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Patents and the Fourth Industrial Revolution

Summary of key findings | December 2017

In co-operation with Handelsblatt RESEARCH INSTITUTE

Aim of the study

The massive deployment of the Internet of Things (IoT) is about to entice a Fourth Industrial Revolution (4IR). By 2025, it is estimated that 26-30 billion of devices in the home and workplace will be equipped with sensors, processors and embedded software, and connected to the Internet of Things (IoT). These objects can operate autonomously based on the data that they collect or exchange with each other. Once combined with other technologies, such as cloud computing and artificial intelligence, they enable the automation of entire business processes, including repetitive intellectual tasks previously performed by human beings. Autonomous objects are already transforming a large variety of sectors from manufacturing and agriculture to health and transportation. However, the deepest changes are yet to come.

This study draws on the latest available patent information to analyse the innovation trends that signal the dawn of 4IR. All European patent applications relating to autonomous objects have been identified up to 2016. These 4IR inventions have been further classified into one or more of the three main sectors, each of which is subdivided into several technology fields:

- **Core** technologies (*Hardware, Software* and *Connectivity*) that make it possible to transform any object into a smart and connected device.

- **Enabling** technologies (*Analytics, Security, Artificial intelligence, Position determination, Power supply, 3D systems, User interfaces*) that are used in combination with connected objects.

- **Application** domains (*Home, Personal, Enterprise, Manufacturing, Infrastructure, Vehicles*) where the potential of connected objects can be exploited.

About patent information

Patents are exclusive rights that are granted only for inventions that are new and inventive. High-quality patents are assets for inventors because they can help attract investment, secure licensing deals and provide market exclusivity. Patents are not secret. In exchange for these exclusive rights, all patent applications are published, revealing the technical details of the inventions in them.

Patent databases therefore contain the latest technical information, much of which cannot be found in any other source, which anyone can use for their own research purposes. The EPO's free Espacenet database contains more than 100 million documents from over 100 countries, and comes with a machine translation tool in 32 languages.

This patent information provides early indications of the technological developments that are bound to transform the economy. It reveals how innovation is driving the Fourth Industrial Revolution.

Main findings

4IR innovation is taking off

More than 5 000 patent applications for inventions relating to autonomous objects were filed at the EPO in 2016 alone and in the last three years, the rate of growth for 4IR patent applications was 54%. This far outpaces the overall growth of patent applications in the last three years of 7.65%. *Connectivity* and the application domains *Personal* and *Enterprise* have attracted the largest numbers of such patent applications so far, while the fastest-growing fields are *3D systems, Artificial intelligence* and *User interfaces*.

Europe, the USA and Japan are the established leaders, but China and Korea are rapidly catching up

Europe (EPC), the USA (US) and Japan (JP) were the main innovation centres in 2016. However, 4IR innovation in the Republic of Korea (KR) and the People's Republic of China (CN) has been increasing at a faster rate in recent years. 4IR innovation in these two countries is highly concentrated in a few companies.

In Europe, Germany and France are ahead

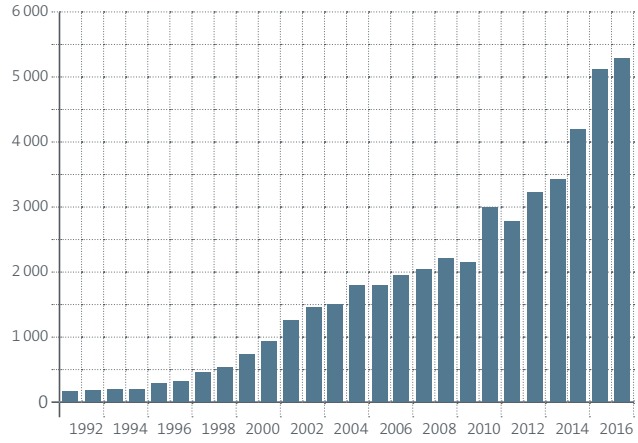
Within Europe, Germany (DE) and France (FR) are foremost in 4IR innovation. Germany stands out in the application domains of *Vehicles, Infrastructure* and *Manufacturing*, while France leads in enabling technologies such as *Artificial intelligence, Security, User interfaces* and *3D systems*. The United Kingdom (GB) and other European countries such as Sweden (SE), Switzerland (CH), Finland (FI) and the Netherlands (NL) also show inventive activity.

Top 4IR applicants active in different industries

Twenty companies, most of them located in Asia, accounted for 42% of all 4IR patent applications filed with the EPO between 2011 and 2016. Innovation in core technologies is mainly led by a limited number of large companies focused on information and communication technology (ICT). Inventions in enabling technologies and application domains are less concentrated, and the top applicants in these sectors originate from a larger variety of industries.

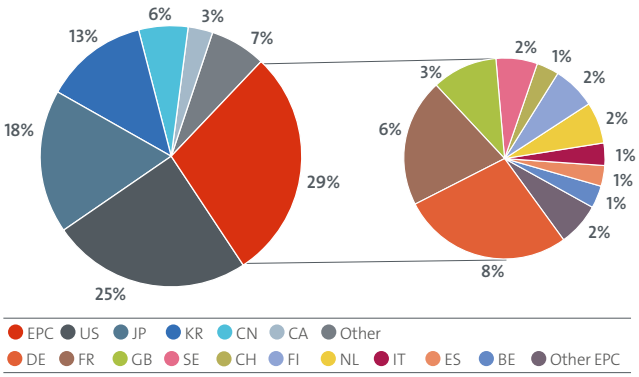
Read the full study
epo.org/4IR

4IR patent applications at the EPO 1991-2016



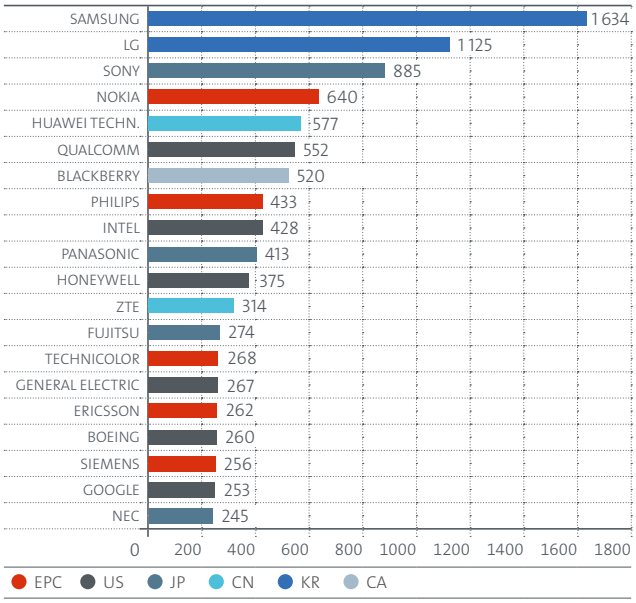
Source: European Patent Office

Geographic origins of 4IR inventions 2011-2016



Source: European Patent Office

Top 20 4IR applicants at the EPO 2011-2016



Source: European Patent Office

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Published by the EPO
Munich, Germany
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