SINGAPORE
Patent Landscape Report
2016
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Introduction

Singapore is a small and open economy, largely dependent on international investments and trade for growth and economic prosperity. Under the intense pressure of rapid technological changes and globalisation, it is no longer adequate for Singapore to keep up with the evolution of technology. Instead, staying ahead of the technological innovation cycle is the key to sustainability and survival across all levels of granularity, be it enhancing an individual’s employability in a global workforce environment, upgrading business efficiency or strategising nationwide policies.

In the present knowledge-based economy, innovations arising from R&D are captured in the form of intangible intellectual assets known as patents. From a strategic standpoint, it is advantageous for companies to seek patent protection early in the product life-cycle and consequently, patent information is often available before the product launch. As such, patent information is a lead indicator of commercialisation.

While companies and organisations file patents primarily to protect new technologies from competitors, and occupy and bolster market presence, there are other strategic considerations at play.

Some companies apply patents to avert litigation in a hotly-contested technology space; others use patents to increase their bargaining power in business IP negotiation or as a means to generate revenue through licensing fees. Analysis of a company’s patent portfolio can thereby provide precious insights into its business objectives. On a larger scale, an analysis of a collection of patents filed by companies and/or organisations in a technology field can uncover gaps and opportunities in the technology space.
Key insights derivable from patent analytics are summarised in Figure 1. Patent analytics supports the practice of evidence-based and data-driven decision making. Combining this capability with other information sources such as market data and non-patent literature allows us to make a holistic assessment of the R&D landscape.

In the context of this report, IPOS draws insights from the patent dataset with the intent to answer one crucial question: Moving ahead in this innovation-centric world, how can Singapore tap on new opportunities to complement its existing strengths?

To this end, the report delivers a snapshot of the worldwide and Singapore patent landscape over 2010 – 2014.

Leading questions relating to the worldwide patent landscape include: What are the fast-growing technologies? What is the underlying key driver of growth? What do these trends mean for Singapore?

Shifting its focus to Singapore as a source of innovations, some leading questions include: Where does Singapore stand globally in the different technologies? What are the strengths of our Singapore innovators? How can we utilise our strengths to boost our key economic sectors?

We hope that our study can provide insights to help companies and organisations understand the worldwide patenting trends and pivot on the strengths of Singapore innovators.
Globalisation has been and remains vital to Singapore’s growth and productivity, as it blurs physical boundaries, and thus provides access to global markets, ideas and talent. Along with these benefits, globalisation also brings competition. In order for Singapore to stay relevant in a global knowledge economy, it is important to keep abreast of the changing technology landscape and seize opportunities in a timely fashion.

“Technological progress becomes even more exciting when it enters into the service of the social idea which demands that not only a small elite but humanity at large should profit by it.”

Rudolf Christoph Eucken
German Philosopher, 1846 – 1926
1908 Nobel Prize for Literature
An overview of the worldwide patent trends and technology landscape is illustrated in a plot of worldwide patent share against worldwide growth rate for 35 technology fields (refer to the WIPO IPC technology concordance table in Annex C) using PCT data from 2010 – 2014 (Figure 2). The patent share represents intensity of global patenting activity in respective fields accumulated over the five-year period, while the growth rate serves as a proxy for the interest in the technology and the potential demand in the future.

Detailed analysis shows that the matrix can be divided into two radial bands. A large cluster of the 35 technology fields fall within the inner radial band and are “conventional” technologies such as Pharmaceuticals, Biotechnology and Semiconductors. These technologies are experiencing slower growth and lower patent share worldwide.

Technology fields in the outer radial band are the faster-growing ones: Digital & Wireless Communication, Computer Technology, Electrical Machinery and Energy, Medical Technology, Measurement, Transport, IT Methods for Management (ITMM) and Control.
Smart Digital Technologies on the Rise – Paving the Way for Industry 4.0

Digital & Wireless Communication and Computer Technology stand out at the top right corner of the chart, having the largest patent share and experiencing high growth in the five-year period.

The Internet of Things (IoT), Big Data & Analytics, and Cybersecurity, which are the core domains classified under the fields of Digital & Wireless Communication and Computer Technology, support the widespread digitalisation across industries and are experiencing high patent growth (Figure 3). In this report, technologies within Digital & Wireless Communication and Computer Technology are referred to as “smart digital technologies” since they impart or enable “smartness” (i.e. gathering large datasets, making sense of the data and having a predictive element).

The high growth of smart digital technologies is a testament that IoT and Big Data are more than hyped-up buzzwords. These smart digital technologies are also key enablers of phenomena such as Industry 4.0, which is the digitalisation of the manufacturing industry due to the rising demands in automation and data exchange, as well as the Internet of Everything (IoE) which weaves together people, processes, data and things to create a network of connections.

- Classified under Digital & Wireless Communication
- Innovations in communication protocols and infrastructure
- Applications in E-commerce (marketing and advertising), FinTech (contactless payments and mobile wallets) and Healthcare (medical patient record access, telemedicine)

- Classified under Computer Technology
- Innovations in database structures and information retrieval methods have increased with the aim of realising more efficient and real-time retrieval of Big Data

- Classified under Computer Technology
- Crucial in the age of the Internet of Everything
- Innovations in network security and user authentication techniques have increased, particularly in biometrics

Figure 3: Core Domains of Smart Digital Technologies
The other six technology fields, namely Electrical Machinery and Energy, Medical Technology, Measurement, Transport, Control and ITMM, round up the list of faster-growing technologies in the outer radial band.

In-depth analysis reveals that innovations in these technology fields are given a boost when they assimilated smart digital technologies. Indeed, innovation opportunities abound if smart digital technologies can be applied into respective industries.
Singapore Innovators

Singapore Innovators’ Strength in Smart Digital Technologies Provides Growth Opportunities

As demonstrated in the previous section, smart digital technologies are indeed experiencing high growth and high patent share, and have a “multiplier effect” on conventional technologies. As such, smart digital technologies present opportunities for Singapore to strengthen key economic sectors, diversify growth, and drive the Smart Nation and Sustainable Singapore initiatives.

The next question that needs to be answered is: Does patent information indicate that Singapore innovators\(^1\) possess capabilities in smart digital technologies to seize the opportunities?

“The Singapore story is the story of ordinary Singaporeans doing extra-ordinary things together.”

Lee Hsien Loong
Prime Minister of Singapore
2017 New Year Message

\(^1\) Singapore innovators refer to inventors or companies with a registered address in Singapore.
A comparison of the patenting activity of Singapore innovators with the worldwide patenting activity reveals our relative strength and interest in smart digital technologies (Digital & Wireless Communications and Computer Technology). Figure 4 illustrates Singapore innovators’ interest and global market interest in the 35 technology fields, as well as the patenting strength of Singapore innovators in each field, the bubble size representing the number of Singapore innovators’ patents and the bubble colour corresponding to the percentage share of total global patents (light orange: >2.0%, orange: 0.7 – 2.0%, white: < 0.6%).

In the field of Digital & Wireless Communication, both Singapore innovators and the World display strong interest. Singapore ranks among the top ten in the provision of infrastructure for information & communication technologies and also relies heavily on ICT in businesses. Top Singapore innovators in Digital & Wireless Communication include MediaTek, Lenovo, A*STAR, IBM and Panasonic. These multinational corporations (MNCs) have set up either innovation centres or Asia-Pacific headquarters in Singapore. The patent portfolio of Singapore innovators centres on innovations related to LAN configuration.

Figure 4: Singapore Innovators’ Patenting Activity Compared with the World (2010 – 2014)

2 The 35 technology fields were arbitrarily divided into three bands. The top 20% of the technology fields corresponded to a percentage share of total global patents of more than 2%; most of the technologies fell within the band of 0.7 – 2.0% of total global patents; each of the remaining technology fields had less than 0.6% of total global patents.

https://www.globalinnovationindex.org/gii-2016-report
digital signal processing and digital security protocols.

Although Singapore innovators’ interest in Computer Technology is moderate compared to the strong global market interest, Singapore is well-positioned to seize opportunities in this field due to the patenting strength present, as indicated by the large bubble size and light orange bubble corresponding to a percentage share of total global patents of more than 2.0%. Patenting areas include data analytics, information retrieval and computer-aided design (CAD) (Figure 4).

Another technology field that is worth highlighting when considering the strengths of Singapore innovators in smart digital technologies is IT Methods for Management (ITMM). As evident from the term “IT Methods for Management”, IT is integral to this technology field, and patents filed in this field possess many elements of smart digital technologies. This field represents software specially adapted for administrative, commercial, financial, managerial, supervisory or forecasting purposes. ITMM is located at the top right corner of the chart, and is the technology field that the World is most interested in. Mirroring the world trend, Singapore innovators show the highest interest in ITMM (Spotlight on IT Methods for Management, page 12), as well as patenting strength (light orange bubbles), demonstrating their ability to apply smart digital technologies.

Continued emphasis and skills development in smart digital technologies is encouraged as these technologies present opportunities when combined with conventional technologies. For example, Big Data & Analytics can be applied across all four domains under RIE2020 and support Singapore’s Smart Nation efforts: (a) Services and Digital Economy – e.g. Biometric authentication in online banking, (b) Urban Solutions and Sustainability – e.g. Smart Grids and Precision Farming, (c) Health and Biomedical Sciences – e.g. Precision Medicine, and (d) Advanced Manufacturing and Engineering – e.g. Industrial Internet of Things.
Fostering Innovation by Building on Singapore’s Strengths

Singapore innovators’ other strengths (Figure 4, light orange bubbles) include Semiconductors, Basic Communication Components, Micro-structural and Nano-technology, Audio-Visual Technology as well as Control. A summary of the top Singapore innovators and top areas of patenting is provided in Table 1. The top Singapore innovators are from MNCs in all fields of technology except in Micro-structural and Nano-technology, where the top innovators are from public institutions.

As collaborative work accelerates innovation, opportunities lie in the integration of multiple disciplines. Expertise in these technology fields can be applied synergistically with smart digital technologies, creating endless possibilities. For example, semiconductor companies can partner biopharmaceutical businesses to develop biochips for diagnostic purposes.

<table>
<thead>
<tr>
<th>Strengths</th>
<th>% Share&lt;sup&gt;4&lt;/sup&gt;</th>
<th>Top Innovators</th>
<th>Top Areas</th>
</tr>
</thead>
</table>
| Semiconductors                    | 7.5                  | - STATS ChipPAC  
- GlobalFoundries  
- Unisantis Electronics                                                      | - Details of semiconductor or other solid state devices  
- Processes or apparatus adapted for the manufacture or treatment of semiconductor or solid state devices or of parts thereof  
- Semiconductor devices adapted for rectifying, amplifying, oscillating or switching, or capacitors or resistors with at least one potential-jump barrier or surface barrier |
| Basic Communication Components    | 6.0                  | - Avago  
- MediaTek  
- A*STAR                                                            | - Networks comprising electromechanical or electro-acoustic devices; electromechanical resonators  
- Amplifiers  
- Coding and decoding                                                  |
| Micro-structural and Nano-technology | 5.0            | - A*STAR  
- NUS  
- NTU                                                              | - Nanoparticles  
- MEMS  
- Carbon nanotubes                                                   |
| Audio-visual (AV) Technology      | 4.1                  | - Siemens  
- MediaTek  
- Lenovo                                                         | - Deaf-aid sets  
- Television systems  
- Methods for magnetic recording of information on a record carrier |
| Computer Technology               | 2.9                  | - Lenovo  
- Avago  
- IBM                                                              | - Hardware operations  
- Software processing operations e.g. information retrieval, CAD  
- Data analytics                                                     |
| IT Methods for Management         | 2.1                  | - Mastercard  
- VISA  
- IBM                                                               | - Payment architecture, schemes and protocols  
- Finance, insurance, tax strategies  
- Commerce                                                             |
| Control                           | 2.0                  | - Lenovo  
- IBM  
- Rockwell Automation                                              | - Automatic systems for regulating electric variables  
- Programme-control systems  
- Traffic control systems for road vehicles                            |

<sup>4</sup> % share calculated with reference to total global patents. Singapore innovators’ percentage share of total global patents was calculated based on the number of inventions by Singapore innovators which were filed in any jurisdiction as a percentage of the total number of PCT applications in the corresponding technology field.
Additive Manufacturing Presents Opportunities to Build a Globally Competitive Manufacturing Sector

The role of manufacturing in Singapore’s economy was emphasised in the report of the Committee on the Future Economy 2017, which recommended building a globally competitive manufacturing sector at around 20% of GDP.

Conventional manufacturing involves mechanical engineering expertise in the design, production and operation of machinery. Singapore innovators’ patenting activity in mechanical engineering, particularly Engine Systems, Machinery Parts and Heating and Cooling Systems (Figure 4, white bubbles), is lower compared to the World, having less than 0.6% share of total global patents in each field. Singapore innovators’ interest in Engine Systems and Machinery Parts is also significantly lower than the global market interest.

Advanced manufacturing technologies, such as Additive Manufacturing, present opportunities to boost innovation in the manufacturing sector.

Building on Singapore’s Foundation in Biomedical Sciences for Future Growth

In 2000, the government identified biomedical sciences as the fourth pillar of the economy in order to diversify the economy and propel Singapore up the value chain\(^5\) and has since provided strong support in the biomedical sciences. The biomedical industry is not only capital-intensive, but a knowledge-intensive one as well. However, with evident R&D progress and continued strong government support, this seemingly high barrier to entry is one which Singapore is well-placed to overcome.

Patenting data shows the fruit of the labour, with Singapore innovators having a higher interest in the field of Biotechnology than the World. With the digitalisation of the biomedical sector, innovators can build upon Singapore’s foundation in Biotechnology and integrate smart digital technologies for future growth.

Likewise, opportunities can be found in the field of Medical Technology where our Singapore innovators have a strong interest (Spotlight on A*STAR, NUS and NTU, page 16). Together with the strong base of high-quality and ISO-certified suppliers that adhere to the strict regulatory requirements necessary for Medical Technology applications\(^6\), more innovative medical technologies can be developed and tested in Singapore.

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\(^5\) The Biopolis Story: Commemorating Ten Years of Excellence, Biomedical Research Council (A*STAR) & JTC Corporation, 2013.  

Spotlight on IT Methods for Management

ITMM Registered
Strong Interest Both Locally and Globally

‘IT Methods for Management’ (ITMM)-related patent applications worldwide registered the highest growth rate (+15.7%) among the 35 technology fields in the past five years. This high growth rate is also mirrored in the patent applications filed by Singapore innovators, where ITMM is also the fastest growing field (+26.1%).

The technology field of ITMM constitutes data processing and/or software methods which are specially adapted for administrative, commercial, financial, managerial, supervisory or forecasting purposes.

Accordingly, this technology field comprises systems or processes for:
- Administration and management, such as database processing and office applications,
- Payment architectures, schemes and protocols,
- Commerce, which includes buying, selling, marketing or servicing of products or services,
- Finance, insurance and tax strategies,
- Other business sectors, such as utilities, healthcare and tourism.
A comparison of Singapore innovators’ patenting activity in ITMM with some key jurisdictions is shown in Figure 5 (patent applications per million residents), with Singapore ranking ahead of other developed countries such as Germany, UK and Denmark. Korea is the clear leader in this field, filing more than twice the number of applications per capita compared to second-placed USA.

“In the digital age, it would not just be about things, in fact, it will be about bits, it will be about designs. Therefore, it is important for us to be part of the digital silk road of the future. To be a port, a nodal point, for digital bits of the future. That is where our future is – to be a digital port.”

Vivian Balakrishnan
Minister for Foreign Affairs of Singapore
Internet-of-Things Asia Conference 2016
Singapore Innovators are Patenting More in FinTech

Singapore innovators’ ITMM portfolio shows a heavy focus on FinTech, having a higher proportion of ITMM filings in FinTech compared to the World. FinTech is the merger of financial services with information and communications technology, comprising two of the six categories classified as ITMM, namely payment architectures, schemes and protocols and finance, insurance and tax strategies (Figure 6).

Examples of such filings include:

- Banking technologies (e.g. security, customer relationship management),
- Payment technologies (e.g. point of sale, P2P money transfer),
- Digital currency (e.g. blockchain, bitcoin, wallets, cryptocurrency),
- Business and personal finance (e.g. P2P lending, wealth management),
- Other traditional financial services disrupted by smart digital technologies (e.g. insurance technology, regulatory technology).

![Figure 6: Categories of Patent Filings in ITMM (Singapore vs World)](image-url)
The larger proportion of FinTech-related patent applications is reflective of Singapore’s status as a global financial hub\(^7\), which demands a robust IT infrastructure and innovative solutions to facilitate the efficient running of commercial operations.

Top Singapore FinTech innovators include MasterCard, Visa, Global Blue, Citibank and DBS Bank, which are large, well-established financial institutions providing technologies that facilitate financial services transactions. Indeed, patenting activity of Singapore innovators in these institutions shows a strong integration of smart digital technologies into traditional services such as electronic wallets and cloud-based transactions.

**Strong Core of Singapore Innovators Delivering Online Commercial Solutions**

While MNCs appear to dominate the top ranked patent assignees in the ITMM space, a deep-dive into the patenting data reveals that a significant number of Singapore innovators are in fact locally-registered small-scale enterprises which rely upon IT innovations as platforms for providing online businesses and commercial solutions. Examples of top Singapore innovators in the small-scale enterprise category include Lets Corp Pte Ltd and Arcadier Pte Ltd, both of which are offering business scaling solutions using their patented IT systems.

Financial start-ups are also patenting actively in specific niche areas to compete with the incumbents. For instance, Numoni Pte Ltd, a local FinTech enterprise, serves up innovations to provide online platforms for remittance, payments and loans; Fastacash came up with a novel solution to manage payment in social networks and mobile apps; and M-Daq specialises in security trading in multiple currencies to facilitate cross-border transactions.

Indeed, this trend points to a growing breed of local entrepreneurs who recognise IT as a cost-effective method to achieve competitive breakthroughs, thereby setting a promising tone to the nation’s economy.

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\(^7\) Singapore ranks 3\(^{rd}\) in The Global Financial Centers Index (GFCI 20), China Development Institute & Z/Yen Group, 2016.  
A*STAR, NUS and NTU are Singapore’s top publicly-funded institutions in terms of patenting activity, filing both locally and worldwide. Over the last decade, the three institutions are the only publicly-funded institutions which rank among the top ten Singapore innovators, the rest being multinational corporations (Figure 7).

Figure 7: Top Singapore Innovators (2005 – 2014)
The most intense patenting activity was observed in the Biotechnology field (Figure 8). This finding is consistent with the government’s push towards developing Singapore as a biomedical hub, where $3.7 billion out of the $16.1 billion committed to R&D between 2011 and 2015 was dedicated to enhancing existing biomedical R&D infrastructure, integrating multi-disciplinary research and translating basic science into tangible outcomes.

Substantial patenting activity was observed in the fields of Semiconductors and Computer Technology, which is unsurprising, considering that both technology fields are the strengths of Singapore innovators. NTU’s focus in the Semiconductors field is evident both in patent and non-patent literature, with the largest proportion of Semiconductor applications in its patent portfolio amongst the three institutions. NTU was also listed as one of the world’s most prolific scientific research institutions in semiconductors, based on the number of academic papers published from 2005-2015.

Although the Instruments sector formed a smaller proportion (21%) of the patent portfolio as compared to the Chemistry (42%) and Electrical Engineering (32%) sectors, significant patenting activity was observed in the fields of Medical Technology and Measurement within the Instruments sector.

Between 2010 and 2014, all three institutions are among the top five Singapore innovators in Medical technology and Measurement, demonstrating innovative capacity in the two fields.

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Conclusion

The success of transforming Singapore’s economy begins with an understanding of her core strengths as well as identifying opportunities to create new frontiers. Using patenting activity as a proxy for R&D interest, the report provides a succinct account of the innovative strength in Singapore, highlighting Singapore’s strong interest in smart digital technologies which can play a pivotal role in the sustainability and growth of industries in the local landscape.

The worldwide landscape analysis in this study also identifies digital revolution as the key driver of global change. Indeed, patenting data shows that growth is strong when smart digital technologies such as the IoT and Big Data & Analytics are applied in conventional industries. Consequently, this key insight of leveraging on smart digital technologies provides strategic guidance to innovation processes at the enterprise, industry and national levels.

Data-driven and evidence-based R&D decisions will ensure a smooth transition to a more knowledge-intensive and innovative economy. Going forward, Singapore looks well-equipped to apply new technologies to drive economic progress as well as achieve the vision of a Smart and Sustainable Singapore.

Indeed, patenting data shows that growth is strong when smart digital technologies such as the IoT and Big Data & Analytics are applied in conventional industries.
Annex A – Methodology

Data Collection

(a) Innovative Capacity (Patent Applications Filed in Singapore and Worldwide) of Singapore Applicants/Inventors

The dataset consisted of all patent applications filed by Singapore-registered companies or local inventors, between 2005 and 2014. These applications included those which were filed by foreign companies wherein one of the inventors was residing in Singapore. The dataset was retrieved from the Derwent World Patents Index™, a database of patent applications and granted patents from 50 patent jurisdictions around the world produced by Clarivate™ Analytics, formerly the Intellectual Property and Science business of Thomson Reuters. The search syntax used for data retrieval was: (AY>=2005 and AY<=2014) and (paod=(sg) or paod=(singapore) or inad=(sg) or inad=(singapore)). Data retrieval was performed on 28 January 2016 and the dataset manually reviewed for its relevance prior to carrying out the analyses.


The dataset consisted of all patent applications filed under the PCT International Patent System administered by the World Intellectual Property Organization. The PCT facilitates patent protection for an invention simultaneously in 152 countries by filing a single “international” patent application instead of filing several separate national or regional patent applications. From a statistical perspective, the PCT has become an increasingly popular procedure for many jurisdictions since the 2000s, making it a good representation of the worldwide patenting trend. In this report, patent applications with application year ranging from 2005 to 2014 were examined. Data retrieval was performed on 23 February 2016.

(c) Search String

The search strings (Annex B) used in this study for the respective technological domains were formulated incorporating keywords (and their variants) and/or patent classification codes and indexing, e.g. International Patent Classification (IPC) and Cooperative Patent Classification (CPC). The patent classification codes were identified based on initial reviews of highly relevant codes, as well as statistical analysis of returned patent datasets.
Classification of Technology Fields by International Patent Classification (IPC)

The first International Patent Classification (IPC) code (at subclass or main group level) was used to match each application to the respective technology sector/field as set out by the WIPO IPC technology concordance table (Annex C). IPC codes are assigned by experienced patent examiners and/or patent classifiers to categorise patent documents. Generally, the most relevant technology is represented by the first IPC code. It should be noted that IPC codes are typically assigned a few months after application. As such, newly-filed patent applications and withdrawn applications do not have assigned IPC codes. Consequently, the technology sector/field analysis was performed using dataset with valid IPC codes. In this report, 99.4% of the patent applications filed in Singapore and worldwide by Singapore applicants/inventors and close to 100% of the PCT patent applications had valid IPC codes.

Calculation of Growth Rates

Growth rate was derived by using the best-fit exponential line method for the set of data in Microsoft Excel. \( y = a e^{bx} \), where \( b \) is the growth rate.

Refinement of Applicant Field: Subsidiaries, Mergers and Acquisitions

Automated algorithms from VantagePoint were used to group variations of an applicant’s name together as these variations represent the same applicant. For example, spelling and punctuation mark discrepancies were corrected. The refined results were manually checked for accuracy. Additionally, applicants were also checked for known subsidiaries, mergers and acquisitions, and then grouped and renamed according to the parent company.

Grouping by Patent Family

A DWPI patent family is a group of patents filed in various countries and related to a single invention. Analyses that take into account patent families reflect innovation productivity more accurately as only one invention is counted per patent family. In contrast, considering individual patent applications filed in multiple countries will give an overestimation of the number of inventions.
Annex B – Search String

Internet of Things

Main Keywords Used
IoT; Internet of Things; IIoT; Industrial Internet of Things; connected systems; connected devices; connected homes; networked applications

Wireless networks; web services; wireless devices; wireless systems; networks; smart networks; intelligent homes; smart homes; smart devices

Transmission control procedure; LAN; WAN, communication processing; communication control; network topologies; data networks; self-organising networks; sensor networks

Main Patent Classification Codes Used
H04L29/08; H04L12/28; H04L29/06; G06F15/16; G05B19/418; H04W84/18; H04W4/00; G08C17/02; H04W72/04; H04B7/26; H04L67/00

Big Data & Analytics

Main Keywords Used
Big data; data cloud; data warehouse; parallel data processing

Data handling; data manipulation; data analysis; forecasting; data optimisation; query

Hadoop; YARN data; ASTER data; Datameer; FICO data; BLAZE data; Platfora; Splunk; MapReduce

Main Patent Classification Codes Used
G06F21/00; H04L9/00; H04L29/06; H04L63/00; H04W12/00; G06F12/14; G07F7/08; G07F7/10; G07F7/12; G06F13/362; G06Q20/40; G06K9/00; H05K9/00; G09C; G06N

Cybersecurity

Main Keywords Used
Cybersecurity; protection; malicious; hacking; backdoor; cryptography; cryptanalysis; cyber-threats

IOT security; mobile security; cloud security; endpoint security; network security; telecommunication; communication security; multimedia security; information security

User access; user control; verification; authentication; biometrics; intrusion systems; unified threat management; rootkit; symmetric key

Encryption; decryption; ciphertext; malware; anti-virus; phishing; DDoS; DoS, denial of service; spam; botnet; black hat; white hat; Trojan; worm; digital signatures; zero vulnerability; ransomware; anti-spoof; data loss prevention; DLP; intrusion detection system; IDS

Main Patent Classification Codes Used
G06F21/00; H04L9/00; H04L29/06; H04L63/00; H04W12/00; G06F12/14; G07F7/08; G07F7/10; G07F7/12; G06F13/362; G06Q20/40; G06K9/00; H05K9/00; G09C; G06N
Annex C – IPC Concordance Table

The WIPO IPC technology concordance table links the International Patent Classification (IPC) codes with thirty-five fields of technology. The concordance table\(^\text{10}\) is updated on a regular basis to reflect revisions to the IPC. The version used in this report is February 2016.

<table>
<thead>
<tr>
<th>Technology</th>
<th>IPC code</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical Engineering</td>
<td>B01B, B01D 1, 3, 5, 7, 8, 9, 11, 12, 15, 17, 19, 21, 24, 25, 27, 29, 33, 35, 36, 37, 39, 41, 43, 57, 59, 61, 63, 65, 67, 69, 71, B01F, B01J, B01L, B02C, B03B, B03C, B03D, B04B, B04C, B05B, B06B, B07B, B07C, B08B, C14C, D06B, D06C, D06L, F25J, F26B, H05H</td>
<td>Technologies at the borderline of chemistry and engineering. It refers to apparatus and processes for the industrial production of chemicals.</td>
</tr>
<tr>
<td>Macromolecular Chemistry, Polymers “Macromolecular Chemistry”</td>
<td>C08B, C08C, C08F, C08G, C08H, C08K, C08L</td>
<td>Chemical aspects of polymers.</td>
</tr>
<tr>
<td>Micro-structural and Nano-technology</td>
<td>B81B, B81C, B82B, B82Y</td>
<td>Some of the Micro-structural and Nano-technology-related applications are found directly under e.g. Semiconductors (FinFET) and Pharmaceuticals (drug nanoparticles).</td>
</tr>
</tbody>
</table>

\(^{10}\) For simplification purposes, phrases in *italics* have been adopted in this report to replace the original classification terms.
## Organic Fine Chemistry

<table>
<thead>
<tr>
<th>Classification</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>A61Q, A61K 8, C07B, C07C, C07D, C07F, C07H, C07J, C40B</td>
<td>Primarily refer to pharmaceuticals. Documents with co-classification in A61K were excluded, except A61K 8 which refers to cosmetics.</td>
</tr>
</tbody>
</table>

## Pharmaceuticals

<table>
<thead>
<tr>
<th>Classification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A61K 6, 9, 31, 33, 35, 36, 38, 39, 41, 45, 47, 48, 49, 50, 51, 101, 103, 125, 127, 129, 131, 133, 135, A61P</td>
<td>Surface and Coatings</td>
</tr>
</tbody>
</table>

## Electrical Engineering

<table>
<thead>
<tr>
<th>Subcategory</th>
<th>Classification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Communication Processes</td>
<td>H03B, H03C, H03D, H03F, H03G, H03H, H03J, H03K, H03L, H03M</td>
<td>Basic technologies such as oscillation, modulation, resonant circuits, impulse technique, coding/decoding. These techniques are used in Telecommunications, Computer Technology, Measurement, Control.</td>
</tr>
<tr>
<td>Electrical Machinery, Apparatus, Energy</td>
<td>F21H, F21K, F21L, F21S, F21V, F21W, F21Y, H01B, H01C, H01F, H01G, H01H, H01J, H01K, H01M, H01R, H01T, H02B, H02G, H02H, H02J, H02K, H02M, H02N, H02P, H02S, H05B, H05C, H05F, H99Z</td>
<td>Non-electronic part of electrical engineering, for instance, the generation, conversion and distribution of electric power, electric machines but also basic electric elements such as resistors, magnets, capacitors, lamps or cables.</td>
</tr>
<tr>
<td>IT Methods for Management</td>
<td>G06Q</td>
<td>Software for special purposes.</td>
</tr>
<tr>
<td>Semiconductors</td>
<td>H01L</td>
<td>Methods for production, integrated circuits or photovoltaic elements.</td>
</tr>
<tr>
<td>Telecommunications</td>
<td>G08C, H01P, H01Q, H04B, H04H, H04J, H04K, H04M, H04N 1, H04Q</td>
<td>Analysis of biological materials for medical purposes (mainly biotechnological methods).</td>
</tr>
<tr>
<td>Instruments</td>
<td>G01N 33</td>
<td>Analysis of biological materials for medical purposes (mainly biotechnological methods).</td>
</tr>
<tr>
<td>Measurement</td>
<td>G01B, G01C, G01D, G01F, G01G, G01H, G01I, G01K, G01L, G01M, G01N 1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 22, 23, 24, 25, 27, 29, 30, 31, 35, 37, G01P, G01Q</td>
<td>Controlling and regulating electrical and nonelectrical systems and referring to arrangements, traffic control or signalling systems etc.</td>
</tr>
<tr>
<td>Category</td>
<td>Codes</td>
<td>Description</td>
</tr>
<tr>
<td>----------</td>
<td>-------</td>
<td>-------------</td>
</tr>
<tr>
<td>Medical Technology</td>
<td>A61B, A61C, A61D, A61F, A61G, A61H, A61J, A61L, A61M, A61N, H05G</td>
<td>High technology and also less sophisticated products and technologies such as operating tables, massage devices, bandages etc.</td>
</tr>
<tr>
<td>Optics “Optics and lasers”</td>
<td>G02B, G02C, G02F, G03B, G03C, G03D, G03F, G03G, G03H, H01S</td>
<td>Optical elements and apparatus; laser beam sources.</td>
</tr>
<tr>
<td>Other Fields</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In this statistical compilation, the dataset consisted of all patent applications that sought protection in Singapore i.e. filed with Intellectual Property Office of Singapore (IPOS), including those that were unpublished or withdrawn. Patent applications with application year\(^\text{11}\) dated 2006 to 2015 were compiled herein in this Annex.

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Figure 9: Patent Filing Trend in Singapore

Figure 10: Breakdown of Patent Applications in Singapore (Singapore Residents and Non-Singapore Residents)

\(^{11}\) The application year referred to the year when a patent application filed in Singapore was completely and successfully received at IPOS. This date may differ from the filing date of a PCT application entering the Singapore national phase. For our purpose, this application year took into account the entry of the application into Singapore and was most reflective of the patenting trend in Singapore.
Figure 11: Top 10 Applicant Countries in Singapore

Figure 12: Top 10 Patent Applicants in Singapore
### Table 2: Number of Patent Applications Filed in Singapore Across Technology Fields

<table>
<thead>
<tr>
<th>Field of technology</th>
<th>Sparkline</th>
<th>Application year</th>
<th>Growth rate SG filing (%)</th>
<th>Growth rate worldwide (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chemistry</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic Materials Chemistry</td>
<td>415</td>
<td>486</td>
<td>414</td>
<td>389</td>
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<tr>
<td>Biotechnology</td>
<td>720</td>
<td>669</td>
<td>719</td>
<td>717</td>
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<tr>
<td>Chemical Engineering</td>
<td>323</td>
<td>305</td>
<td>306</td>
<td>369</td>
</tr>
<tr>
<td>Environmental Technology</td>
<td>100</td>
<td>165</td>
<td>136</td>
<td>150</td>
</tr>
<tr>
<td>Food Chemistry</td>
<td>101</td>
<td>130</td>
<td>188</td>
<td>130</td>
</tr>
<tr>
<td>Macromolecular Chemistry</td>
<td>293</td>
<td>339</td>
<td>304</td>
<td>292</td>
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<tr>
<td>Materials</td>
<td>140</td>
<td>123</td>
<td>132</td>
<td>157</td>
</tr>
<tr>
<td>Micro-structural and Nano-technology</td>
<td>24</td>
<td>12</td>
<td>11</td>
<td>11</td>
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<tr>
<td>Organic Fine Chemistry</td>
<td>1144</td>
<td>1027</td>
<td>871</td>
<td>918</td>
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<tr>
<td>Pharmaceuticals</td>
<td>832</td>
<td>600</td>
<td>618</td>
<td>619</td>
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<tr>
<td>Surface and Coatings</td>
<td>254</td>
<td>213</td>
<td>218</td>
<td>210</td>
</tr>
<tr>
<td><strong>Electrical Engineering</strong></td>
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<td></td>
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<tr>
<td>Audio-visual Technology</td>
<td>246</td>
<td>224</td>
<td>259</td>
<td>289</td>
</tr>
<tr>
<td>Basic Communication Components</td>
<td>38</td>
<td>43</td>
<td>45</td>
<td>33</td>
</tr>
<tr>
<td>Computer Technology</td>
<td>364</td>
<td>397</td>
<td>436</td>
<td>358</td>
</tr>
<tr>
<td>Digital &amp; Wireless Communication</td>
<td>327</td>
<td>303</td>
<td>302</td>
<td>272</td>
</tr>
<tr>
<td>Electrical Machinery and Energy</td>
<td>312</td>
<td>268</td>
<td>296</td>
<td>232</td>
</tr>
<tr>
<td>IT Methods for Management</td>
<td>154</td>
<td>158</td>
<td>219</td>
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<tr>
<td>Semiconductors</td>
<td>650</td>
<td>580</td>
<td>524</td>
<td>444</td>
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<tr>
<td>Telecommunications</td>
<td>114</td>
<td>104</td>
<td>139</td>
<td>106</td>
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<tr>
<td><strong>Instruments</strong></td>
<td></td>
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<td></td>
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<tr>
<td>Biological Material Analysis</td>
<td>102</td>
<td>91</td>
<td>120</td>
<td>94</td>
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<tr>
<td>Control</td>
<td>103</td>
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<td>115</td>
<td>116</td>
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<tr>
<td>Measurement</td>
<td>245</td>
<td>203</td>
<td>330</td>
<td>277</td>
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<tr>
<td>Medical Technology</td>
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<td>405</td>
<td>421</td>
<td>382</td>
</tr>
<tr>
<td>Optics and Lasers</td>
<td>219</td>
<td>258</td>
<td>212</td>
<td>205</td>
</tr>
<tr>
<td><strong>Mechanical Engineering</strong></td>
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<tr>
<td>Engines Systems</td>
<td>119</td>
<td>110</td>
<td>105</td>
<td>201</td>
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<tr>
<td>Handling Systems</td>
<td>199</td>
<td>210</td>
<td>213</td>
<td>231</td>
</tr>
<tr>
<td>Heating and Cooling Systems</td>
<td>75</td>
<td>89</td>
<td>76</td>
<td>95</td>
</tr>
<tr>
<td>Machine Tools</td>
<td>150</td>
<td>136</td>
<td>117</td>
<td>150</td>
</tr>
<tr>
<td>Machinery Parts</td>
<td>127</td>
<td>126</td>
<td>136</td>
<td>129</td>
</tr>
<tr>
<td>Other Special Machines</td>
<td>228</td>
<td>193</td>
<td>194</td>
<td>209</td>
</tr>
<tr>
<td>Textile and Paper Machines</td>
<td>61</td>
<td>54</td>
<td>55</td>
<td>35</td>
</tr>
<tr>
<td>Transport</td>
<td>162</td>
<td>142</td>
<td>162</td>
<td>188</td>
</tr>
<tr>
<td><strong>Other Fields</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Civil Engineering</td>
<td>358</td>
<td>398</td>
<td>389</td>
<td>340</td>
</tr>
<tr>
<td>Furniture, Games</td>
<td>110</td>
<td>121</td>
<td>113</td>
<td>141</td>
</tr>
<tr>
<td>Other Consumer Goods</td>
<td>100</td>
<td>108</td>
<td>105</td>
<td>151</td>
</tr>
</tbody>
</table>
About The Intellectual Property Office of Singapore (IPOS)

The Intellectual Property Office of Singapore (IPOS) is a statutory board under the Ministry of Law. IPOS advises and administers the Intellectual Property (IP) regime, promotes its usage and builds expertise to facilitate the development of Singapore’s IP eco-system. With IP fast becoming a critical asset in today’s global markets, IPOS aims to be a trusted partner to empower all creators in our knowledge economy. IPOS’ vision is for Singapore to be an IP Hub of Asia. More information on IPOS can be found on [www.ipos.gov.sg](http://www.ipos.gov.sg).

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