** maintain a globally diversified strategy, with substantial filings in China, the US, Europe (EP), and Japan. Bosch, in particular, shows broad coverage, reflecting a strategy aimed at securing protection in all major markets.

In contrast, many Chinese academic and industrial players, such as **Gree Electric Appliances, Zhejiang University**, and **Beijing University of Technology**, appear to concentrate their patent filings almost exclusively in China. This suggests a more localized IP protection approach, likely targeting the domestic market and manufacturing ecosystem.

A few companies such as **Canon, Applied Materials,** and **Fanuc** demonstrate a balanced distribution between Asia, the US, and EP regions, consistent with their global operations. Additionally, LG and Hitachi show select filings across multiple jurisdictions, albeit on a smaller scale. Overall, the chart reflects varying patenting strategies some globally expansive, others regionally focused aligned with each entity's market presence and commercialization plans.

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4. FILING STRATEGY ANALYSIS

4.1. First Application Year

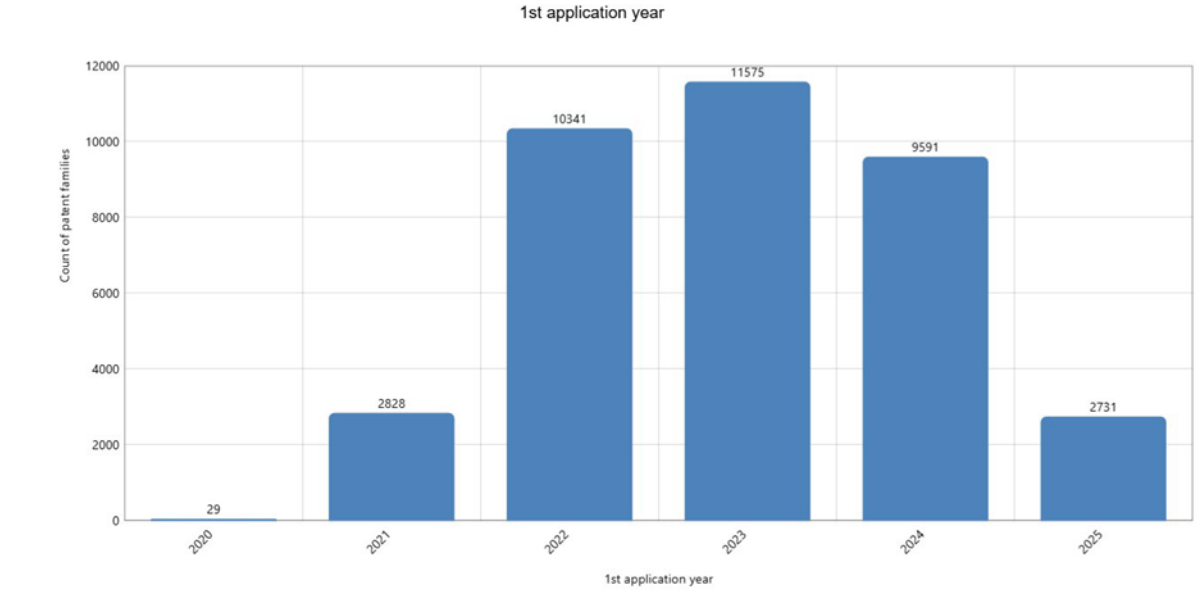

Figure 8 First Application Year

"**1st application year** (Figure 8)" presents the number of patent families filed for the first time between 2020 and 2025. It illustrates a clear growth trend beginning in 2021, with a sharp rise peaking in 2023. This indicates a significant increase in innovation and patenting activity during the 2022–2023 period, likely reflecting expanded R&D investments or a response to global technological shifts.

Following this peak, there is a slight decline in 2024, though the level remains relatively high compared to earlier years. The drop observed in 2025 may not reflect a real decrease in activity but could be due to data incompleteness, as filings for the current year are still ongoing and not yet fully recorded. Overall, the chart suggests a robust and recent surge in patent activity, with 2022 and 2023 being particularly active years for first-time applications.

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4.2. First Priority Year

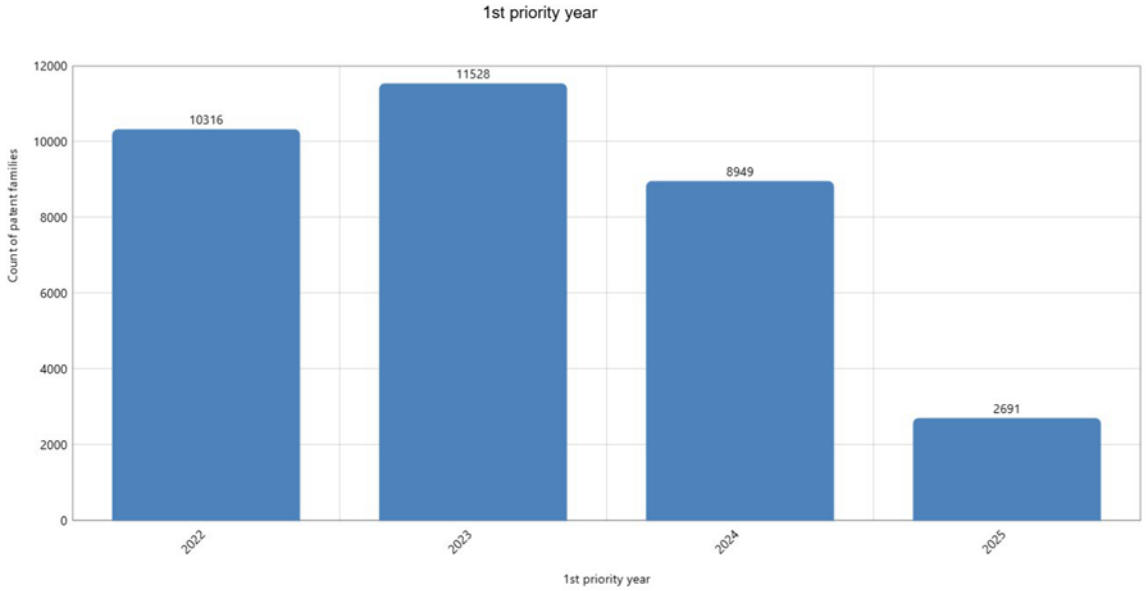

Figure 9 First Priority Year

"**1st priority year** (Figure 9)" displays the annual distribution of patent families based on their priority filing date from 2022 to 2025. The data shows a peak in 2023, indicating that this was the most active year for initiating new patent families. This suggests that R&D activity or strategic patent filings reached a high point during that period.

The number of filings declines in 2024 and drops further in 2025. This decrease in 2025 is likely influenced by the recency of the year, as many applications may not yet be published or indexed. Despite this, the sustained high numbers in 2022 and 2023 reflect a strong innovation cycle, while the 2024 numbers remain substantial, signaling ongoing though slightly reduced innovation efforts.

Another reason for the low number of patents observed in 2025 is that a significant portion of the filed patents have not yet been published, and the year itself has not yet concluded. This leads to incomplete data and suggests that the actual number of applications will become clearer by the end of the year.

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4.3. Patent Families by 1st Priority Year / Standardized Assignees

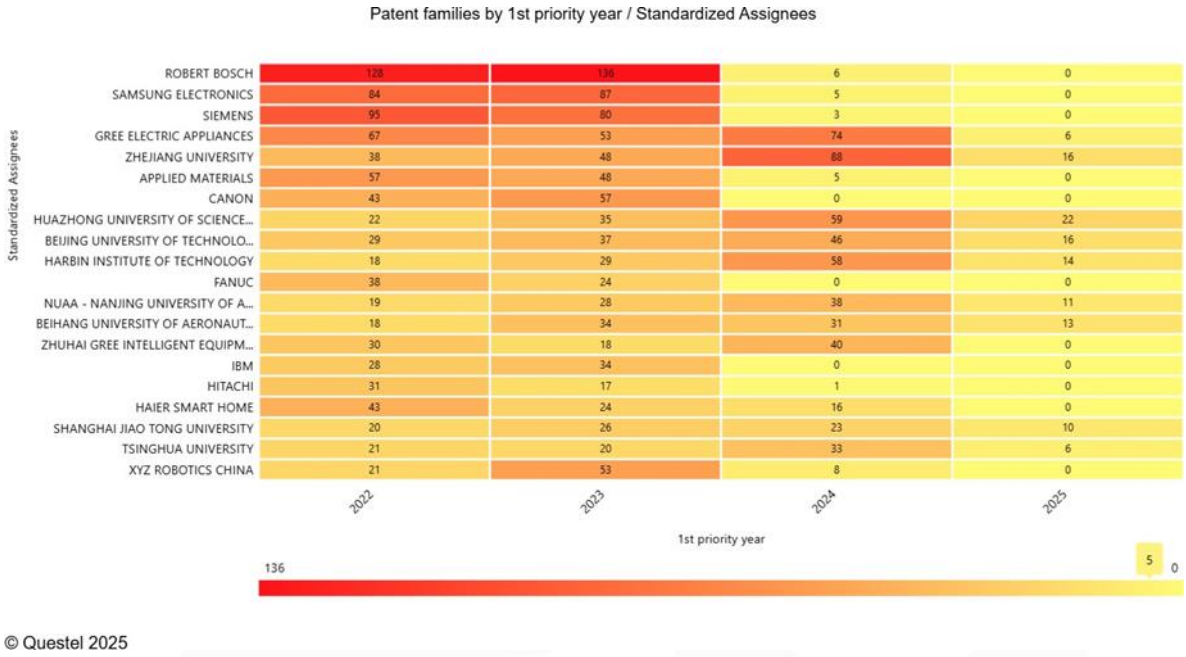

Figure 10 Patent Families by 1st Priority Year / Standardized Assignees

The Figure 10 presents the filing behaviour of key organizations from 2022 to 2025 based on the year in which patent priority was first claimed. It clearly shows that **2022 and 2023** were the most active years for many top assignees, with **Robert Bosch, Samsung Electronics**, and **Siemens** demonstrating high volumes of new priority filings during this period indicating strong R&D and early innovation efforts.

In 2024, a shift is observed: although corporate players like Bosch and Siemens significantly reduced their first priority filings, several Chinese institutions and companies such as **GREE Electric Appliances, Zhejiang University**, and **Huazhong University of Science** and Technology increased their activity, suggesting a growing push in academic and domestic innovation in China.

For 2025, the numbers appear low across all assignees, likely due to data lag, as applications filed recently may not yet be published or indexed. Nonetheless, select players such as **Huazhong University of Science and Technology**, **Harbin Institute of Technology**, and **Beihang University of Aeronautics and Astronautics** already show notable activity, indicating their continued momentum into the current year.

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4.4. Patent Families by 1st Priority Year / Publication Country

Figure 11 Patent Families by 1st Priority Year / Publication Country

The Figure 11 illustrates the distribution of patent publications by country, based on the year in which priority was first claimed. It reveals a consistent and dominant presence of China (CN) across all years, indicating that the majority of priority filings are both originated and published in China. This reflects China's central role in the global patent landscape for the analyzed period.

In contrast, other jurisdictions such as the United States (US), WIPO (WO), South Korea (KR), Japan (JP), and the European Patent Office (EP) show significantly lower volumes, with decreasing trends from 2022 to 2024. The data for 2025 is still emerging, but early filings are visible primarily in China and India, suggesting a continued focus on domestic protection in these markets.

Overall, the chart reinforces the observation that China is not only the primary filing country but also the main publication destination for early-stage innovation, while global patent coverage via international and regional offices remains more limited in comparison.

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5. TECHNOLOGY ANALYSIS

5.1. Concepts by Assignee

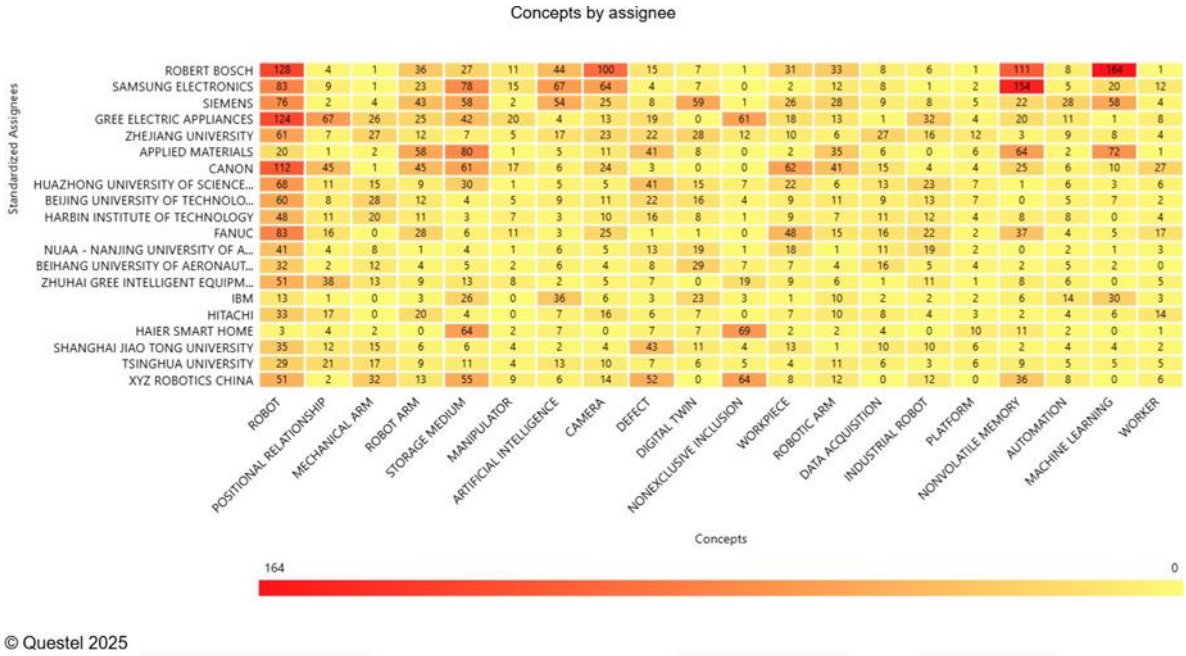

Figure 12 Concepts by Assignee

"**Concepts by assignee** (Figure 12)" presents the distribution of technological focus areas (concepts) across different patent assignees. Each cell reflects the frequency with which a particular concept appears in the patent portfolio of a given entity, highlighting areas of specialization and innovation strategies.

Robert Bosch, Samsung Electronics, and **Siemens** demonstrate strong emphasis on a wide range of advanced concepts. Bosch, in particular, leads in areas such as robot, automation, platform, and worker, indicating a comprehensive investment in robotics and intelligent manufacturing systems. Samsung exhibits dominance in robotic arms, camera, and platforms, suggesting a balanced approach between hardware and control systems. Siemens shows significant concentration in digital twin, artificial intelligence, and automation, reflecting its leadership in Industry 4.0 technologies.

Chinese institutions such as **Gree Electric Appliances**, **Zhejiang University**, and **Huazhong University of Science and Technology** also show strong activity in emerging domains like robot arm, manipulator, and machine learning, pointing to their growing role in applied robotics and AI. Notably, academic institutions exhibit more focused concept coverage, whereas industrial players tend to span a broader range of technologies.

Overall, the chart highlights the competitive landscape and thematic priorities across players, helping identify leaders in key technological areas and emerging innovators in niche fields.

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5.2. Concept Clusters

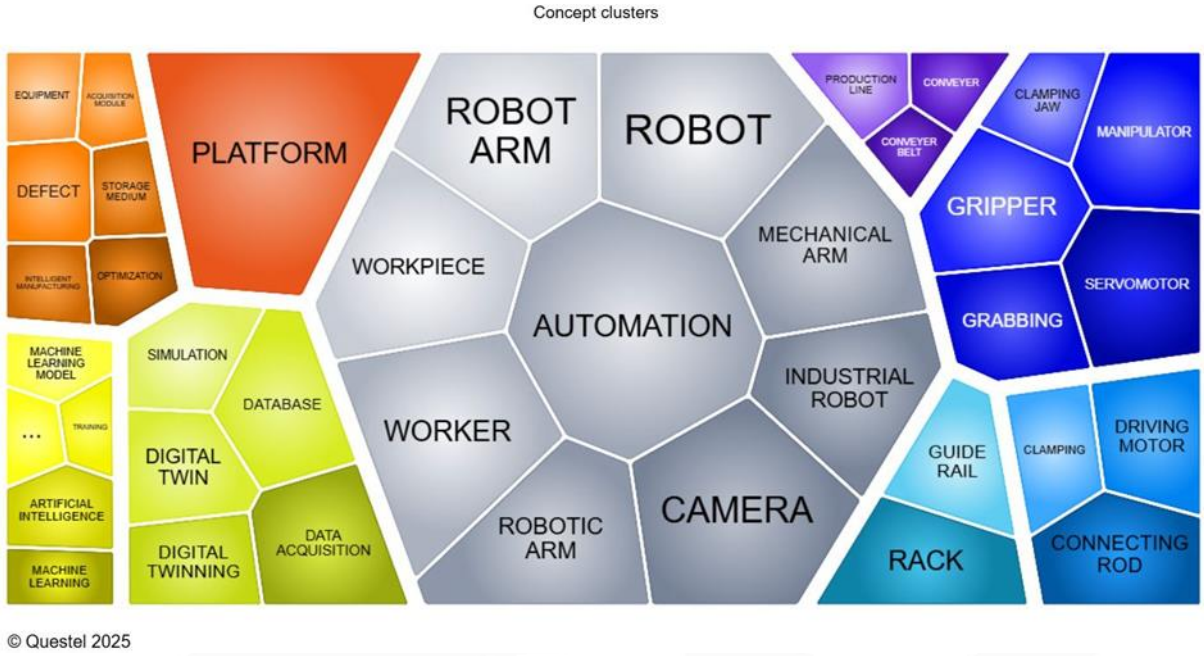

Figure 13 Concept Clusters

"**Concept clusters** (Figure 13)" diagram visualizes the thematic grouping of key technological terms extracted from patent data, illustrating how concepts co-occur and form broader innovation themes. At the core of the diagram, the largest cluster revolves around **automation, robot, robot arm, industrial robot**, and **mechanical arm**, indicating that robotics and automated systems are central to the technology landscape analyzed.

Surrounding the core, clusters such as **gripper, manipulator, servo motor**, and **grabbing** highlight focus areas in mechanical end-effectors and movement control systems. On the opposite side, another major cluster emphasizes **digital technologies** like **digital twin, data acquisition, simulation**, and **machine learning**, reflecting integration of AI-driven modeling and cyber-physical systems into industrial automation.

Additional clusters such as **platform, defect detection, rack**, and **guide rail** suggest supporting technologies for infrastructure, control systems, and quality management. Altogether, the diagram reveals a well-structured innovation ecosystem where mechanical components, intelligent control, and digital transformation converge, forming a comprehensive view of advanced robotics and smart manufacturing domains.

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APPENDIX

PA	APD	FAN	AB	FAMILY_ACT.STATUS	ACT.STATUS
LG ELECTRONICS	2023-09-26 2023-09-26 2023-09-26	109187831	(WO2024/072033) The present disclosure relates to measurement reporting based on machine learning in wireless communications. According to an embodiment of the present disclosure, a method performed by a user equipment (UE) configured to operate in a wireless communication system comprises: receiving, from a network, a configuration for measurement reporting related to a plurality of machine learning (ML) models; determining a set of ML models for measurement reporting among the plurality of ML models configured for the UE, based on the configuration; obtaining measurement results by taking inputs to the set of ML models; and transmitting, to the network, at least one of the measurement results.	PENDING	(WO2024/072033) PENDING (KR10-2025-0072955) PENDING (CN119948918) PENDING
LG ELECTRONICS	2023-09-26 2023-09-26	109187845	(WO2024/072037) The present disclosure relates to a measurement reporting of mixed types in wireless communications. According to an embodiment of the present disclosure, a method performed by a user equipment (UE) configured to operate in a wireless communication system comprises: receiving, from a network, a first measurement configuration and a second measurement configuration, wherein the first measurement configuration is related to generating a measurement result for a measurement object based on measuring a reference signal, and the second measurement configuration is related to deriving a measurement result for the measurement object based on a machine learning (ML) model; obtaining, based on the first measurement configuration, a first measurement result by measuring the reference signal; obtaining, based on the second measurement configuration, a second measurement result by taking an input to the ML model; and transmitting, to the network, at least one of the first measurement result or the second measurement result.	PENDING	(WO2024/072037) PENDING (CN120019683) PENDING
LG ELECTRONICS	2022-08-29 2022-08-29 2022-08-29 2022-08-29 2022-08-29	104215403	(EP4393255) The present invention relates to a method of transmitting a Scheduling Request (SR) based on a time Alignment Timer (TAT) by a user equipment (UE) in a wireless communication system. In particular, the method includes the steps of receiving information related to a time Alignment Timer (TAT) for a Timing Advance Group (TAG) to which a serving cell belongs; starting the TAT for the TAG; based on a data packet to be transmitted via the serving cell being received from an upper layer, determining a difference time between a time point of a first available SR resource in SR resource configuration for the TAG and an expected expiring time of the TAT; based on the difference time being greater than a threshold, transmitting a SR for the data packet on the first available SR resource to a network, wherein, based on the difference time being less than the threshold, a random access (RA) procedure is triggered.	PENDING	(EP4393255) PENDING (WO2023/043085) LAPSED (US20240357660) PENDING (CN117917165) PENDING (KR10-2024-0024297) PENDING
LG ELECTRONICS	2021-12-22 2021-12-22 2021-12-22	101871551	(EP4309415) A method and apparatus for performing AI based procedure for dual connectivity in a wireless communication system is provided. The master node (MN) receives, from a source secondary node (SN), a SN change required message including (i) information on a candidate target SN and (ii) information informing that the candidate target SN is decided by the source SN using an AI model. The MN performs a SN addition procedure with the candidate target SN without using an AI model.	PENDING	(EP4309415) PENDING (WO2022/196900) LAPSED (KR10-2023-0153465) PENDING
LG ELECTRONICS	2022-07-012022-07-012022-07-01	103517342	(EP4373002)The present specification proposes a method and a device for transmitting or receiving beam information in a wireless communication system. The method performed by a terminal comprises the steps of: receiving configuration information of the beam information from a base station; receiving at least one reference signal (RS) from the base station on the basis of the configuration information; predicting second beam information relating to a second instance on the basis of artificial intelligence (AI); and transmitting the beam information including the first beam information and the second beam information to the base station.	PENDING	(EP4373002)PENDING (WO2023/287086)LAPSED(KR10-2024-0036036)PENDING

LG ELECTRONICS	2021-12-22 2021-12-22 2021-12-22 2021-12-22	101683423	(EP4302525) A method and apparatus for performing handover based on AI model in a wireless communication system is provided. The source node acquire a mobility information for a specific UE. The source node transmits, to the specific UE, a measurement configuration including a request for a location information. The source node receives, from the specific UE, the location information. The source node determine a target RAN node for the specific UE by using an AI model, based on the mobility information and the location information. The source node performs a handover procedure for the specific UE with the determined target RAN node.	PENDING	(EP4302525) PENDING (WO2022/186458) LAPSED (US20240381199) PENDING (KR10-2023-0122156) PENDING

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