Internet of Things South Korea

Market Intelligence Report

Department for International Trade
Report prepared by Intralink Limited

July 2018

TECHNOLOGY IS GREAT
BRITAIN & NORTHERN IRELAND

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1. Introduction

South Korea (Korea) is a nation renowned for its hyper-connected population. Having topped the rankings for high-speed internet adoption and smartphone ownership, Korea is now racing towards new frontiers such as 5G and the Internet of Things (IoT). Thanks to the combined efforts of government, telecommunication companies and world-class electronics manufacturers such as Samsung, Korea is likely to become the first country in the world to boast a 5G network, with large-scale commercial tests completed during the Pyeongchang Winter Olympics in February 2018. Even more remarkable, Korea has been almost entirely covered by LPWAN IoT networks since 2016, and now has fully-functioning nationwide IoT platforms in place.

Korea's IoT market was estimated to be worth GBP 4.9bn in 2017 and is expected to grow at a rate of 38.5% a year to reach GBP 11.8bn by 2020. While there is a strong foundation of small and medium-sized enterprises (SMEs) active in the sector, the three telecommunications giants, SK Telecom, KT and LG U+, dominate the ecosystem. SK Telecom was the first telecommunications company to develop an IoT-specific network, based on the LoRa Alliance standard, which was completed in 2016. KT and LG U+ completed their NB-IoT national networks shortly thereafter and, in an attempt to gain an edge over SK Telecom, announced that the two companies would form an alliance to drive the adoption of the NB-IoT standard.

Despite the rapid roll-out of infrastructure, Korea still lags behind its more advanced peers in terms of core IoT technologies. The Moon Jae-In administration, which came to power in May 2017, is determined to close this gap and has made large sums available to support the research, development and commercialisation of IoT technologies and to foster the emergence of a strong ecosystem in Korea. These funds should build on the momentum created by the previous government's decision to open several frequency bands for IoT and ease regulations related to the broadcasting of radio waves in 2016.

This situation has created fertile ground for British companies seeking partnerships with Korean firms. In terms of specific application areas for IoT products and services, there are opportunities in areas such as Smart City (smart transportation, smart resource management, smart healthcare etc.); Smart Factory (automation, efficiency, monitoring, etc.); and Smart Home (automation, voice control, smart metering, entertainment, security, etc.) In addition, IoT solutions designed to mitigate natural disasters and to aid in the upkeep and repair of civil infrastructure, such as those designed to monitor weather conditions or to detect cracks in buildings and bridges, are increasingly sought after.

Korea's highly developed ICT infrastructure and its explicit aim to lead the world in the so-called Fourth Industrial Revolution has created an environment that is conducive to the rapid integration of IoT solutions. In this sense, the large and growing Korean market offers British companies both an attractive opportunity in itself and a potential springboard to expand into East Asia and beyond.

2. Korea – An Overview

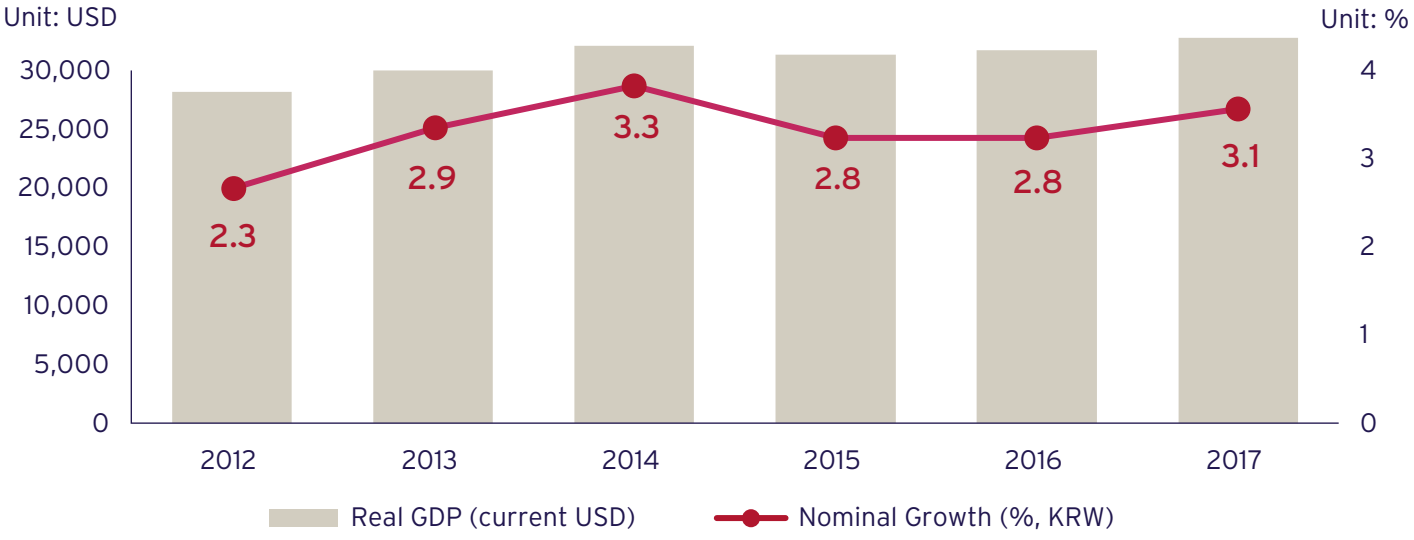
KEY POINTS

- Korea has climbed out of poverty to become a technology powerhouse over the last 60 years
- The country is the world's 11th largest economy with a GDP of just over GBP 1 trillion
- It has maintained annual GDP growth of around 3% in recent years

In the space of just 60 years, Korea has transitioned from an agricultural economy to one driven by high-value industries such as automotive, shipbuilding and advanced manufacturing. Perhaps most remarkable of all, however, is the country's success in the areas of electronics and information communications. As well as dominating the global semiconductor industry, Korea has leap-frogged its peers in terms of ICT infrastructure (smartphone penetration rate, broadband speed etc.) and this, coupled with a demanding and technology-embracing population, means Korea is becoming an economy driven by creativity and innovation.

With a population of 51 million, Korea boasts the 11th largest economy in the world, a GDP of GBP 1.11 trillion in 2017 and a per capita GDP of GBP 22,218 in the same year. Whilst not experiencing the growth witnessed in China, the country has maintained a strong annual growth rate for a developed economy of around 3% in recent years, outpacing its regional rival Japan. Korea's trade dependency ratio is extremely high at over 80% and its economic performance is heavily affected by the economies of China, the US and Japan. Trade and investment flows between Korea and the EU are growing as a result of the FTA that came into effect in 2011. Trade between Korea and the UK specifically has grown rapidly over that period and both countries have expressed a strong desire to conclude a trade deal once the UK leaves the EU.

Figure 1: Korean GDP per Capita (2012 – 2017)



Source: World Bank

3. The IoT Industry in Korea

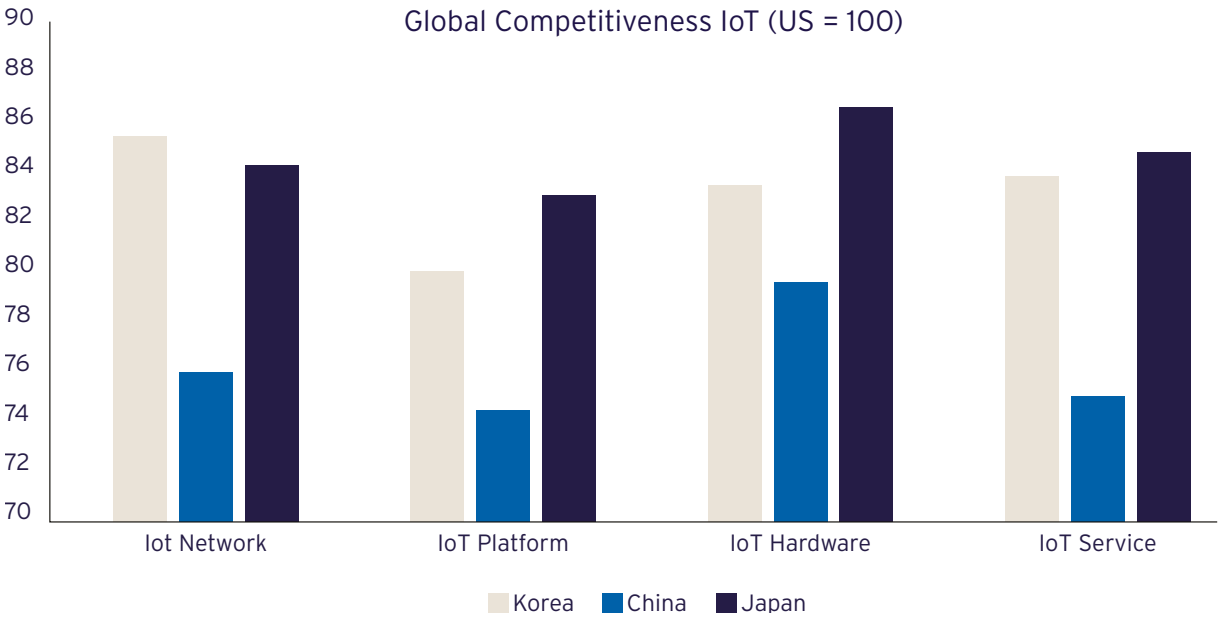
KEY POINTS

- The Korean IoT market is expected to be worth GBP 11.8bn by 2020
- SK Telecom, KT and LG U+ control over 90% of the telecommunications landscape
- SK Telecom completed its IoT-specific network in Korea in 2016; KT and LG U+ achieved broad domestic network coverage with their equivalents in 2017
- SK Telecom's network is based on LoRa, while LG U+ and KT formed an alliance to deploy an IoT-specific network based on NB-IoT technology
- KT and SK Telecom have both developed open platforms: KT developed the "GiGA IoT Alliance", while SK Telecom operates the "ThingPlug" open platform. LG U+ will establish an open platform with KT

The Korean IoT market is estimated to be worth GBP 4.9bn and is expected to grow to GBP 11.8bn by 2020. Although the development of the IoT ecosystem is being driven and shaped by the major electronics and telecommunications companies, 83.8% of IoT-related businesses are start-ups and SMEs (<300 employees) and this number is increasing rapidly. The Korean government has been promoting ICT technologies and encouraging their integration into Korean cities and households but, despite these positive trends, the direction of the market is as yet unclear, with various stakeholders interviewed for this report saying both industry and government are testing different approaches to integrating IoT solutions.

This lack of direction is reflected in Korea's global competitiveness figures in terms of IoT technology. According to the Institute for Information & Communications Technology Promotion (IITP), Korea's IoT technology is currently at 82.9% of US development levels, with Japan at 84.5% and China at 75.8% (see figure 2). Korea is relatively strong vis-à-vis the US in its network development (85.1%) but in terms of platform development, Korea trails most of its technologically-advanced peers. In terms of hardware and service, Korea performs better but still trails its regional rival, Japan.

Figure 2: Korea's IoT Global Competitiveness



Source: Institute for Information & communication Technology Promotion (IITP)

The Korean telecommunications landscape is dominated by the three main operators: KT, SK Telecom and LG U+. KT was the first operator in Korea and was established in 1981. Despite KT being the country's first telecommunications company, the top position in the mobile market belongs to SK Telecom, which controls around 45% of the market. LG U+, Korea's third telecommunications operator, was introduced in 2010 to break the duopoly and has a mobile market share of around 19%.

The three telecommunications companies together account for 90% of the market. The remaining 10% belongs to minor Mobile Virtual Network Operators (MVNOs), although many of the MVNOs are subsidiaries of the large telecommunications companies. SK Telecom was the first to complete an IoT-specific network, based on the LoRa Alliance standard, in Korea in 2016. In July 2017, KT and LG U+ also announced they had finished developing their national NB-IoT networks.

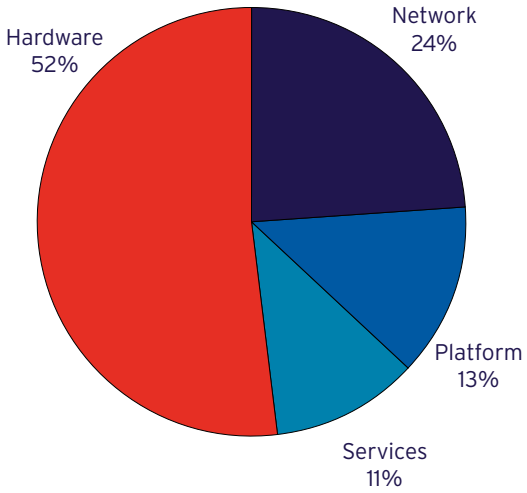
Table 1: Korean Telecommunications Landscape

Company	SK Telecom	KT	LG U+
Date of Establishment	1984	1981	2009
Number of subscribers (LTE+3G+2G)	26.6 million	15.4 million	10.2 million
Market Share	45%	26%	19%

Source: Korea Information Society Development Institute (KISDI)

The IoT industry can be divided into four broad sub-sectors: platform, network, hardware and services. The network and platform sub-sectors are heavily influenced by the major Korean telecommunications companies and multinational companies that seek to integrate solutions of smaller enterprises into their ecosystems. Hardware solutions currently account for the largest portion of revenue within the Korean IoT industry at 52% or GBP 2.55bn. Network solutions are the second largest category with sales of GBP 1.18bn (24%). Platform and service solution sales are significantly lower and account for GBP 637m (13%) and GBP 539m (11%) respectively.

Figure 3: IoT Industry Composition by Revenue



Source: National IT Industry Promotion Agency

Considering IoT's growth potential, the Korean government has adopted a set of measures in an attempt to encourage Korean companies to enter the IoT market including the opening of several frequency bands for IoT and easing regulations related to the broadcasting of radio waves in 2016. The Ministry of Science and ICT is the body responsible for regulatory procedures related to telecommunications and, consequently, IoT.

The Ministry considers IoT an important future growth engine and one in which smaller companies may be able to succeed in an economy that is otherwise dominated by the large conglomerates. Because most of the companies in the IoT industry are small compared to traditional telecommunications companies, the Ministry has initiated a simplification of the procedures required for IoT operators to broadcast on LPWAN networks with a view to encouraging SMEs to play a major role in this area and tackling the dominance of the larger players in the economy more generally.

Figure 4: Korea's IoT Ecosystem

3.1 IoT-dedicated Networks

3.1.1 SK Telecom: LTE-M, LoRa, and LTE Cat.M1

Initially, SK Telecom focused on developing a network leveraging its existing 4th generation infrastructure. The company upgraded its LTE network to LTE-M in March 2016. In parallel, SK Telecom initiated the construction of a dedicated IoT network in co-operation with the LoRa Alliance. It announced the construction of a Low-Power Wide Area Network (LPWAN) nationwide employing the LoRa standard, using the unlicensed 920MHz frequency band starting in early 2016.

SK Telecom also announced in February 2018 that it had completed nationwide LTE Cat.M1 coverage and planned to begin commercialisation in April 2018. LTE Cat.M1 is based on 3GPP release 13 that also gave birth to NB-IoT and is the latest IoT network to be deployed in Korea. The network's main purpose is to fill the gap between LoRa, mainly focused on small data payloads, and LTE-M (Cat 1) focusing on larger data payloads. For example, while pictures can be sent through LTE Cat-M1, sensors sending a small amount of data several times per day use the LoRa network. The network was completed with the help of Qualcomm and Ericsson and deployment was rapid as the only investment required was that of upgrading the existing LTE Network, which already has 100% coverage in Korea.

3.1.2 KT & LG U+: LTE-M and NB-IoT Alliance

KT has developed an LTE-M IoT solution based on 3rd Generation Partnership Project (3GPP) global standards. KT uses 3GPP release 8 devices (CAT-1) but also includes part of the 3GPP release 13 (aka PSM, or Power Saving Mode), a feature usually associated with LPWAN. The company uses its legacy LTE network and thereby avoids the types of interference that is likely to be found in unlicensed bands such as LoRa. KT officially announced complete coverage of the country in March 2016, in a timeframe similar to that of SK Telecom. It is expected that the cost of a module for LTE-M will be around GBP 15.

LG U+ was guarded about progress with deploying its IoT network until March 2016 when it announced that it would offer an IoT solution based on the LTE network. LG U+'s network standard is based on 3GPP release 8 (CAT-1) and integrates PSM. In this respect, LG U+'s network standard is similar to the current technology used by KT. The network was completed in the summer of 2016.

LTE-M cannot sustain long battery lifetimes, an important requirement in the IoT field. Therefore, despite its easy implementation, LTE-M usually acts as a temporary IoT solution. As mentioned, of the three major Korean telecommunication companies, SK Telecom was the first to deploy a LPWAN network and this may give it an edge over its rivals KT and LG U+.

To compete with SK Telecom, LG U+ and KT announced an 'NB-IoT Alliance' in November 2016. The alliance aims to build a fully-functional IoT-specific network based on NB-IoT technology as a counter to SK Telecom's LoRa Network. In July 2017, LG U+ and KT announced the national NB-IoT network was complete and covers more than 80 cities throughout Korea. On this network, the companies provide services such as remote control and monitoring of electricity and gas, transport tracking and asset management. Developers can test their product in LG U+'s and KT's "NB-IoT Open Labs" located in Sangam-dong and Pangyo respectively.

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Industry Insider's Thoughts

Based on leadership of NB-IoT technologies, we are going to seek to co-exist with small and medium-sized South Korean companies and are planning to actively support these companies to enter global markets.

Director of IoT Business, LG U+

3.1.3 Other Network Providers

The big three telecommunications companies in Korea own the networks and therefore largely have the ability to shape the domestic IoT market. These companies function as a one-stop channel for SME IoT businesses to purchase chipsets, data plans, and to build applications using software development kits (SDK) provided by the telecommunication companies and it is extremely difficult for other protocols to emerge. With SK Telecom having adopted LoRa, and with KT and LG U+ having formed an alliance to develop an NB-IoT network, the market is reaching the point where introducing new protocols will be difficult. However, there is one player, Sigfox, that is hoping to make in-roads into the Korean market with another protocol.

According to Sigfox's country manager in Korea, despite the challenging local environment, Sigfox has been actively looking for a partnership in Korea and, with a breakthrough in the summer of 2017, expects a large part of the country to be covered by the Sigfox infrastructure by 2019.

Table 2: IoT Network Landscape

	NB-IoT	LoRa	Sigfox	LTE Cat.M1	LTE-M
Operator	LG U+ and KT	SK Telecom	Amotech	SK Telecom	LG U+, KT, SK Telecom
Completion	2017	2016	2018/19	2018	2016
Frequency	Fixed to 180kHz of LTE band	Unlicensed spectrum 8 channels of 125kHz	Unlicensed spectrum around 868Mhz	Variable up to 1.08MHz of LTE bandwidth	Variable up to 20 MHz of LTE bandwidth
Speed	Up to 250kbps	Up to 5.4kbps	<1kbps	Up to 1Mbps	Up to 10Mbps
Applications	Small data (sensor data, etc.)	Small data (sensor data, etc.)	Small data (sensor data, etc.)	Data, voice and photo	Data, voice and video
Battery Life	Years	Years	Years	Years	Days/Months*

** Based on PSM function integration*

Closer Look

In 2016, the government released unlicensed frequency ranges to be used for IoT-related businesses.
- 940.1-946.3MHz; 1788.478-1791.950MHz: released for long-distance IoT and Home IoT
- 5,650-5,725MHz, 5,825-5,850MHz: released for Wi-Fi, IoT, drones, and other wireless object applications
- 433MHz: released for car parking applications

The Frequency Department, under the Telecommunication Regulation Bureau of MSIP, oversees the frequencies allocation. These newly-released frequencies do not require authorisation to broadcast. Additionally, the bulletin stated that the emissions level limit was raised from 10mW to 200mW.

3.2 Development Platforms

3.2.1 KT: The GiGA IoT Alliance

KT was the first operator to develop a one-stop support centre, both online and offline, for SMEs that wish to develop IoT solutions. The GiGA IoT Alliance (gigaiot.olleh.com) is focused on "creating a co-operative system that develops qualified business models with partners at home and abroad in various fields across the entire IoT industry, such as chipsets/modules, devices, solutions, etc." The GiGA IoT Alliance does not limit its scope to Korean companies and partners with organisations all over the world, including Nokia, China Mobile and Microsoft. The main mission of the GiGA IoT Alliance is to provide educational and financial support, as well as access to infrastructure owned by KT, for companies to commercialise their solutions.

"IoT Makers" (iotmakers.kt.com) is the online platform of the GiGA IoT Alliance. Solutions, APIs and educational materials are available online, along with a community where participants can propose business projects. The platform allows developers to connect their devices to the platform and manage and analyse the collected data. The platform is partly sponsored by the Ministry of Science and ICT. In parallel, KT is developing a user interface that will help companies implement NB-IoT specific devices. IoT Makers supports a wide range of business areas such as smart home, smart city, smart metering, smart factory and others.

3.2.2 SK Telecom: ThingPlug

SK Telecom has released its one-stop community for IoT developers called ThingPlug (sandbox.sktiot.com).

ThingPlug is an open IoT platform, jointly developed by SK Telecom and the Korean IoT service platform DaliWorks, where developers can register devices, download APIs and register for events. APIs are provided based on international standards (e.g. oneM2M, ETSI, etc.).

The ThingPlug lab is located near Seoul and is the main centre for the development of LoRa-based applications in Korea. The centre is open to developers seeking to test their applications. Over 560 companies have partnered with the ThingPlug platform to develop LoRa-based solutions. While most of the companies are Korean, ThingPlug is open to overseas companies as well. Most of the non-Korean companies that partner with ThingPlug at the moment are Chinese and Taiwanese hardware manufacturers looking to combine their hardware with in-house developed software and commercialise these solutions in Korea. There are very few European companies currently working with the ThingPlug platform.

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Industry Insider's Thoughts

The launch of ThingPlug is significant as it allows anyone to develop an IoT service, leading to the creation of a rich IoT ecosystem that brings value and convenience to developers across the globe.

CTO – SK Telecom

3.2.3 LG U+: NB-IoT Open Lab

LG U+ partners with LG Innotek, a module maker, and LG Electronics (all three are LG Group subsidiaries) to conceive and commercialise IoT applications. In July 2017, LG U+ announced the creation of a joint open platform with KT as part of the NB-IoT alliance and launched "NB-IoT Open Lab" (openlab.uplus.co.kr) to act as a support centre for developers. In particular, the centre provides developers with an IoT communication module that can be used for the development of smart phone applications. In order to receive the module, a company should submit its development plan and an IoT project proposal to the NB-IoT Open Lab.

3.2.4 Samsung: ARTIK IoT Platform

ARTIK is an IoT platform that belongs to Samsung's Strategy and Innovation Center (SIC division), which focuses on acquiring and developing future technologies. ARTIK provides all the necessary components required to implement IoT solutions quickly, including chipsets, hubs, software, analytical tools, cloud storage etc. ARTIK considers security to be a distinguishing trait of its platform. Pricing and a listing of the free software tools available can be found on ARTIK's website (www.artik.io).

The ARTIK platform is generally connected to Samsung appliances such as fridges and air conditioning units. However, Samsung is eager to integrate all kinds of innovative technologies into the platform. To this end, Samsung ARTIK has a UK-based team in charge of scouting technologies that can help bring additional value to the ARTIK platform solution.

4. Government Initiatives

KEY POINTS

- The Korean government has assumed a leading role in promoting Industry 4.0 and funding IoT projects
- Government-funded projects pose opportunities (and challenges) for foreign IoT companies
- Korea is seeking to lead in the commercialisation of IoT in the areas of smart homes, smart cities, smart factories and network improvement
- To facilitate innovation, President Moon has announced the implementation of regulatory sandboxes and the relaxation of certain parts of the Telecommunication Business Act

The Korean government has taken an active lead in policy making related to industries included in the so-called "fourth industrial revolution", including IoT. It is important for overseas companies that seek to do business in South Korea to pay careful attention to government-run projects as they can become a focal point for establishing priorities and the direction of research funds for firms in the private sector as well.

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Industry Insider's Thoughts

The Korean government has identified five focus areas for the Fourth Industrial Revolution, abbreviated as ICBM + AI. ICBM stands for IoT, Cloud, Big Data and Mobile and Korea aims to become a global test bed in these areas based on the strong ICT infrastructure and a loosening of relevant legislation.

Director, ICT Policy Planning Team – Institute for Information & communications Technology Promotion (IITP)

When President Moon Jae-In took office in May 2017, he emphasised the importance of Korea being a front-runner in the fourth industrial revolution. With Korea traditionally being a global leader in ICT infrastructure, the Korean government is aiming for IoT to be one of the pillars of its drive into the growth engines of the future. Moon affirmed this with the statement that "IoT is the basic infrastructure for the latest industrial revolution". Announcements to open new frequencies for smart cities by 2019 (5 GHz extension) and smart factories by 2020 (125MHz extension) are some of the early signs of this policy focus. And after the successful testing of KT's 5G-network during the Pyeongchang Olympics, the installation of a nationwide 5G-network is currently ongoing with commercialisation planned for March 2019. Auctioning of the 5G frequencies will take place in June 2018. The starting price of a ten-year use of 280MHz of 3.50GHz bandwith was set at GBP 1.83 billion and that of a five-year use of 2400MHz of 28GHz bandwith at GBP 428.7 million. Some experts, however, predict that the frequencies will be sold for up to GBP 3.5 billion.

Apart from the network, the Korean government will concentrate much of its support on smart homes and smart cities. The Moon administration has announced the goal to have three million smart homes, 20,000 smart factories and nationwide smart metering by 2022 and aims to make Korea a "global IoT test bed". The vision is to establish an open and innovative ecosystem in which anybody can develop IoT services by making use of platforms that are based on 5G and IoT. All of which suggests there are strong opportunities for Korean and overseas IoT businesses alike in Korea under President Moon.

This open approach is illustrated by the legislative reforms that the Korean government has initiated since Moon took office. Two examples are the amendment to the Telecommunications Business Act and the regulatory sandboxes announced in early 2018. The Amendment eases the registration requirements for smaller companies looking to offer IoT products and services because the regulations were considered too cumbersome. The determination criteria will now be based more on whether the company applying for a telecommunications licence possesses the necessary equipment and business scale. Companies that aren't telecommunications companies (e.g. automotive or home appliances), but provide products that incidentally have telecommunication functions, may be exempted from the need for registration altogether.

A more general sign of the opening up of the industry was the formal announcement of regulatory sandboxes in January 2018, with the first Fintech sandbox launched in March 2018. The sandbox entails an exemption from certain regulatory requirements for 'innovative' businesses, although the standards for determining which companies are considered 'innovative' are as yet unclear.

Closer Look

A government-led smart home initiative

The Korean government is planning to stimulate the expansion of the IoT-based smart home market through a large-scale demonstration project. In this project, government-owned contractors such as the Korea Land and Housing Corporation will co-operate to create a real-life test environment of over 10,000 smart homes. The first stage of the project will focus on reducing the utility bills for households, while the second and third stages will focus on linking neighbourhood and city facilities.

Pyeongchang Winter Olympic Games: K-ICT Olympic

In 2014, the Pyeongchang Winter Olympic Games Organising Committee, the government of Gangwon Province and the Ministry of Science and ICT signed an MOU to build a new ICT infrastructure in Pyeongchang for the 2018 Winter Olympic Games. "A Convenient IoT Olympic Games" and "The World's First 5G Olympic Games" were two of the main slogans for the Pyeongchang ICT Winter Olympic Games Project. The infrastructure for a 5G network in Pyeongchang was built by KT and formed part of the larger K-ICT project.

The "Convenient IoT Olympic Games" solutions were divided into three groups. The first was designed to make navigation easier for visitors and participants of Pyeongchang Olympic Games by installing chips and sensors in hotels and public transportation, data from which can be utilised via a smartphone app. The second group targeted city management which includes street light control, traffic control and disaster and crime prevention. The last group of solutions was centred around wearables, data gathering and analytics, and aimed to collect information about the athletes' performance. Apart from a security hack of the Olympic network during the opening ceremony, no technical issues arose during the Pyeongchang Olympics and the project was largely deemed to be a success.

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Industry Insider's Thoughts

The Pyeongchang project was a part of a 'K-ICT Strategy' that aims to make Korea a leading ICT country and show its development to the global community at a cost of around GBP 1.4bn.

Executive Director – Korea IoT Association

5. Opportunity Areas for British Companies

KEY POINTS

- Sustainable development has been emphasised in recent years with 'smart cities' the current focus
- Smart transport, smart resource management and smart healthcare are key areas in smart cities
- The adoption of Industrial IoT (IIoT) solutions is spreading into the SME sector, creating many opportunities for British companies
- Consumer electronics giants, such as Samsung and LG, are actively targeting 'smart home' services
- The telecom providers, ICT companies and construction companies are all actively involved in the smart home sector

This section identifies three opportunity areas for British companies in the Korean IoT sector: smart cities, smart homes and smart factories. The Korean government has highlighted these three as focus areas and emphasised IoT as an area that could foster growth for smaller firms and therefore contribute to sustainable economic development. In interviews conducted for this report, representatives from the large conglomerates have acknowledged that they expect SMEs and foreign firms to play a large role in the sector and indicated that they look forward to welcoming foreign businesses on their IoT platforms as well.

5.1 IoT in Smart Cities

Generally, the Korean smart city sector can be divided into three sub-sectors: smart transport, smart resource management and smart healthcare. In these sub-sectors, there is a natural synergy between (local) government, conglomerates and SMEs. The (local) government co-ordinates, the conglomerates deliver the necessary network and platforms, and the SMEs often develop the hardware and software.

Table 3: Subsectors and Application Areas for Smart Cities

Smart Transport	Smart Resources	Smart Healthcare
Intelligent transportation & Smart Parking	Smart grid	Remote health infrastructure
Congestion solution	Energy/ water consumption visualisation	Fitness applications
Public transport system information	Smart water meters	Chronic disease management
Transport sharing	Water/energy distribution network control	Maternity care

Smart Transport

In October 2017, the Korean government opened K-City. K-City is a town built to test the performance of autonomous vehicles in real-life environments. The town is comprised of motorways, downtown areas, city outskirts and communal areas over an area of over 300 km2. The test site recreates an environment with 35 traffic situations through which the self-driving cars can be tested, including toll gates, pedestrian and train-track crossings and even has potholes and construction sites. In February 2018, SK Telecom announced it had successfully completed a test of vehicle-to-vehicle communication over K-City's 5G network. One test that was conducted had a model child run onto the road. A CCTV system installed on a street light sensed the child and immediately sent warning signals to vehicles in the area, bringing them to an immediate stop. It took the cars merely 0.001s to react after being alerted.

Not only could K-City be of interest to British companies looking to conduct tests, but the initiative has larger implications. With a 5G network that is expected to be applied on major roads in Korea from 2019, K-City is a model for Korean public roads in the near future. Hardware and software solutions that are being used at the test site give a great indication of future demand in the Korean smart transport market. As such, opportunities for British companies lie in areas such as smart roads, smart parking and traffic control (congestion solution and smart traffic lights), among many other smart transport areas.

Smart Resource Management

Advanced Metering Infrastructure (AMI), also referred to as smart metering, is also a burgeoning field in Korea. There have been a number of delays due to technical and patent-related issues, but 4.5 million smart meters are expected to be deployed throughout the country by the end of 2018, with a comprehensive nationwide smart metering network targeted for 2022.

The AMI sector represents a great opportunity for British companies looking to enter the Korean market. However, it should be noted that utility companies are sensitive to both the frequency on which the data is sent and the pathway through which the data travels. Korea Electric Power Company (KEPCO), Korea's national electric utility company, stated that it maintains an absolute requirement to transmit data over licensed bands with data remaining at all times within the Korean territory. This means that only LoRa or NB-IoT are suitable for smart metering applications. Currently, the biggest players ranked by revenue in the field of AMI are LS Industrial Systems (LS IS), Nuri Telecom, OmniSystem and PS Tec for AMI hardware, and KEPCO KDN (a subsidiary of KEPCO), LS IS and SK Telecom for AMI systems.

Apart from smart metering, smart grid, energy distribution network control and consumption visualisation are all areas that have been designated as points of focus by the Korean government. As such, these areas also hold potential for British IoT companies.

Smart Healthcare

IoT solutions for both patients and hospital staff are already being used and show great potential for future growth. One representative case for the Korean smart healthcare sector is a connected hospital service in Daegu Fatima Hospital. A medical examination – from making an appointment to making payments for prescribed medicine – can be completed through a smart healthcare platform the hospital calls 'M-care'. IoT solutions that have started appearing in the Korean smart healthcare sector for hospital staff are solutions such as patient treatment monitoring, management of important equipment and tracking of equipment usage through sensors.

Smart healthcare is another area that shows promise because of Korea's strong ICT infrastructure and its ageing and technology-embracing population. Further, although the sector is expected to grow rapidly over the coming years, the smart healthcare sector in Korea is still relatively underdeveloped meaning there are chances for British companies that can offer superior technology.

5.1.1 Case Studies – Smart City

EPS EnE	
Website	www.eps-ene.co.kr
Application area	Smart resource management
Key Technologies	Sewer monitoring system, sewerage facility management system, sewer pipe interpretation system, water supply facility management system
Platform	Technical details not disclosed
Overview	EPS EnE specialises in water and waste water monitoring and control systems. Sewer Optimal Operation Management System (OMAS) is one of the company's products and allows customers to evaluate sewer pipe operations. The company also develops water supply network management, diagnosis, analysis and management solutions. The data is collected through various devices such as flow meter, water gauge and water quality meter. Collected data is then analysed and sent to the terminal server, which forwards it to management facilities and citizens. To implement its smart water management solution in smart cities projects, EPS EnE has partnered with local governments including the governments of Gwangju, Incheon and Daejeon. LG Electronics, POSCO, GS Neotek, Hanwha S&C and other major Korean companies are among EPS EnE's clients.

Safe Mate	
Website	www.kt.com
Application area	Smart security
Key Technologies	Voice recognition
Platform	KT GIGA IoT
Overview	Safe Mate is an abnormal voice recognition technology that is being used to detect unusual sounds such as screaming, assaults, beating, glass breaking etc. It was co-developed by KT and Ives Technology, a company specialising in intelligent video surveillance. When voice recognition devices record an unusual sound, they immediately send the data via KT communication network to the police command station. The system allows police to react to the threat immediately and is more effective for crime prevention and investigation compared with CCTV. Safe Mate system is currently being installed in women's public restrooms in Seoul.

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Industry Insider's Thoughts

We aim to keep installing our Safe Mate service in potentially dangerous areas such as public restrooms and underground parking lots in co-operation with metropolitan municipalities and provincial police agencies. KT will keep developing a variety of IoT-based public safety services to fulfil its responsibility as a public company.

Project Manager – KT GiGA IoT

5.2 IoT in Smart Factories

The advancement of the Korean ICT industry is apparent when it comes to Industrial IoT, or IIoT. The government has encouraged the installation of smart factory solutions in smaller factories by providing subsidies for SME manufacturers. This has spurred demand in the SME factory sector and, along with the strong demand from the largest manufacturers in the country, means the Korean IIoT market is dynamic across the whole spectrum of manufacturing.

Korean multinational companies have been applying smart solutions, such as sensor predictive analytics and real-time monitoring, since around 2012, when advances in technology allowed for data from the cloud to be analysed in real time. Companies such as Samsung Electronics and LG Electronics are active adopters of smart factory solutions but are heavily reliant on non-Korean ICT technologies as they remain the most complete solutions to date.

Table 4: Number of Smart Factories in Korea

2014	2015	2016
227	1,240	2,800

Industry Insider's Thoughts

The government will give its full support to have more than 30,000 smart factories by 2025 in order for the country to become a leader in the fourth industrial revolution.

Korean Minister of Trade, Industry and Energy

Korea is home to two of the world's largest semiconductor manufacturers, Samsung Electronics and SK Hynix, that together control 86.6% of the global DRAM market. Semiconductor manufacturing requires a high degree of precision, which makes it a natural environment for the development and deployment of IIoT solutions. Most smart factories in Korea belong to the electronics, automotive and steel industries, although the government has set a goal to expand this to start incorporating the energy and textile industries.

The adoption of smart solutions has been slower for Korean SMEs, a price-sensitive category of IIoT consumers. This category of Korean businesses has been supported by the Ministry of Trade, Industry and Energy (MOTIE) and organisations such as the Korea Smart Factory Foundation (KOSF). According to the KOSF, a total of 2,800 SMEs have implemented or were in the process of implementing smart factory solutions with government support.

Opportunities for British companies in the smart factory sector lie mainly with the Korean SMEs, because the Korean market is dominated by European and American firms like Siemens, Rockwell Automation and GE Brilliant Factory which used to be the only providers of such solutions. However, due to significant market growth, home-grown solutions are being developed and commercialised both for the domestic and for the global IIoT market which means that there could be strong partnership opportunities here for British firms.

With the government looking to dramatically increase IIoT penetration through subsidies to smaller factories, these factories will be good targets for British companies. These customers have simpler needs, the number of platforms available to them is limited and the solutions are usually custom-made by systems integrators such as POSCO ICT, Hyosung IS or LG CNS. These integrators are looking for new options and technologies to integrate into their existing offerings. Sources at several of these companies confirmed they are scouting for and evaluating overseas technologies.

5.2.1 Case Studies – Smart Factory

ulalaLAB	
Website	www.ulalalab.com
Application area	Smart factory
Key Technologies	Sensors, cloud and machine learning
Platform	Mainly 3G/Wi-Fi
Overview	Founded in 2011, ulalaLABS is one of the key domestic players in smart factory solutions for small-sized enterprises. UlalaLABs' solution, WIMFactory, is a Smart Factory IoT platform comprising sensors, a cloud server and a machine learning algorithm, offering multi-device support. The platform enables line managers to get instant feedback from the equipment about the status of the production line. The sensors are installed in strategic locations along with gateways (WiFi, 3/4G, BLE) and are connected to the cloud. The WIMFactory platform is a small-scale solution that is cheaper compared with similar systems made by Siemens, ABB or LS IS. Because most factories in Korea are owned by SMEs, ulalaLABS has been well-received and has been adopted in factories in China and South East Asia.

LiveCare	
Website	www.livecare.kr
Application area	Livestock Healthcare System
Key Technologies	"Bio-capsule" sensor and LTE
Platform	LoRa
Overview	uLikeKorea is a Korean start-up that launched "LiveCare", a solution for livestock health monitoring that measures fluctuations in a cow's body temperature. Ruminant animals are sensitive to temperature changes and a fluctuation of as little as 1–2°C may indicate illness. LiveCare is a bio-capsule which is placed within the cow's rumen to collect data about its body temperature, physical activity and physical health. Data is transmitted to the Data Collection Box through an LTE link. In 2016, uLikeKorea received GBP 1 million in investment from Mirae Asset Venture. Later that year, ULikeKorea also won the Start-up World Cup hosted by U.S.-based Fenox Venture Capital and took home another GBP 768,000.

5.3 IoT in Smart Homes

The smart home sector is rapidly developing in Korea. It has been designated by the Ministry of Trade, Industry and Energy as one of the five innovative business sectors on which it will focus. According to the latest numbers from the Smart Home Association, the Korean smart home market reached GBP 8.49bn in 2016 and is expected to grow at a CAGR of 20% over the next 3 years. Convergence home appliances are expected to form the largest sub-sector of the Korean smart home market reaching a value of GBP 5.56bn by 2019, followed by home entertainment (GBP 5.26bn), security (GBP 2.43bn), home automation (GBP 960m), and energy-related green home solutions (GBP 150m).

The release of smart assistants by SK Telecom and KT has been the most visible innovation in the Korean smart home market in the 2016-2017 period. SK Telecom recorded 400,000 sold units of its smart assistant Nugu over 2017, while KT sold 350,000 units of GiGA Genie. With IT giants Kakao and Naver also launching smart assistants in 2017, the smart assistant market shows high growth potential with a projected CAGR of 216% over the period 2015-2020 and therefore offers great opportunities for British companies active in the smart assistant sector.

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Industry Insider's Thoughts

For SK Telecom, NUGU is a large-scale experiment. We are carefully watching consumers' response to this new, exciting technology that increases the efficiency of household appliance management.

Director, Global Business Development – SK Telecom

The smart home market includes a wide range of convergence products and services and has diverse stakeholders including construction companies, appliance manufacturers, security companies, network providers and others. Because solutions from different providers need to be integrated into one system, the Korean IoT market is experiencing increased collaboration between companies in different fields. One broad form of co-operation is between the government, conglomerates and SMEs in the IoT sector. This entails an alliance in which SMEs can develop products and solutions on the foundation of conglomerates' IoT platforms. Currently, this initiative, driven by the Ministry of Science and ICT, has 100 members and the target is to have 1,000 members by 2022. One of the main projects under this initiative is the 10,000 smart homes project, mentioned earlier in this report.

5.3.1 Case Studies – Smart Home

Hyundai E&C and SK Telecom	
Website	www.hdec.kr
Application area	Smart home / smart apartment building
Key Technologies	Sensors, voice control and machine learning
Platform	LoRa
Overview	Construction companies are naturally in the best position to implement smart home IoT solutions in new apartments and office buildings. One of the biggest Korean construction companies, Hyundai Engineering & Construction (E&C), partnered with SK Telecom to launch the "Intelligent Smart Home". The project covers 2,000 Hillstate apartments in and around Seoul. The "Intelligent Smart Home" combines IoT and machine learning technologies and features voice recognition technology with an accuracy of 95% according to SK Telecom. The system allows residents to control light and energy consumption and is paired with a smartphone app.

KD Navien	
Website	www.kdnavien.com
Application area	Smart heating/smart energy
Key Technologies	Remote energy control
Platform	Wi-Fi
Overview	KD Navien, the largest Korean boiler manufacturer, recently launched "Navien Home IoT" hub, which enables customers to control their boiler remotely via a smartphone application. The hub also allows users to connect and control lighting, switches and video systems. The data is aggregated from various devices which are all connected to a "wall pad" via Wi-Fi. By monitoring consumption patterns in real time and comparing it to periodic data, users can manage their resource usage more effectively.

6. Market Entry Strategies

KEY POINTS

- The big three telecommunications companies largely determine the direction of the IoT market
- Direct sales to large factories can be challenging due to strong SI incumbents
- SIs that supply to smaller factories are evaluating foreign technologies to bolster their offerings
- Integrating with one of the Korean IoT platforms may be the quickest way to enter the market. SK Telecom, KT and Samsung all have IoT platforms that are open to non-Korean partners
- Smaller start-ups or companies specifically interested in smart city projects may wish to consider cooperating with government-operated innovation centers and accelerators

At the moment, the IoT market in Korea is shaped almost entirely by the big three telecommunications companies. Developing a channel to supply to SK Telecom, LG U+ and KT should be considered a priority for a British IoT company wishing to enter the Korean market. While the exact mode of entry can differ slightly depending on the technology's application (e.g. smart factory versus smart home), UK companies looking to engage in a strategic partnership or introduce their technology or product to Korea should take into account both business-related and cultural factors. UK businesses can approach the market either through direct sales from the UK, by appointing an agent or distributor or by setting up an office in Korea.

Direct Sales from the UK

The simplest market entry option is for UK companies to sell or license a particular IoT technology directly to Korean end-users. The main downside of a direct sales approach is the lack of local language and time-zone support as Korean companies tend to be particularly demanding of their partners. This can be mitigated by using a local agent or business development consultancy, such as Intralink, capable of bridging time-zone, language and cultural gaps without the long-term commitment of local incorporation and hiring. Market-specific factors to consider include:

- Do we have a strong differentiator – something that sets us apart from our competitors in the market?
- Do we have a strong track record in other major markets? Korean companies are not easily convinced to use a new, disruptive technology as a first-mover without case studies
- Are we willing to localise the product for the market and/or for local regulations, if necessary?
- Are we ready to provide a Proof of Concept (PoC) at little or no cost to the customer? Korean companies will look to drive the price down and will not commit before proving the value through testing
- How do we provide after-sales support? Korean customers expect high-quality, local-language support

Appointing a Reseller or Distributor

Perhaps a more common way to approach the market is to seek a partnership with an established local company that complements your product, has experience in the target sector and can help navigate the legal environment. A local channel partner, perhaps a systems integrator (SI), can provide services such as pre-sales, sales, consulting, installation, technical training, service maintenance, technical support and system integration in the Korean market. Even large multinationals take this route in the early stages of market entry. Market-specific factors to consider when seeking a partner include:

- Does the partner already serve the type of customer that we do?
- Does the partner have a good understanding of the market in general and my particular application?
- Does the partner already offer solutions similar or complementary to our offering?
- Is the partner focused on short-term wins or will they be able to drive our business in the long run?
- Does the partner have specific experience with public sector projects?
- Are we comfortable communicating with the local partner and are they transparent with us?v

Establishing a Local Presence

There are broadly three ways of establishing a local presence: (1) a liaison office, (2) a branch office or (3) a local corporation through foreign direct investment (FDI). Setting up a liaison office is a simple process but a liaison office can only perform non-profit generating activities in Korea such as market surveys, research and development and quality assurance. Setting up a branch office can be a complicated process that requires a lot of documentation to be translated, but it will allow for sales activities and the exchange of revenues with the head office. The most common process for an overseas company to open a branch office in Korea is through FDI where an initial investment exceeding approximately GBP 68,000 is made by the head office, which in return owns stock in the branch. The local corporation leads independent activities and is authorised to perform direct transactions. Market-specific factors to consider when establishing a local presence in Korea include:

- Is our business generating enough revenue in Korea to consider a local presence? Businesses usually consider establishing a local presence after several years of sales (either direct or through a partner)
- Is Korea a strategic market for us, either in terms of securing use-cases or securing further funding?
- Do we need to engage in profit generating activities?
- Will we transfer staff from our head office or hire local staff? In Korea, visas can be difficult to secure for foreign employees and social insurance contributions and severance pay must be paid to all staff that complete one year of employment. An employer's share of these costs equates to 18% of salary
- What location shall we pick for our local presence? Scouting, negotiating, and conclusion of contracts are time-intensive processes that often are hard to conclude without local support

In conclusion, the Korean IoT market offers strong opportunities to UK companies but, whichever option a UK company selects to enter the market, these and other business and cultural considerations must be addressed, and local support often proves invaluable in the market entry process.

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