Market & Technology Trends

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List of Acronyms

Acronym	Definition	Acronym	Definition
AEISS	Advanced Earth Imaging Sensor System	MaaS	Mobility as a Service
AGV	Automated Guided Vehicles	MAFF	Ministry of Agriculture, Forestry and Fisheries
AI	Artificial Intelligence	MIC	Ministry of Internal Affairs and Communications
AR	Augmented Reality	MiFID-2	Markets in Financial Instruments Directive - 2
AS	Automated Storage	MitM	Man-in-the-middle-Attack
BDS	BeiDou Navigation Satellite System	MLIT	Ministry of Land, Infrastructure, Transport, and Tourism
BEL	Bharat Electronics Limited	MOLIT	Ministry of Transport
BIM	Building Information Modelling	MOST	Ministry of Science and Technology
BIPM	Bureau International des Poids et Mesures (BIPM)	MOTIE	Ministry of Industry
CARATS	Collaborative Actions for Renovation of Air Traffic Systems	MSAS	MTSAT Satellite-Based Augmentation System
CORS	Continuously Operating Reference Station	MTSAT	Multi-Functional Transport Satellites
FDMA	Fire and Disaster Management Agency	NGII	National Geographic Information Institute
GEMS	Geostationary Environment Monitoring Spectrometer	NICT	National Institute of Information and Communications Technology
GIS	Geographical Information System	NLSC	National Land Surveying and Mapping Centre
GLONASS	GLObal NAvigation Satellite System	NR	New Radio
GNSS	Global Navigation Satellite System	NSA	non-standalone
GNSS-R	Global Navigation Satellite System Reflectometry	NSPO	National Space Organisation
GOCI-II	Geostationary Ocean Colour Imager-2	OBD	Onboard Diagnostic Devices
GPS	Global Positioning System	OPPAV	Optionally Piloted Personal Air Vehicle
GSI	Geospatial Information Authority of Japan	PBV	Purpose Build Vehicles
HEMS	Helicopter Emergency Medical Services	PIPA	Personal Information Protection Act
HSFC	Human Spaceflight Centre	PNT	Positioning, Navigation and Timing
IIT-M	Indian Institute of Technology-Madras	POS	Position and Orientation System
IoT	Internet of Things	PPE	Personal Protective Equipment
ISRO	Indian Space Research Organisation	PTP	Precision Time Protocol (PTP)
ITRI	Industrial Technology Research Institute	QZSS	Quasi-Zenith Satellite System
JAPB	Japan Agricultural Production Bureau	RNP-AR	Required Navigation Performance - Authorisation Required
JASIC	Japan Automobile Standards Internationalization Centre	RS	Retrieval System
JCAB	Japan Civil Aviation Bureau	RTB	Road Transport Bureau
JMA	Japanese Meteorological Agency	RTK	Real-time kinematic
JSDF	Japan Self-Defence Force	SBAS	Satellite-based Augmentation System
KARI	Korea Aerospace Research Institute	SESAR	Single European Sky ATM Research
KISA	Korea Internet & Security Agency	SLAS	Sub-Metre Level Augmentation Service
KOMPSAT	Korea Multi-Purpose Satellite-	SRP	Solution-Ready Package
KPS	Korea Positioning System	TWCC	Taiwan Computing Cloud
KRRI	South Korea's Railroad Research Institute	UAM	Urban Air Mobility
LBS	Location Based Services	UAV	Unmanned Aerial Vehicle
LIDAR	Light Detection and Ranging		

1 Key Trends

This GNSS Market & Technology Trends insight report is a comprehensive source of knowledge and information on Asia's diverse GNSS markets. This is the second edition of the new GNSS.asia format, which maps upstream and downstream market and technology trends in our focus regions: China, South Korea, India, Japan, Taiwan, and Australasia.

The table below outlines the areas in which developments have been seen. It should allow readers to identify potential new business opportunities.

Market	Upstream Developments
India	The Indian Institute of Geomagnetism (IIG) has developed a global ionospheric model to improve the accuracy of GNSS ISRO and the Aryabhatta Research Institute of Observational Sciences (ARIES) have signed a MoU in the field of Space Situational Awareness (SSA) and Astrophysics.
China	BDS-3 core constellation fully deployed. Geely launching their own LEO satellites by the end of the year
Taiwan	President Tsai Ing-Wen is looking to strategically develop the defence and space industries, including developing domestically produced satellites and components
South Korea	Public interest in an indigenous satellite system, with KT looking to launch 5G satellites as early as 2024
Japan	One year of success for the Japanese GNSS Constellation

Alongside the upstream developments, there have been developments in downstream GNSS market segments, streamlined with the categorisation of the European GNSS Agency: Consumer Solutions, Road Transportation and Automation, Manned Aviation, Drones, Emergency Response, Rail, Agriculture, Geomatics, and Critical infrastructure.

GNSS Market Segment	Trends
Consumer Solutions	Real-time tracking and **geofencing used to fight COVID-19** in India Taiwan has just launched their 5G network and it has great success so far in consumer solutions, with a focus on **smart buses and 5G smartphones**. There has also been a rise in the popularity of smartphone-based **payments** South Korea has seen a rise in the popularity of location-based apps, including **fitness, contactless fuel payment, and navigation** apps
Road	India have launched a new **smart-fleet management system** Chinese developments seen across the segment, including smart highways, intelligent cars, and a **centimetre level accurate location service via a GBAS** **Taiwan and South Korea** announced **funding for autonomous vehicles** GNSS allowed Malaysian public utility Jeepneys to return back to work JRC began preparations for European expansion of **Electronic Toll Collection (ETC) Systems**
Manned Aviation	**BDS** to be used in a three-stage plan to ensure the **safe flight** of aircraft, building on the research completed by Huali Chuangtong to use BDS in low altitude general aviation, with testing being conducted on the AG600 amphibious aircraft Hanwha Systems looking to launch an **air taxi service in 2025** in Korea
Drones	Successful trial of the **new UTM system in Taiwan** Important updates and restrictions of **drone regulations in Vietnam** Drones used to **fight against the coronavirus** by monitoring crowd densities in India and by enforcing the Malaysian movement control order India has recently tested drone food delivery and is looking to complete BVLOS testing in the near future Wide use in many different scenarios including curbing the **spread of locusts, inspect power plants, disaster prevention, disaster relief, air pollution monitoring, and to measure industrial production** throughout the region Singapore have successfully trialled drone delivery and are looking to trial 5G for consumer solution focused drone deliveries
Emergency Response	**Geological disaster monitoring platform using BDS in China**, as well as a coordinated medical waste disposal program **Korean e-Call developments, not compatible with EU e-Call** HERE and UNL collaborate in forming the Human Unlimited #tech4good foundation, using location-based data to enhance emergency response capabilities
Rail	**Smart rail systems and early warning systems** now using **BeiDou** **Smart fleet management** being developed in the Philippines
Agriculture	GNSS used in **fishery management in China**, and in **fishing patrols in Taiwan** **GNSS-tracking used to monitor buffaloes** in Australia Drones used to **reseed burnt land in Australia** GNSS-based technology used to **track migration flyways** for inland waders GNSS used to track wild elephants in Riau, Indonesia

Geomatics	Australian-owned Position Partners Expands into Malaysia Komatsu Ltd have launched their SMARTCONSTRUCTION Retrofit kit which includes GNSS correction services Topcon offers First in the Market RTK Thermal Mapper System for Paving
Critical Infrastructures	BDS used in last kilometre port management and in the monitoring of the national gas system in China

In addition to the upstream developments and GNSS market segments, macro technology trends also have a potential (indirect) impact as their application domain often requires location data. Asia is a particularly relevant region in these domains and is in the driver seat behind several key enabling technologies.

Macro Trends	Trend
Robotics	AI-powered robots to be tested in India China is combining BDS with 5G for smart guidance robots, as well as the development of 100 smart factories, and connected vehicle advancements Taiwan is seen to shift from manufacturing components, to full scale system development Robots are being used to assist in social distancing in Korea New space robotics, automation, and AI centre to be funded in Perth Robotic Staff used at a Tokyo Hotel for COVID-19 Patients
Big Data	Big data used in smart city management in Beijing and Shanghai Apps used in COVID-19 crisis management in Taiwan
Digitalisation and AI	AI-enabled drones used to police lockdown in India AI used to manage delivery drivers in China New national digital technology development agency in Taiwan AI used in healthcare and manufacturing in Taiwan Korean New Deal announced with a focus on AI, and AI in the semi-conductor industry Daikin, a Leading AC Manufacturer have Invested USD 2 Million in an indoor positioning startup, Locix Inc.
Climate Change	Smart cities and clean factories announced as part of the Korean new deal New Method of GNSS Analysis used to study Heavy Rain Phenomena in Japan
Cyber Security	Anti-jamming and anti-spoofing developments seen in the Central Cyberspace Administration's *Innovative Development Strategy of Intelligent Vehicles* strategy, which includes an announcement of the building of a national smart car system to enhance network security protection capabilities
Silver Economy	SK telecoms sign a memorandum to develop a care-tech industry
Sharing Economy	Hello Bike and Qingju Bike gain BDS access Funding for smart-scooter sharing using GNSS in Taiwan

The below table provides a general overview of the potential EU industry opportunities in each segment, based on GNSS.asia's analyses highlighted in this report as well as previous market studies.

Segment	Taiwan	China	Korea	India	Japan	Australasia
Consumer Solutions						
Road						
Manned Aviation						
Drones						
Emergency Response						
Rail						
Agriculture						
Geomatics						
Critical Infrastructures						

1.1 Our Takeaways

1.1.1 Upstream and R&D

Researchers in India have developed a global model to predict the ionospheric electron density, this model is an Artificial Neural Network-based model, using long-term observations to predict electron density. This model is able to reproduce anomalies caused by solar and cosmic radiation, two of the most major sources of error for GNSS-based systems.

Important satellite launch information has been seen in China, with the completion of the core constellation of BDS-3, with the system deployed a year and a half ahead of schedule. Alongside this, automotive manufacturer Geely is planning to launch two LEO satellites by the end of the year.

The Australian Centre for Space Engineering Research (ACSER) has been awarded a grant to develop domestic multi-frequency, multi-antenna GNSS systems to replace imported receivers.

1.1.2 Downstream

There have been two peer-reviewed papers covering the recent developments in the proposed UTM system in Taiwan. This quarter saw the positive results of the recent trials, with the expectation of a full UTM system being seen in the near future.

Vietnam has recently updated its drone and ultra-light aircraft regulations. These regulations make it illegal to fly drones within 500m of any area of significant national defence or military importance, to fly drones near crowds, and make it illegal to fly near some border areas.

Singapore has successfully completed trial drone deliveries and is now looking to expand drone deliveries with a focus on 5G drone deliveries.

GNSS-enabled drones have been used to reseed burnt land in Australia. This project has been so successful at replenishing 49 hectares of burnt land that it is now the recommended method to reseed land in fragile environments. Not only does this method cause less environmental damage to the delicate ecosystem, it also offers massively reduced cost and increased efficiency. That it was the first approved commercial use of 'swarm piloting', with up to five drones being controlled by one pilot, has made it an even greater success.

South Korea's latest drone decree came into effect this quarter, which included the designation of a Special Free Drone Zone to be used for testing and development of delivery, security, and environmental monitoring functions. This is a well needed space for companies to prove their products, and to get valuable real-life testing data. It is expected that this is going to benefit the upcoming consortium that is investigating AI-powered drones that are using machine learning to provide autonomous and clustered flight beyond the current visual range.

All across Asia there have been advancements regarding the use of GNSS for rail, with smart railway system in China using BeiDou, and the development of smart fleet management systems in the Philippines. Similar initiatives are observed in Europe such as the integration of the Galileo enhanced Level 2 European Rail Traffic Management System (ERTMS) in the Italian Railway Network.

2 India

2.1 Introduction

India has emerged as the fastest-growing major economy with an estimated GDP growth of 12%in 2019-20. The country has retained its position as the world's third-largest startup market, with a total amount of up to-9,300 startups. The huge as potential user base, the rapid growth of the market for smartphones, and the accessibility of the internet at an affordable cost, creates vast opportunities for GNSS applications.

Segment		Key Trends
Upstream		ISRO postponed missions due to the ongoing pandemic Ionospheric Modelling used to Improve the Accuracy of GNSS
Market Trends	Consumer Solutions	Real-time tracking and geofencing used for COVID-19 crisis management Drones tested to deliver food, with plans for BVLOS testing
	Road Transportation & Automotive	Aries Communication Launched a Smart Fleet Management Platform
	Drones	Drones Deployed by the State Governments to Combat the Coronavirus and to curb the spread of locusts
	Emergency Response	Kerala government launched mobile app for citizen services
Macro Technology Trends	Robotics	AI powered robot iMap-9 will be tested by AIIMS
	Digitalisation and AI	AI-enabled drones helping police amid lockdown

2.2 Upstream Developments

2.2.1 Ionospheric Modelling to Improve the Accuracy of GNSS

Researchers from the Indian Institute of Geomagnetism (IIG) have developed a global model to predict the ionospheric electron density with larger data coverage — a crucial need for communication and navigation. The Artificial Neural Networks-based global Ionospheric Model (ANNIM) uses long-term ionospheric observations to predict electron density and peak parameters of the ionised part of the Earth's upper atmosphere, between 46-621 miles above the Earth's surface. The model successfully reproduced large-scale anomalies in the ionosphere caused by solar and cosmic radiation – both of which are a major source of error for GNSS-based positioning systems.[1]

[1] https://sputniknews.com/world/202004211079044247-india-develops-unique-model-to-hit-enemy-targets-without-positioning-error/

2.2.2 ISRO-ARIES SSA MoU to Combat Space Debris

As the number of private companies entering the space sector rises, the number of micro and nano-satellites in orbit are rising. This increase adds to the growing concern about space debris. As part of the fight against this, ISRO has signed a MoU with ARIES (Aryabhatta Research Institute of Observational Sciences) to safeguard Indian space assets from space debris – ARIES has experts with years of research on observational astronomy, astrophysics, and atmospheric sciences.[2]

2.3 GNSS Market Trends

2.3.1 Consumer Solutions

2.3.1.1 Ola Connect – A Real-Time Navigation and Tracking Solution

Ola - an Indian ridesharing company – has launched "Ola Connects", a navigation and real-time tracking solution. This tool has been opened to all government and public service organisations free of charge. The team is already in discussion with the government to provide customised solutions to the complex problems arising from the COVID 19 pandemic. The solution will help to manage war rooms established by various state government and track enrolled vehicles/people around the clock. This tool also features an alerting mechanism if they divert into an area of concern (including coronavirus hotspots) through geo fencing controls. This solution can be replicated with many other use cases such as emergency and healthcare support, supply chain management, and even law enforcement.[3]

2.3.1.2 Approval for Beyond Visual Line of Site Drone Testing for Food Delivery

Drones are increasingly being used for last-mile connectivity, which is the final stage of the delivery of goods, most common in food and medicine delivery. Food delivery is another hot topic in this area, with the Director General of Civil Aviation (DGCA) providing approval to Zomato, Swiggy, and Dunzo to start testing beyond the visual line of site (BVLOS) drones for deliveries. Food delivery start-up Zomato has already tested delivery using drones where they carried a payload of 5 kg for 5 km for 10 minutes with a peak speed of 80 km/h. This application of drones could lead to the delivery of food to customers in less than 15 minutes.[4]

2.3.2 Road Transportation & Automotive

India has one of the largest road networks in the world with a road network that transports 64.5% of the goods in the country, as well as 90% of the passenger commuter traffic. This coverage provides a key market for location-based navigation solutions.

2.3.2.1 Aeris Communications Launched their Smart Fleet Management Platform

Aeris Communications launched its smart fleet management platform to address the three biggest challenges that fleet owners face: accidents, thefts, and low fleet efficiency. The smart platform offers features including easy navigation, alerts for speeding, crashes, and thefts, as well as remote tracking and

[2] https://www.newindianexpress.com/nation/2020/jun/07/isro-signs-mou-with-aries-to-tackle-space-debris-2153355.html
[3] https://www.financialexpress.com/industry/sme/ola-to-help-state-govts-manage-their-covid-19-war-rooms-launches-navigation-tracking-tool/1930635/
[4] https://www.livemint.com/companies/news/food-delivery-in-india-via-drones-zomato-swiggy-dunzo-can-start-testing-11591253543250.html

tracing of vehicles. Aeris' earlier solutions were confirmed to use GPS to track vehicles and geofence areas – key features that are seen in this fleet management system.[5]

2.3.3 Drones

India's drone industry is currently booming due to the increased use of drones for commercial applications. Drones are capable of simplifying complex tasks, can work in extreme conditions, and are often capable of working much longer hours than the alternatives. The Indian UAV market is expected to reach $885.7 million (EUR 748 million) by 2021, with the drone space is expected to grow at a CAGR of 18% during 2017-23.

2.3.3.1 Drones Deployed by the State Governments to Combat the Coronavirus

State governments throughout India have worked with startups to assist in the fight against the coronavirus. The governments have deployed drones to monitor crowded places, disinfect contaminated areas, and deliver medicine and essential goods during quarantine.[6]

2.3.3.2 Drones to Curb the Spread of Locusts

India is the first country to use drones to combat the spread of locusts, with the UN's Food and Agriculture Organisation (FAO) appreciating the government's efforts to fight against the desert locusts plaguing the western and central states. The agriculture ministry has just approved the operation of drones at night to combat the locusts when they are more active. Another change in policy is the approval of engine powered drones which can carry larger payloads than the typical battery-powered models.[7]

2.3.4 Emergency Response

2.3.4.1 Kerala Government Launched Mobile App for Citizen Services

Kerala chief minister Mr. Pinarayi Vijayan has launched official app "POL-APP". This app offers 27 citizen services in six domains such as Women and Child related Services, Citizen Safety Services, Information Services, Report to us (complaint redressal system), and Rate our Services (feedback from citizens).

In the Citizen Safety domain, the app facilitates sharing of the user's location with three pre-selected private mobile numbers. In case of any emergency/panic situations, SOS call is generated and sent out to the addressees.

[5] https://analyticsindiamag.com/aeris-launches-smart-fleet-connected-platform/
[6] https://efymag.com/2020/05/08/drone-deliveries-thriving-amid-covid-19/
[7] https://tech.economictimes.indiatimes.com/news/technology/dgca-allows-use-of-drones-at-night-to-ward-off-locusts/76692662

2.4 Macro Technology Trends

2.4.1 Robotics

There is a remarkable adoption of robots, with the automotive industry being the largest adopter of robotic solutions in India. Robots are also being used to do jobs such as sanitizing hospitals or food deliveries.

2.4.1.1 AI Powered Robot IMAP-9 to be Tested In AIIMS

As the number of COVID-19 cases keeps rising, India is experimenting with the deployment of robots in hospitals. Under this effort, AI powered robot iMap-9 will be tested by the All India Institute of Medical Sciences (AIIMS). iMap-9 is a floor disinfecting robot that can navigate and sanitise rooms without any human intervention.[8]

2.4.2 Digitalisation and AI

2.4.2.1 AI Enabled Drones Helping Police Amid Lockdown

The UK-based Blockapps AI and Bangalore-based Tsalla aerospace have developed AI-enabled drones for crowd surveillance. In addition to enabling the manual monitoring of a crowd, the devices are able to automatically detect patterns and anomalies. The tool not only offers the recording but can also calculate the number of people in a crowd – information which police can use to decide whether their involvement is necessary for dispersing the crowd.[9]

[8] https://www.business-standard.com/article/current-affairs/aiims-deploys-robots-to-help-medical-staff-in-the-war-against-coronavirus-120042101078_1.html
[9] https://www.edexlive.com/happening/2020/may/09/ai-enabled-drones-a-result-of-two-start-ups-coming-together-is-alleviating-the-troubles-of-frontli-11821.html

3 China

3.1 Introduction

China has seen many GNSS-related developments this quarter, with the completion of the BDS-3 core constellation, and significant advances in the downstream application industries.

Segment		Key Trends
Upstream		BDS-3 core constellation completed Geely to launch their first LEO satellites this year
Market Trends	Road Transportation & Automotive	Qianxun Location (QXWZ) to provide centimetre level accuracy using GBAS QXWZ and GAC Group New Energy jointly announced the world's first BeiDou 5G vehicle-to-everything (V2X) intelligent car with high precision positioning Zhejiang announced more than 100 transportation projects, including smart highways The piloting of autonomous taxi's on road of Shanghai along with other connected vehicles announced
	Manned Aviation	In order to ensure safe flight, it will be possible for China's civil aviation transport aircraft to use BeiDou for autonomous navigation. Hence, BeiDou will become the standard equipment for China's aircraft China remains very active in in promoting BeiDou application within the International Civil Aviation Organization ICAO
	Drones	Power grid inspection to be done by autonomous drones using the 5G wireless network and QXWZ
	Maritime	BDS used for a contactless ship lock for inland waterways Beibuwan Port Group exploring BDS for smart ports
	Emergency Response	Trial of the geological disaster monitoring early warning platform BDS used in citywide medical waste disposal platform
	Rail	BDS implemented in smart railways and early warning systems
	Agriculture	BDS communication equipment used in fisheries management
	Critical Infrastructures	BDS used in last kilometre port management and in the monitoring of the national gas system

Macro Technology Trends	Robotics	BDS combined with 5G for smart guiding robots 100 smart factories announced
	Big Data	Smart city management in Beijing and Shanghai
	Digitalisation and AI	Meituan super brain uses AI to ensure correct number of delivery drivers
	Climate Change	Unmanned climate station project uses BeiDou for Big Data
	Cyber Security	Increased anti-jamming and anti-spoofing for intelligent vehicles
	Sharing Economy	Hello Bike and Qingju Bike gain BDS access

3.2 Upstream Developments

On 23 June, China successfully launched the 55th navigation satellite of the BeiDou system and the last satellite of the BeiDou-3 network. The BeiDou-3 global satellite navigation system constellation deployment has been fully completed half a year ahead of schedule. The satellite launched is a geostationary orbit satellite, and BDS's services and applications include high-precision GNSS navigation timing services, satellite-based augmentation, short message communication (RDSS), precision single-point positioning, and other special services.[10]

Service Types Provided by BDS in 2020				
Services Types		Services Types	Service Signal(s)	Broadcast Satellites
Worldwide	Positioning, Navigation, and Timing (RNSS)	Spatial signal accuracy is better than 0.5 metres Global positioning accuracy is better than 10 metres, speed measurement accuracy is better than 0.2 metres/second, timing accuracy is better than 20 nanoseconds; with even higher accuracy in the Asian-Pacific region	B1I, B3I	3GEO + 3IGSO + 24MEO
	Global Short Message Communication (GSMC)	Single communication capability 40 Chinese characters (560 bits).	B1C, B2a, B2b	3IGSO + 24MEO
	Inter-national Search and Rescue (SAR)	According to the relevant standards of the International Satellite System for Search and Rescue, it forms a global mid-orbit search and rescue system with other satellite navigation systems for global users, while providing a return link.	Uplink: L Downlink: GSMC-B2b	Uplink: 14MEO Downlink: 3IGSO+24MEO

[10] https://jingyan.baidu.com/article/454316ab128739f7a7c03aca.html

In addition to the global services, BDS also provide the following regional services.

Service Types Provided by BDS in 2020				
Services Types		Services Types	Service Signal(s)	Broadcast Satellites
China and Surrounding Areas	Satellite-based Augmentation System (SBAS)	It meets and in some areas even exceeds performance requirements by the International Civil Aviation Organization (ICAO).	Uplink: UHF Downlink: SAR-B2b	Uplink: 6MEO Downlink: 3IGSO+24MEO
	Ground Augmentation System (GAS)	Provides high accuracy to users within the coverage area of the BeiDou base station network using mobile communication networks or the Internet.	BDSBAS-B1C, BDSBAS-B2a	3GEO
	Precise Point Positioning (PPP)	Provide users in China and surrounding areas with dynamic decimetre-level and static centimetre-level precision positioning services.	2G, 3G, 4G, 5G	Mobile communication networks, Internet
	Regional Short Message Communication (RSMC)	The service capacity is increased to 10 million times/hour. The receiver transmission power is reduced to 1-3 W. The single communication capability is 1000 Chinese characters (14,000 bits).	PPP-B2b	3GEO

Besides the big news from BeiDou, Geely's aspiration for a satellite constellation is also worth attention. Geely first began its venture into the aerospace industry back in 2018 by establishing Geespace – a space technology company. Geespace focuses on the development, launch, and operation of low Earth Orbit(LEO) satellites which will ultimately form a self-sufficient independent satellite network. On 24 April, Geely announced the plan to launch its first two LEO satellites by the end of this year.[11]

[11] https://gnss.asia/blog/gaining-an-edge-in-the-autonomous-driving-industry-geelys-aspiration-for-a-satellite-constellation/

3.3 GNSS Market Trends

In the next 3-5 years, BeiDou is expected to contribute 50% of the output value of the downstream operation services markets, including component, system integration, and services such as maps, telecoms, and other related markets. The market space for location services is valued at 130 billion yuan (EUR 16 Billion), the market space for road applications is projected to reach 230 billion yuan (EUR 28 Billion), and the market space for industrial applications is estimated at 20 billion yuan (EUR 2.5 Billion).[12]

3.3.1 Road Transportation & Automotive

The BeiDou high-precision time and space service network is expanding as the global network of Beidou-3 is completed. The improvement of the infrastructure is expected to speed up China's connected vehicles.

3.3.1.1 Qianxun Location (QXWZ) To Provide Centimetre Level Accuracy Using GBAS

QXWZ announced on 24 June that the "one national network" provided by BeiDou's ground-based augmentation system will achieve full coverage of the national highway network in 2020. This coverage will provide centimetre-level positioning time and space intelligence services in the service area to meet the extensive needs of L3 level and above autonomous driving and vehicle road coordination.[13]

Based on the BeiDou satellite navigation system, QXWZ has built 2,600 BeiDou ground-based augmentation stations across the country, forming a "nationwide network" of BeiDou ground-based augmentation system. It is capable of providing time-space intelligence services of centimetre-level positioning, millimetre-level sensing, and nanosecond-level timing in most regions of China (excluding uninhabited areas). The application of this high-precision positioning service in the smart car industry has very broad prospects.

3.3.1.2 BeiDou High Precision Positioning Service and Connected Vehicles

On 16 June, QXWZ and GAC Group New Energy jointly announced the world's first BeiDou 5G vehicle-to-everything (V2X) intelligent car with high precision positioning. Relying on the BeiDou high-precision spatio-temporal intelligence service provided by QXWZ, the positional accuracy of GAC's New Energy vehicle Aion V reaches centimetre level.[14]

3.3.1.3 Smart Highway Construction

On 17 April, Zhejiang announced more than 100 transportation projects, including the Hangzhou Bay smart highway, and the Shanghai-Hangzhou Maglev - a coastal high-speed rail - with a total investment of over 3.2 trillion yuan (EUR 365 billion). Other project such as the Hangzhou Shaoxing-Ningbo smart highway project and the Hangzhou West Highway project are the first batch of smart highway projects of the Chinese Ministry of Transport. The pilot project – a key supporting project of the 19th Hangzhou Asian Games – is scheduled to be officially opened to traffic by the end of 2022.[15]

[12] https://www.yicai.com/news/100524683.html
[13] https://www.mbachina.com/html/cjzx/202006/241169.htm
[14] https://www.qxwz.com/news/839061153.html
[15] https://finance.sina.com.cn/chanjing/cyxw/2020-05-09/doc-iircuyvi2186833.shtml

3.3.2 Manned Aviation

3.3.2.1 Three Stage Plan to Utilise BeiDou to Guarantee Safe Flight

In order to ensure the safety of aircraft flight, the Civil Aviation Administration of China (CAAC) has **actively promoted the application of BeiDou in transport aircraft**, issuing both *The Implementation Roadmap for the Construction of the Aircraft Tracking and Monitoring System for Civil Aviation of China* and *The Implementation Roadmap for the Application of the BeiDou Satellite Navigation System for Civil Aviation of China*. A "three-step" strategy is proposed to ensure the safe flight of the aircraft.

Year	Planned Development
2021	Realise low-flying positioning and surveillance applications
2025	Fully realise the BeiDou system for general aviation positioning, navigation and surveillance applications
2035	Fully realise the BeiDou system in general aviation

It will be **possible for China's civil aviation transport aircraft to use BeiDou for autonomous navigation which means BeiDou will become the standard equipment for China's aircraft and the guardian of safe flight**.[16] Alongside this, China has been very active in promoting BeiDou application within the International Civil Aviation Organization (ICAO).

3.3.3 Drones

3.3.3.1 Smart Grid

Power drones combine high-precision positioning, speed measurement, and GIS to achieve stable, reliable, and efficient route patrol, saving significant labour, material, and time costs. Through their access to the smart grid proprietary services, Guangdong Power Grid partnered with QXWZ, operating 900 drones with autopilot which have reached a total operating mileage of 120,000 km. Guangdong province will manage all power grid inspection work using autonomous patrolling drones by 2023.[17]

3.3.4 Maritime

3.3.4.1 Shipboard BeiDou Smart Terminal

Beibuwan Port Group is the first enterprise in China to apply "BeiDou Terminal +APP" for contactless ship locking in the inland waterway sector. **The system will automatically generate vessel information when the vessel sails near the reserved lock using BeiDou to locate the vessel with high precision**. It will assist the dispatching centre by allowing vessels to report to the gate without docking, to pay fees without stopping, and to report to the gate as soon as it has passed through the entire river basin. As of June 2020, more than 3,700 ships in the Xijiang River Basin have been equipped with on-board BeiDou smart terminals, with the cumulative total of "ETC" (Automatic Toll Collection without Stopping Vessels) ships reaching 355,000 and the cumulative amount of fees paid by shipowners online exceeding RMB 160 million (EUR 20 million).[18]

[16] http://company.stcn.com/2020/0119/15607382.shtml
[17] https://www.qxwz.com/news/224457810.html
[18] https://www.sohu.com/a/404378533_732289

3.3.4.2 Smart Port and Logistics Network

In addition to ship lock management, Beibuwan Port Group is also exploring the application of BeiDou technology in port, logistics, and in the engineering construction businesses. The Group has carried out all-round strategic cooperation with Huawei and other top domestic technology companies to jointly tackle scientific research and increase the "BeiDou+" application technology. There is focus on the construction of information technology, to support the digital transformation of the group, and to ultimately realise a paperless port that operates using smart logistics.

3.3.5 Emergency Response

3.3.5.1 Natural Disaster Monitoring

In May, Mianyang's brand new geological disaster monitoring and early warning platform had a trial operation, with the first 176 geological potential disaster sites in Mianyang city being included on the platform which is providing 24-hour online monitoring. The most "scientific and technological" of these is Jiuzhou BeiDou – who participated in the research and development of automated landslide monitoring system. This is a "Mianyang-made" system with BeiDou high-precision positioning terminal which can provide real-time monitoring of landslides.[19] Before a landslide or collapse occurs, the mountain begins with a small displacement at the millimetre level, this displacement increases over the following days until it reaches a critical point where a disaster could occur within minutes. The BeiDou system, with its precise positioning function, pays attention to this "tiny difference" in the danger zone through real-time monitoring.[20]

3.3.5.2 Monitoring and Management of Medical Disposal

Wuhan, Hubei Province, has established a citywide, medical waste disposal, dispatch command centre to assist in the regulation of the medical waste during the COVID-19 pandemic with the support of IoT and BeiDoi. As part of this initiative, the system uses a peer-to-peer approach to collect data on medical waste including its location, quantity, origin, timing, and final destination. The Wuhan Municipal Commission of Urban Management and Wuhan Eason Electronic Information Technology created a joint Intelligent Surveillance Platform to ensure that medical waste can be transferred and disposed safely and efficiently to prevent secondary contamination.[21]

3.3.6 Rail

3.3.6.1 BeiDou Railway Industry Application Demonstration Project

A special project of China's second-generation satellite navigation system – BeiDou Railway Industry Comprehension Application Demonstration Project, co-sponsored by the National Railway Administration and the China Satellite Navigation System Management Office – kicked off on June 9. This project aims to combine BeiDou with China's state of the art high-speed railway system, and it is to be deployed in nine major railway industries, with a total of 8,000 sets of BeiDou terminal equipment already having been installed. The project will include location-based data to track containers and trains as well as assist in measurements and inspections. This project is being built around "1+1+9" – which involves the construction of a big data centre, building a spatio-temporal information cloud platform, and integration of big data, GIS, IoT, 5G, cloud computing, and BIM technology – all of which is aimed at serving the construction of the 'Belt and Road' initiative.[22]

[19] http://www.sc.chinanews.com/bwbd/2020-05-16/128139.html
[20] https://www.scbdlbs.com/info-news.aspx?m=SCCompass&cid=384&mid=266&t=%d0%c2%ce%c5%d7%ca%d1%b6
[21] http://www.beidou.gov.cn/yw/xydt/202004/t20200428_20421.html
[22] https://tech.sina.com.cn/roll/2020-06-09/doc-iirczymk6083360.shtml

3.3.6.2 Railway Collapse Disaster Monitoring and Early Warning System

The Chengdu-Kunming railway construction was rerouted between Lianghong and Ed'ai station, with the water damage related construction being completed on 28 April. A multi-source geological disaster monitoring system based on the BeiDou system was established and the "air-sky-earth" system was built. The team has developed a "Chengdu-Kunming Railway Collapse Disaster Monitoring and Early Warning System", which provides early warning to the deformation characteristics of the slope to foresee and avoid disasters in advance. For rockfall on the road and other emergencies, the alarm information will be transmitted to the on-site monitoring command centre within 3 seconds.[23]

3.3.7 Agriculture

3.3.7.1 1,300 Ships Equipped with Ship Position Monitoring Systems

Ships in the middle and distant seas – beyond 50 nautical miles off the southeast coast of China – are equipped with BeiDou-based maritime communication equipment for fisheries management. More than 1,300 ship position monitoring systems have been established, and a centralised ship monitoring and control management system integrating sea, sky, and land has been built. By the end of 2018, such metasystem supplied nearly 70,000 users with access to the network and 8 million daily position data points, fusing BeiDou short messages and Internet and other means of communication technology. As a result, a cumulative total of more than 210 fishing boats were rescued in the past three years, preventing economic losses of more than 1 billion yuan.[24]

3.3.8 Critical Infrastructures

3.3.8.1 State Grid Management

Relying on the BeiDou system, the State Grid will build 1,200 BeiDou ground-based augmentation base stations nationwide to form a ground-based augmentation system for the BeiDou precision space-time service network. It will provide real-time centimetre-level and post-processing millimetre-level high-precision positioning services both above and below ground for power grid business and industrial applications.[25]

The BeiDou system can effectively detect subtle anomalies in the power grid composition system, avoid large accidents, and provide the basic service of satellite navigation system – timing service. BeiDou's timing accuracy is better than 20 nanoseconds globally, which improves to better than 10 nanoseconds in the Asia-Pacific region. In addition to being sufficiently fast, the BeiDou timing terminal has a bi-directional timing function, which allows the synchronisation of all time within a region. The device's over-the-air wireless network channel can send always-on data to the management system in the monitoring centre, maintaining the device's Normal operation.[26]

3.3.8.2 Smart Port

Port transportation efficiency directly affects the quality and efficiency of the "last kilometre" of port logistics and is an important part of smart port construction. The main challenge is how to make dozens of container trucks in the closed and complicated port area to locate precisely, move in order, and move smarter. Shenzhen Mawan Harbour District and Cathay Nebula adopted the combined navigation technology based on BeiDou, effectively solving the problem of temporary failure or instability of satellite

[23] http://www.beidou.gov.cn/yw/xydt/202004/t20200429_20428.html
[24] http://www.beidou.gov.cn/yw/xydt/202004/t20200417_20387.html
[25] https://ecep.ofweek.com/2020-06/ART-93016-8120-30445771.html
[26] Ibid

positioning signal caused by blocking and differential link interference, as well as achieving continuous and stable positioning of the container truck.[27]

3.3.8.3 Consumer and In-House Gas Network Smart Management

In the Beijing gas industry, **BeiDou navigation is widely used in pipeline operation, leak detection, construction cooperation, emergency repair, and other major event services**. In 2020, Beijing Gas Group employees should have the ability to use the BeiDou handheld mobile terminal production and operation system to optimise a variety of production and operation business. The app, which provides access to BeiDou's precise navigation services, **allows operations and inspection personnel to view individual pipelines at particular locations and to compare pipeline networks in real time GIS diagram**. It greatly reduces the area of a leakage detection, lowers the risk of sabotage, and improves timely detection of potential gas leaks, operation coverage, and testing self-examination rates.[28]

3.4 Macro Technology Trends

3.4.1 Robotics

3.4.1.1 Guiding Robots for the Visually Impaired

The convergence of 5G and BeiDou is a catalyst for the rapid grounding of AI with guided robots being one example application scenario. To solve the problem for the visual impairment individuals to be able to travel independently, Li Qingzhong, chairman of the China Visual Impairment Association, submitted a report on **Accelerating the Development of Artificial Intelligence in the 5G Environment of Guide Robots** and suggested that the research and development of guide robots should be increased, and policy protection should be strengthened.[29]

3.4.1.2 100 Benchmark Unmanned Factories Plan

Shanghai released its plan in mid-June, where it is aiming to build **100 unmanned factories in the city by 2022**. They will be creating ten demonstration smart factory, eight smart manufacturing industrial parks – including the Jinqiao 5G Industry Ecological Park, Lingang Nanqiao Zhixing Eco Valley, and other industrial parks focusing on the **development and testing of connected vehicles**.[30]

3.4.1.3 Vehicle-to-Everything Testing Equipment Rolled Out for Robotaxi Services

Chinese ride hailing giant Didi Chuxing is **piloting its "robotaxi" service in Shanghai's Jiading District**, taking a tentative step toward its grandiose goal of **operating more than 1 million autonomous vehicles by 2030**. The driverless taxis are powered by "vehicle-to-everything" (V2X) technology, which enables cars to interact with road infrastructure such as traffic lights. **The company said that it has installed V2X equipment at major junctions within the test areas**.[31]

[27] http://cn.cathaynebula.com/
[28] http://sdjsb.bjd.com.cn/html/2020-07/06/content_12470243.htm
[29] http://canjiren.china.com.cn/2020-05/27/content_41166035.html
[30] http://sheitc.sh.gov.cn/zxxx/20200617/2b33ea1749974bb0b096031f37efc8ec.html
[31] https://mp.weixin.qq.com/s/xa2zVD-FA6moP0aOtQI6GQ

3.4.2 Big Data

3.4.2.1 Shanghai City Supervision Network

Shanghai will implement a database to supervise street-side businesses by the end of 2020 according to Xu Zhihu, director of the Shanghai Urban Management and Law Enforcement Bureau. The data base will contain 22 sub-categories covering supervision objects such as transportation and disposal units for kitchen waste and waste oil, construction sites and transfer terminals, persons responsible for domestic waste management, catering enterprises, real estate brokerage agencies and personnel, street advertising and shop signs, real estate development enterprises, commercial property sales enterprises, housing rental enterprises, real estate surveying and valuation agencies amongst other sub-groups.[32]

3.4.2.2 Beidou Technology Innovation and Industrial Development

According to Beijing's '*Implementation Plan for Promoting BeiDou Technology Innovation and Industrial Development (2020-2022)',* BeiDou will be deeply applied in seven major fields such as the smart Winter Olympics, environmental protection, and smart transportation which will create a benchmark for smart cities in China. The plan proposes to build a high-precision signal service network based on core technologies such as Geographic Information Systems (GIS) and Building Information Modelling (BIM) which will be integrated with Beijing's 5G planning layout. The high-precision signal service network will ensure that the city's outdoor real-time precise positioning accuracy is better than 1 meter and that the accuracy in key areas is better than 5 centimetres.[33]

3.4.3 Digitalisation and AI

3.4.3.1 Meituan Super Brain

The "Meituan Super Brain" system dispatches 700,000 riders across the country, delivering more than 30 million orders per day. At its peak, the system executes its path planning algorithm approximately 2.9 billion times per hour, silently ensuring that all orders are delivered safely and quickly to customers. It is reported that the "Meituan Super Brain" system has gone through 5 generations since it was launched in 2015, and the latest version 5.0, when the "Meituan Super Brain" system upgrade was released. The biggest challenge is matching the influx of new orders with the surrounding riders in real time or in a very short period of time. Achieving the optimal balance between efficiency and cost requires huge computational volumes, extremely high computational speeds, and complex algorithmic models.[34]

3.4.4 Climate Change

As one of the eight national unmanned climate station projects, the Nalingrad River National Standard Unmanned Climate Monitoring Station in Qinghai Province successfully utilised BeiDou to upload data in May. The completion of the unmanned climate station is not only useful for research and development, but also for the creation of a new climate system. It provides an important scientific basis for the protection of the ecological environment of the Nalingrad River basin as well as rationalisation of the climate resources of the region and the country as a whole.[35]

[32] http://www.shanghai.gov.cn/nw2/nw2314/nw2315/nw4411/u21aw1455005.html
[33] http://www.beijing.gov.cn/zhengce/zhengcefagui/202002/t20200224_1667898.html
[34] http://finance.eastmoney.com/a/202007101549824925.html
[35] https://www.thepaper.cn/newsDetail_forward_7493664

3.4.5 Cyber Security

3.4.5.1 Smart Vehicle Cybersecurity Eco-System

The Innovative Development Strategy of Intelligent Vehicles states that China will build a comprehensive and efficient smart vehicle cybersecurity system, enhancing the network security protection capability and establishing anti-jamming and anti-spoofing security protection systems for BeiDou.[36]

3.4.5.2 In-Vehicle and Cloud Connection Security

360 Sky-Go is a complete solution for cyber security risks of connected vehicles, which consists of "in-vehicle and cloud" end-to-end solutions. It is composed of security products and systems which jointly establish a deep defence system that can sense, analyse, and respond to automotive network attacks. By deploying hardware and software security products at the end of the vehicle, security-related data is collected at the cloud platform to evaluate the risk of automotive network security.[37]

3.4.6 Sharing Economy

3.4.6.1 Hello Bike

On 23 June, Hello Travel announced that its shared bikes have full access to the BeiDou positioning service. The big data centre of Hello receives hundreds of millions of positioning information data points from the Hello bikes on the road every day. The BeiDou positioning device is included in the smart lock of each Hello bicycle, which receive BeiDou satellite signals and sends them to the data centre. By collecting vehicle positioning information in the background, Hello Travel understand the real-time location and action trajectory of each vehicle, turning the data into big data. Even in specific areas where the BeiDou signal is weak, Hello now augments the signal with a Bluetooth beacon electronic fence positioning technology. The technology's positioning accuracy has been tested successfully at the sub-meter level with a success rate of more than 95%, and it recently received an invention patent authorisation notice, making it the first company in the bike sharing industry to be granted a patent for precise positioning algorithms.[38]

3.4.6.2 Qingju Bike, Didi's Share Bike Brand

Didi's Qingju GEO models equipped with BeiDou's high-precision navigation and positioning chips are in operation in Shenzhen, Wuhan, and Beijing amongst other cities. Shenzhen is the first area where Qingju's intelligent split locking system is in operation, relying on BeiDou's high precision positioning chip. The system can lock the vehicle's door, with the locking position limited at a centimetre level. With the addition of BeiDou technology, operations and maintenance personnel can get real-time information about vehicle dynamics on the road, traffic tides, cycling hotspots. This allows the accumulation of vehicles and the private occupation of bicycles to be controlled effectively. Since April this year, the proportion of users parking their bicycles at designated spots in Shenzhen has reached 95%.[39]

[36] http://www.beidou.gov.cn/zt/zcfg/202003/t20200304_20138.html
[37] https://www.leiphone.com/news/202003/nBUwqOFnHSyc9BhF.html
[38] http://www.cb.com.cn/index/show/gs/cv/cv12531639139
[39] http://www.xinhuanet.com/tech/2020-06/23/c_1126150232.htm

4 Taiwan

4.1 Introduction

Taiwan holds a significant position in the global GNSS industry value chain, being home to some of the largest chip manufacturers and semiconductor board integrators. Taiwan is perfectly located to reap the benefits of a multi-GNSS environment, with access to several global and regional services. The Taiwanese industry is characterised by its swift reaction to market trends, with a current focus on consolidating opportunities in consumer solutions, automotive sector, smart transportation, electronics, and IoT. With an unparalleled foundation in hardware manufacturing, Taiwan companies move on to the growing integration of hardware and software, especially when it comes to 5G, AIoT, big data, and industry 4.0. As digital marketing and e-commerce mature, new opportunities have been shaping up with many Taiwanese startups developing a variety of cross-domain smart tech solutions, such as integration of 5G telecom infrastructure, diverse sensor-based IoT equipment, blockchain, and AR/VR/MR applications

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Segment		Key Trends
Upstream		Increasing NewSpace industry seen in Taiwan
Market Trends	Consumer Solutions	SkyTraq launched a 12mm x 16mm size PX1122R multi-band RTK receiver 5G launched, including pilots of smart buses, and new 5G smartphones Mobile payments more popular than credit card payment
	Road Transportation & Automotive	Funding and subsidies for experimental unmanned vehicles, including several ongoing and future trials
	Drones	Successful UTM trials in Tainan Drones used in disease prevention, disaster relief, and agriculture, as well as observing the atmospheric boundary layer
	Maritime	Automatic identification system used to improve search and rescue, increase safety, and identify ships
	Agriculture	Night-time fishing patrols reduced by using drones
Macro Technology Trends	Robotics	Shift to develop full robot system rather than components
	Big Data	Apps used to fight COVID-19, classifying risk and providing border passes
	Digitalisation and AI	Government looking to develop new national digital technology development agency Advancements in AI in both manufacturing and healthcare
	Sharing Economy	Funding for smart-scooter sharing using GNSS

4.2 Upstream Developments

Taiwan's public, private, and academic space programmes are benefitting from President Tsai Ing-Wen's emphasis on strategically developing the space and defence industries, with the aim to self-build satellites and components, as well as develop applications in earth observation and communications.

On the commercial side, there are already many Taiwanese original equipment manufacturers (OEMs) accepting contracts from companies such as SpaceX to mass produce component-level electronic, mechanical, and telecommunications devices for space applications. This can be considered as an extension of the work these companies have performed in the past as OEMs in the electronics and mobile telecommunications sectors. There is also a growing interest in Taiwan's dominant semiconductor industry for developing space-grade solar cells.

4.2.1 NewSpace focus

Taiwanese companies have begun to develop more sophisticated products such as specialised satellite optical sensor systems as well as ground station systems for spacecraft tracking, telemetry, and communications. There has correspondingly been a push by small and medium enterprises to develop small satellites for AIS and ADS-B tracking (which relate to IoT), and even launch services. Most prominent among these firms is Taiwan Innovative Space (TiSPACE), which is developing hybrid engine sounding rockets and small satellite launch vehicles, with the first launch being planned this year.

On the public and academic sides, multiple universities in Taiwan are developing small satellite programs for educational, scientific, and technological development purposes. These programs are funded by NSPO as well as by the Ministry of Science and Technology (MOST):[40]

- NSPO: continues to work on the development of several large satellite missions such as FORMOSAT-7R/Triton to measure sea surface winds. Another mission is FORMOSAT-8 which will be used for optical remote sensing. NSPO is furthermore beginning to execute the third phase of the national space program. This involves the ambitious goal of developing 10 satellites over the next decade for remote sensing and communications purposes. It also has the objective of moving out of LEO and into deep space.
- National Central University: two small satellites called IDEASSat and SCION-X, which will carry out science missions to study the Earth's ionosphere, atmosphere, and aerosols. The university is also working with international partners in the United States, India, and Singapore to provide scientific payloads.
- National Ocean University and National Formosa University: two small satellites – YuSat and NutSat – will be used as part of the technological demonstrations for maritime and aeronautical tracking.
- National Cheng Kung University: participated in the QB50 constellation with the Phoenix CubeSat and together they are working on integrating machine learning into satellite remote sensing payloads.

Meanwhile, Tong Hsing Electronic Industries – which supplies ceramic substrates and backend services for CMOS image sensors (CIS) and other niche ICs – has broken ground for a new plant complex in Taoyuan, northern Taiwan, which will become the firm's business headquarters. The company will move towards high-frequency modules such as 5G and aerospace applications.

[40] https://filling-space.com/2020/04/17/what-is-happening-in-taiwans-space-sector/

The company is also deploying the 5G market in advance for applications on low-orbit satellites. SpaceX is Tong Hsing's major space client in America for its Starlink satellites. Tong Hsing Electronics currently has three major automotive CIS customer orders.[41]

4.3 GNSS Market Trends

4.3.1 Consumer Solutions

4.3.1.1 Multi-Band RTK Receiver Launched

SkyTraq launched a 12mm x 16mm size PX1122R multi-band RTK receiver for centimetre-level accuracy positioning applications. It works with the four main global navigation satellite systems using GPS L1/L2C, Galileo E1/E5b, GLONASS L1/L2, and BeiDou B1I/B2I signals concurrently to maximise positioning availability even in difficult urban environments. Based on a single-chip SoC design, PX1122R is currently the smallest size, lowest power, multi-band multi-GNSS RTK receiver module on the market.[42]

4.3.1.2 Launch of 5G Services

5G debuted in Taiwan on 1 July 2020, setting off a new round of competition in one of the world's most fiercely contested markets. The National Communications Commission (NCC) has successively granted 5G licenses to Chunghwa Telecom, Far EasTone Telecommunications, and Taiwan Mobile. All three telecommunications company have plans to launch their 5G services in the third quarter of this year. Yet, certain legal aspects such as approval of the frequency allocation are still pending.[43],[44]

Taipei launched a 5G Smart Bus pilot test between June and July. Taipei residents had an opportunity to try out the full potential of the 5G technology as part of the 5G Bus: Ride to Experience Innovative Service project. As part of this proof-of-concept initiative, several 5G-technology-equipped buses operated in Xinyi District and allowed the passengers to enjoy the 8K/4K resolution broadband streaming during the 15-minute journey.[45]

As the 5G services provider on the 5G Smart Bus, Changhua Telecom plans to offer five 5G-enabled smartphones from Samsung, LG, and Sony, while HTC might join the list later. The company also plans to spend more than NT$27 billion (EUR 776 million) deploying wireless networks in the next three years.[46]

4.3.1.3 Growing Presence of Mobile Payment

A survey conducted by Taiwan's Market Intelligence & Consulting Institute (MIC) showed that mobile payment surpassing credit cards as the most popular form of electronic payment. A total of 35% of respondents said they preferred mobile payment, while 33% preferred credit cards. The most popular form of mobile payment is LINE Pay, followed by the local JKoPay and Apple Pay. Among consumers' common transaction methods, mobile payment has grown from 43.8% in 2018 to 59.7% in the first half of 2020, tying the third-placed electronic ticket (60.1%) for the first time.[47]

[41] http://technews.tw/2020/07/17/tong-hsing-powers-5-billion-new-plant-starts-will-attack-the-low-orbit-satellite-market/?fbclid=IwAR3KPIFfSJMdRfk-BwCPVnEMZ0M0dPZUx-emEPWoVfdYRL7w8H6Jcagm8rM
[42] https://www.skytraq.com.tw/homesite/news/skytraq-launches-small-multi-band-gnss-receiver-with-1cm-position-accuracy?send_to=%2Fhomesite%2Fnews
[43] https://www.taipeitimes.com/News/taiwan/archives/2020/06/18/2003738437
[44] https://www.lightreading.com/asia/5g-to-start-in-taiwan-on-july-1/d/d-id/761560
[45] https://english.gov.taipei/News_Content.aspx?n=A11F01CFC9F58C83&sms=DFFA119D1FD5602C&s=DCE488824FA2EF7D
[46] https://taipeitimes.com/News/biz/archives/2020/06/11/2003737997
[47] https://en.rti.org.tw/news/view/id/2003599

4.3.2 Road Transportation & Automotive

4.3.2.1 Development of Autonomous Driving

Based on the Unmanned Vehicle Technology Innovation and Experiment Act passed in 2019, the Ministry of Economic Affairs (MOEA) provides a subsidy scheme for experimental or trial operation of unmanned vehicles. Applicants for MOEA's subsidies have to propose detailed experiment plans, including information on the number of autonomous electric buses, the number of trips a day, the time interval between two consecutive trips, the volume of high-precision electronic maps (in km) in use, and needed roadside IoV (Internet of Vehicle) infrastructure.

As of June 2020, MOEA has approved six applications from four companies including Kingwaytek, Kaohsiung City Shipping, Turing Drive, and Lilee Systems. Among the cases, five are for self-driving cars and one is for self-driving boats. All of them have been tested on actual roads, including Changbin Industrial Park, Kaohsiung Love River, Taipei Xinyi Road Bus Lane, Tainan Shalun Smart Green Energy Science City, Danhai in New Taipei City, Taoyuan Qingpu, and other places.

Turing Drive received permission for the one-year project from the Ministry of Economic Affairs (MOEA) – which oversees the operation of all autonomous vehicles in Taiwan. Turing – a Taiwanese startup specialising in autonomous driving system development – is the coordinator of the project, which also consists of ThinkTron, which is responsible for establishing high-resolution electronic maps; International Integrated Systems for connecting the trail run with the city's traffic lights information system; AIMobile for installing cameras at road intersections; Tron-e Technology for making the autonomous electric buses; and, Trillion Green Energy who are designing a control system for the vehicles.

The three autonomous electric buses were in the POC (proof of concept) experimental stage to test their response to various scenarios between May and August, with technical staff members but no passengers on board. Based on the results of the POC experiment, POS (proof of service) trials with passengers will be conducted from September 2020 till February 2021.[48],[49]

4.3.3 Drones

4.3.3.1 Successful Regional UTM Trials in Taiwan

There have been advancements with Taiwan's upcoming UAV unified traffic management (UTM) system. The proposed UTM is using a similar concept of ATM from the aviation industry. The UTM system has recently finished the current stage of testing, and it proposes to divide the airspace at an altitude of 400 feet. The regional UTM (RUTM) is managed by the local government, with the national UTM (NUTM) being managed by the Civil Aeronautical Administration (CAA). The effectiveness of UAV surveillance under 400 ft was examined using a method similar to an automatic dependant surveillance-broadcast (ADS-D) via on-board units (OBU). This system also includes ground transceiver station (FTS), and in these tests, five long-range area network (LoRa) gateways and one automatic packet reporting system (APRS) I-Gate have been deployed to cover the Tainan Metropolitan area.[50]

[48] https://smartcitiesconnect.org/taipei-and-turing-drive-set-to-trial-runs-of-autonomous-electric-buses-in-may/
[49] https://technews.tw/2020/07/07/moea-autonomous-vehicle-technology-innovative-experimentation-program/
[50] https://www.mdpi.com/2226-4310/7/5/65/htm#B8-aerospace-07-00065

4.3.3.2 Drones Used in Agriculture

Taiwan's drone industry provides applications in the fields of disease prevention, disaster relief, and agriculture. The drones are creating a new "flightpath" for smart agriculture in Southeast Asia.[51]

4.3.3.3 Air Pollution Monitoring

The Central Meteorological Bureau of the Ministry of Communications, in collaboration with the Environmental Protection Agency of the Executive Yuan and the Department of Atmospheric Sciences, National Central University, carried out the first observation of drones in the atmospheric boundary layer at the Tianzhong Weather Station in Changhua County. The new field of air quality integrated observations will be combined with existing ground observations in the future to provide more comprehensive monitoring and forecast information for the three-dimensional observation system. To increase the density and resolution of the atmospheric boundary layer, and to solve the problem of lack of atmospheric boundary layer data, the team tried to use the self-developed drone equipped with various sensors to conduct direct observations of the atmospheric boundary layer in the northern, central, and southern regions of Taiwan and completed the first continuous flight in the Tianzhong Meteorological Station in Changhua County. The uninterrupted flight observation experiment used micro-sensor technology to collect high-resolution temperature, wind speed, relative humidity, atmospheric pressure, and PM2.5 data in the atmospheric boundary layer.[52]

4.3.4 Maritime

4.3.4.1 Automatic Identification System (AIS)

Since 2018, Ministry of Transportations and Communications (MOTC) has planned to let all vessels weighing 20 gross tonnage or more to have an AIS. MOTC also established 14 bases and 19 navigation stations as part of the national AIS and provided dynamic status information for ships within 20 nautical miles of Taipei, Penghu, Kinmen, and Matsu. In addition, in compliance with the International Cospas-Sarsat Programme Agreement (ICSPA), the MPB has increased efficiency of search and rescue: it has initiated the establishment of MEOSAT terminals, which have already entered the test operational phase. Such efforts have contributed to enhancing the safety of maritime routes.[53]

Taiwan International Ports Corporation (TIPC) commissioned the Harbor and Marine Technology Center, Institute of Transportation, MOTC, to establish a Vessel Speed Reduction Surveillance System (VSRSS) to ensure the capability of instantaneous feedback from vessels entering and leaving major ports in Taiwan. The VSR is based on the Automatic Identification System (AIS) navigational equipment that provides dynamic real-time data currently used by ships making international journeys. Seven Ports in Taiwan are now disclosing the VSRSS information the website.[54]

Altek Marin's new WideLink B600S, an upgraded AIS platform, is FCC proved. Its sensor data such as heading, speed, depth, temperature, wind, pressure, etc. along with AIS and GPS information can be sent to and displayed on chart plotters and PC programmes. [55]

[51] https://nspp.mofa.gov.tw/nsppe/news.php?post=180482&unit=410&unitname=Stories&postname=Help-from-Above:-Taiwanese-Drone-Technology
[52] https://www.chinatimes.com/realtimenews/20200714002211-260405?chdtv (in Chinese)
[53] https://en.motcmpb.gov.tw/Information/Detail/1b0bad26-3f38-4b13-8488-f6ab000190d0?SiteId=2&NodeId=10014
[54] https://www.twport.com.tw/en/cp.aspx?n=73EA6EF0477205D4
[55] http://www.alltekmarine.com/news_detail.php?year=2020&nid=72

4.3.4.2 Digital Navigation

Taiwan's Yang Ming Transport Corp is constructing ten new containerships and has selected VisionMaster Net from Sperry Marine as the cornerstone of its digital navigation strategy. VisionMaster Net is a networked bridge solution providing simplified deployment and increased system availability as well as creating the foundation for big data from the bridge to increase operational efficiency whilst reducing through-life costs.[56]

4.3.5 Agriculture

4.3.5.1 Aquaculture Fishery Monitoring

A research team from College of Management, National Sun Yat-sen University (NSYSU) combined drones with cloud monitoring, infrared, IoT and other related technologies and instruments to provide night security monitoring, spectral instrument detection of water quality, automatic path planning, and cloud monitoring systems. The team also integrated these functions into an APP, so that fishermen can grasp the situation of fish farms anytime and anywhere. Fishermen can follow the route to the fishing grounds through the app remote drone, and use image recognition technology to obtain images of the pool to monitor the water quality and confirm the operation of the waterwheel. In addition, they can combine the infrared system to arrange regular drone patrols to effectively prevent people from cutting wires. The use of monitoring systems to replace manpower for malicious acts such as poisoning fish also reduces the need of fishermen patrolling at night. In this project, the asset management team used information expertise to combine the information of fishermen's associations, fishermen, and suppliers to collect and build an "information sharing platform" to allow fishermen to get the latest information in real time through the circulation of information.[57]

4.4 Macro Technology Trends

4.4.1 Robotics

4.4.1.1 Catching up with East Asia

Taiwan is shifting from key components design to full robot system design. Most companies in Taiwan's industrial robot supply chain are involved in component areas and focus primarily on the Greater China markets:

- Airtac who produce pneumatic equipment
- Delta who produce inverters and servo motors
- Hiwin who produce linear motion components, and
- Teco who produce motors.

In recent years, these companies have been increasing their efforts to develop industrial robots in Taiwan. Some companies have even come up with robot products by leveraging their capabilities in other non-robotic areas, such as Quanta Storage who manufacture optical storage.

Taiwan is aware of its lack of capability to deliver large-scale robot automation to its industries and is also very mindful of the looming consequences of its inaction. The higher-scale robots are just the types needed for any shot at successful robot automation of Taiwanese industry. A few manufacturers and research

[56] https://www.thedigitalship.com/component/k2/item/6142-yang-ming-embraces-digital-navigation-with-sperry-marine-s-visionmaster-net
[57] https://www.cm.nsysu.edu.tw/p/406-1024-238490,r16.php?Lang=zh-tw

institutes have begun to develop high-scale robots. However, Taiwan has to import critical components (e.g. server motor, controller, decelerators) for these robots from foreign countries. Companies such as Advantech are working to combat this through joint partnerships with both local and Japanese companies to help foster Taiwan's robot industry, boost intelligent automation, and develop factory automation systems.[58,59] A recent event examining this was the TAIROS – Taiwan's Automation Intelligence and Robotics Show – which was held on 19-22 August 2020.[60]

4.4.2 Big Data

4.4.2.1 Application to Fight Covid-19

Taiwan leveraged its national health insurance database and integrated it with its immigration and customs database to begin the use of big data for analytics. The combined system is now capable of generating real-time alerts during a clinical visit based on travel history and clinical symptoms to aid case identification. Taiwan also used other new technologies, including QR code scanning as well as online reporting of health symptoms to classify travellers' infectious risks based on flight origin and travel history in the past 14 days. People with low risk (no travel to level 3 alert areas) were sent a health declaration border pass to their phones via SMS for faster immigration clearance. Travellers with higher risk (recent travel to level 3 alert areas) were quarantined at home and tracked through their mobile phones to ensure that they remained at the designated area during the incubation period.[61]

A research paper authored by Vice Premier Chen Chi-mai (陳其邁), a physician, along with others on contact tracing used by Taiwan in containing COVID-19 has been published by a leading international medical journal. The article explores how Taiwanese authorities used big data to trace the movements of more than 600,000 people who came into contact with passengers of the Diamond Princess cruise ship in January.[62]

4.4.3 Digitalisation and AI

4.4.3.1 Preparation for a New National Digital Technology Development Agency

President Tsai has said that the government is studying to set up a digital technology development agency to integrate the five fields of information, information security, telecommunication, network, and communication – a move supported by the private sector. [63]

4.4.3.2 AI Workforce and Industry Transformation

Much of Taiwan's industry is being transformed by the introduction of AI technologies, particularly in the areas of manufacturing and healthcare. Taiwan stands to reap the most benefits by integrating innovative software capabilities into its existing hardware infrastructure.[64]

While Taiwan's high-quality workforce is praised by local and international businesses alike, the supply of domestic talent is insufficient to meet the rising demand, especially for those with expertise in such a new technology as AI. Positions in long-established local companies like Taiwan Semiconductor Manufacturing (TSMC) and Mediatek were traditionally more lucrative than those in the software engineering field. One

[58] https://asianroboticsreview.com/taiwan-html
[59] https://asianroboticsreview.com/taiwan-2-html
[60] https://www.tairos.tw/en/visitor.asp
[61] https://www.rand.org/pubs/external_publications/EP68123.html
[62] https://www.taipeitimes.com/News/taiwan/archives/2020/05/07/2003735977
[63] https://digi.taiwan.gov.tw/news/private-sector-in-taiwan-urges-government-to-set-up-new-agency-to-manage-digital-technology/
[64] https://topics.amcham.com.tw/2020/05/where-taiwan-can-make-the-most-of-ai/

of the biggest challenges for incorporating AI and other software-oriented solutions further into Taiwan's industries is the slow pace of digital transformation on the island.

4.4.3.3 AI-Chipsets and the Fight Against Covid-19

Industry, government, and academia are all working together to create a vibrant AI ecosystem in Taiwan.[65] The Taiwan Semiconductor Research Institute (TSRI) presented an AI system on chip (SoC) design and verification platform to help academia to reduce the time and cost needed to develop AI-related chips.[66] The AI New Generation Talent Training Program (AIGO) of the Industrial Development Bureau (IDB) cooperates with Advantech to set up Thailand-Taiwan AI College (TTAIC) to boost AI upgrading and digital transformation for Taiwanese entrepreneurs.[67] A Taiwanese team from the National Cheng Kung University (NCKU) uses AI to detect potential COVID-19 patients in the #BuildforCOVID19 Global Online Hackathon organised by the WHO.[68]

4.4.4 Sharing Economy

4.4.4.1 Development in Scooter Sharing

WeMo recently announced it has raised a multi-million-dollar Series A round of funding led by AppWorks, making it the Taiwanese venture capital firm's first smart mobility investment. The funding is being used to expand beyond Taipei City, New Taipei City, and Kaohsiung – WeMo's current markets – with plans to go international launching first in Southeast Asian countries. In Taiwan, WeMo competes with iRent, a car and scooter rental service, as well as GoShare, the mobility-sharing platform Gogoro launched a year ago. WeMo partnered with Kymco, one of Taiwan's largest scooters brands. Each scooter is equipped with an internet-connected black box that was developed in-house by WeMo. The black boxes enable WeMo to manage its fleet's batteries, while providing data from rides, including traffic and road quality (for example, it detects when streets are bumpy) that can be shared with policymakers to improve transportation infrastructure. The black boxes also connect with WeMo's user app, showing where scooters are available, unlocking them, and sending alerts about traffic conditions.[69]

[65] https://topics.amcham.com.tw/2020/05/taiwan-tests-limits-ai/
[66] https://ai.taiwan.gov.tw/news/semiconductor-research-facility-showcases-soc-design-platform/
[67] https://ai.taiwan.gov.tw/news/aigo-cooperates-with-advantech-on-setting-up-thailand-taiwan-ai-college/
[68] https://ai.taiwan.gov.tw/news/taiwan-shines-in-who-hackathon-for-coronavirus-solutions/
[69] https://techcrunch.com/2020/07/15/wemo-one-of-taiwans-biggest-scooter-sharing-platforms-gears-up-for-international-expansion/

5 South Korea

5.1 Introduction

South Korea is preparing for its leap forward in both upstream and downstream space industries. The most important development this quarter was related to the New Green Deal, which provides investment and encourages developments for everything from autonomous vehicles, to smart houses, clean factories, and investment in AI. In addition to this, Korea's new drone rules have come into force this quarter, as well as interesting developments related to air taxi services.

Segment		Key Trends
Upstream		KT aims to launch new 5G satellite in 2024
Market Trends	Consumer Solutions	Rise in popularity of location based exercise apps, contactless fuel payment apps, and subscription-based navigation apps
	Road Transportation & Automotive	R&D plan released with EUR 830 million in investment to develop Level-4 autonomous vehicles
	Manned Aviation	Korea plan to launch commercial air taxi services in 2025, with a vehicle developed by Hanwha systems and infrastructure by Korea Airports Corporation
	Drones	New drone decree in effect since May, including a Special Free Drone Zone to be used for testing and development Assistance being provided to startups and R&D, with additional assistance for companies to enter overseas markets Experimental joint project using AI-based machine learning to provided autonomous and clustered flight beyond visual range
	Maritime	Hanwha Systems developed an 'uncrewed surface boat' which uses GNSS and AI to prevent collisions
	Emergency Response	ETRI developed devices that support Korean e-Call system
Macro Technology Trends	Robotics	Robot staff help customers amid COVID-19 social distancing
	Digitalisation and AI	The Korean New Deal announced AI heavily featured in the New Deal, including EUR 712 million to invest in AI start-ups Korean government announce 10 year plan to support AI semiconductor industry
	Climate Change	Smart cities and clean factories, including location based data, are part of the Green New Deal
	Silver Economy	SK telecoms sign a memorandum to develop a care-tech industry

5.2 Upstream Developments

South Korea is gearing up to develop space technologies and the respective upstream market with the government-led space projects being executed as planned. Interestingly, the completion of China's BeiDou Satellite System has made multiple headlines and attracted public interest in an indigenous satellite system and space technologies. In the meantime, a telecommunication giant KT released its plan for launching its own communications satellite.

5.2.1 KT aims to launch new satellite in 2024

In June, KT Sat Co., a satellite service arm of KT Corp. announced a plan to launch a new communication satellite as early as in 2024 to provide better 5G data services.[70] The satellite – Mugunghwa-6A will replace the Mugunghwa-6 that is scheduled to phase out in 2025 after 15 years of service.

With high-throughput satellite (HTS) technology applied, the Mugunghwa-6A will be able to process 10 times more data than existing satellites. KT Sat will start a co-research project with the EU later this year to develop solutions that connect the satellite and 5G networks. Once commercialised, users will be able to have access to 5G services even outside the country or places without stable 5G networks.

5.3 GNSS Market Trends

5.3.1 Consumer Solutions

The COVID-19 pandemic has affected the lifestyles of people in various ways. In South Korea, social distancing rules have catalysed the development and use of location-based apps.

5.3.1.1 The Rising Popularity of Location-Based Exercise Apps[71]

Amid COVID-19 pandemic, location-based exercise apps are gaining popularity and experiencing a massive spike in user activity. Nike Run Club's monthly number of users reached 107,371 in April this year, a 150% increase from 42,989 a year earlier. Other apps have also seen 52-129% increase in the number of users. In addition to the people's aspiration to keep their workout routines going, the trend is further explained by the introduction of game elements into the LBS sports applications - i.e. "gamification". One key feature in gamification is the ability to show the records and rankings of top players to stimulate competition between users. The success of exercise apps appears to be catalysing the development of LBS games.

5.3.1.2 The Boom of Navigation Apps[72]

With the current mood of avoiding public transportation due to the fear of COVID-19, the use of navigation apps has increased significantly. The subscription to navigation apps has risen since the first week of March when COVID-19 reached a peak. The weekly users of "Naver Map," "T map," and "Kakao Navi" were 5.6 million, 4.21 million, and 2.3 million respectively around 13-19 April. In comparison, the numbers were 4.8 million, 3.87 million, and 2.03 million in the last week of February.

On the other hand, the usage data between 1-25 January 2020 and 1-25 April 2020 showed that the average daily use of Owin, an app to make petrol payment without contact, had increased by 3.5 times in April. The amount paid through the app had also tripled in the same period, reflecting user demand for non-contact fuelling.

70 https://en.yna.co.kr/view/AEN20200618003700320
71 https://bizn.donga.com/East/3/all/20200531/101296945/2
72 http://biz.heraldcorp.com/view.php?ud=20200430000155

Meanwhile, the data clearly showed the trend of avoiding public transportation and decreasing overseas travel. The number of passengers using public transport dropped by 49.8% in February compared to that in December 2019.

5.3.2 Road Transportation & Automotive

The most noticeable development in the second quarter was the release of the government's R&D plan to develop the "level-4" self-driving cars.

5.3.2.1 callAutonomous Driving Technology Development Innovation Project

On 28 April, the South Korean government announced the mega-R&D initiative with the investment of KRW 1.1 trillion (EUR 830 million) to develop the highest level of fully autonomous vehicles by 2027. Along with the semi-conductor and bio-health innovation, the country aims to boost the future mobility industry. The investment calls for the development of the "level-4" autonomous vehicle - the high-automation car that can fully control steering and speed without the driver's intervention in most situations. The 7-year R&D plan is comprised of 30 main missions and 84 sub-projects and will be managed by multiple government ministries.[73]

5.3.3 Manned Aviation

The Korean government plans to launch commercial air taxi services in 2025, which will link city centres and suburbs.

5.3.3.1 Plans for Air Taxi Services

Hanwha Systems - the defence unit of Hanwha Group – will be developing the flying vehicles ('air taxis') as well as their infrastructure, together with Korea Airports Corporation (KAC). Specifically, they will jointly develop a business model that incorporates plans for urban air transportation terminals, control and navigation ports; verifying core technologies and promoting the international standardization of newly developed technologies; and entering overseas markets by securing successful models in Korea.

Hanwha Systems has been ramping up its investment in urban air mobility. In December 2019, the company invested $25 million (EUR 21 million) in US personal air vehicle company Overair. Hanwha holds 30% of the stake in Overair and is contributing to the development of the 'Butterfly' quad-tilt-rotor personal air vehicle in Overair. Meanwhile, KAC operates 14 airports in the country, and will complete landing pads for air taxis before 2025.[74]

[73] https://en.yna.co.kr/view/AEN20200428005600320?section=economy/auto; also see https://gnss.asia/blog/koreas-ambition-to-be-a-leader-in-autonomous-driving-technologies/
[74] https://koreajoongangdaily.joins.com/2020/07/06/business/industry/air-taxis-hanwha-systems-kac/20200706194 807001.html

5.3.4 Drones

The new drone decree that supplements the promotion of the drone utilisation in 2019 has taken effect since 1 May 2020. South Korea is set on the development of the drone industry at national level, and multiple initiatives have been introduced.

5.3.4.1 New Drone Decree

The new decree clarified the ways of supporting the drone industry laid out in law in 2019. Most noticeably, "the Special Free Drone Zone" shall be designated by Ministry of Land, Infrastructure, and Transport (MOLIT). The drone zone in the city centre will be utilised for test purposes where drones are freely deployed and tested for delivery, security functions, and environmental monitoring.

Moreover, MOLIT will draw up plans to support start-ups and R&D activities to build competitiveness in the drone industry. While backing up companies with financial assistance and test spaces, the government will also assist domestic drone companies with overseas market development.

Another notable move is to integrate drones into the overall unmanned aerial system and create an ecosystem where drone delivery, air taxis, and other unmanned aerial vehicles (UAVs) are utilised. Drone and UAV traffic management system is expected to grow exponentially, and the law has prepared the foundation of such a system. [75]

5.3.4.2 Experimental Drone Utilisation Project by MSIT

On 28 April, the Ministry of Science & ICT (MSIT) released a press release that detailed an experimental joint project. The project aimed at creating new drone service models, incorporating big data, 5G connectivity, and AI technologies.

A consortium had been formed by three public research institutes including Electronics and Telecommunications Research Institute (ETRI), three universities including KAIST, and telecommunications companies as well as 19 private enterprises. The project will employ the 5G network to collect mission data and analyse them through AI-based machine learning, and ultimately try to build a platform capable of providing autonomous and clustered flight beyond visual range.

In five years, the consortium plan to develop and demonstrate four service models - i.e. (i) police drones for search and patrol, (ii) water resources management drones to be used for monitoring flood and pollution, (iii) precision control 'smart-farm' drones, and (iv) inspection drones to check cell towers and high-rise buildings.

A datalink will be set up between drones and the National Geographic Information Service, and small cell 5G technology will be applied during the first phase. Developing AI technologies will also be applied to drone operations. The consortium will also focus on commercialisation of experimental technologies tested in the project. [76]

[75] http://www.korea.kr/news/pressReleaseView.do?newsId=156388112&pageIndex=1&repCodeType=&repCode=&startDate=2020-04-27&endDate=2020-04-30&srchWord=

[76] MSIT press release on 28 April 2020, '5G 이용, 고층 구조물 관리하는 드론서비스 나온다.'

5.3.5 Maritime

Korean defence companies keep their eye on unmanned water systems capable of up to 12-hour surveillance, which can replace coastal guard or surveillance ships.

5.3.5.1 The Unmanned Surface Ship Launched by Hanwha System

The annual market growth for uncrewed surface boats is over 13.8% on average, and the market is expected to reach KRW 1.2 trillion (€ 840 million). For this reason, the Korean government has begun investing KRW 160.3 billion (€ 114 million) in a project from 2020 to 2025 to develop core technologies for autonomous vessels.

Against this background, Hanwha Systems has developed the uncrewed surface boat "Aura", which is 6 meters long and weighs 1.2 tons and operates for 12 hours at an average speed of 20 knots.

The system is equipped with AI, GPS, Inertial Measurement Unit (IMU), and radar signal analysis functions. The key to the unmanned operation is its collision prevention technology based on International Maritime Collision Prevention Rules (COLREG), with which it could avoid or overtake approaching ships. Hanhwa intends to get in and get ahead in the uncrewed boat market. [77]

5.3.6 Emergency Response

South Korea has been developing its own e-Call system taking advantage of its telecommunications network. The Korean system is known as a "call-back" system different from the standard EU model. In the Korean e-Call system, a vehicle sends out a minimum set of data (MSD) immediately as accident happens, then a voice call from a public safety answering point (PSAP) will be established to confirm the accident.

In March 2020, Electronics and Telecommunications Research Institute (ETRI) announced that it developed seven types of handsets and smartphone software that support e-Call services. In this system, accident detection technologies have been improved. Various sensors and devices built in the vehicle can help identify the information on the location of an accident, the number of passengers, and the types of vehicles involved. An example of the type of sensors used include the use of gyroscopic sensors, as vehicle inclination could be measured to determine whether the car has been involved in an accident. Sensors and devices could 'learn' as more data accumulates from the default set of values, thus accident detection could be improved. Further developments in the call-back system will be closely monitored.

[77] https://www.asiae.co.kr/article/2020041709594617015

5.4 Macro Technology Trends

South Korea is envisioning a state-led digital transformation to resurrect the economy from the damage caused by the coronavirus in a Korean-style New Deal project. On 1 June 2020, the government released its plan to invest KRW 76 trillion (EUR 54 billion) in a "Korean New Deal" by 2025. The New Deal was also introduced as an acronym "DNA," standing for 'Data', 'Network technologies', and 'Artificial Intelligence'. Although details remain to be seen, this ambitious plan is likely to affect a wide array of macro technologies, in particular, AI and data related industries.[78]

5.4.1 Robotics

The COVID-19 has accelerated the non-face-to-face trend that has been gaining foothold in Korea in recent years. In the service sector, robots are emerging as a new solution to help people keep their distance in their daily life.

5.4.1.1 Robot Staff to Help Customers

Although South Korea's COVID response has been considered tremendously successful, the fear of another outbreak is still in place. Robots have offered a way to reduce face-to-face interactions while keeping economic activities going.

A café in Daejeon city has brought in a robot barista to make and serve coffee. Vision Semicon, a smart factory solution provider, has developed the robot barista, which uses a robotic arm and a serving tray can make 60 different types of drinks and serves them to customers using self-driving technology.[79]

On the other hand, CGV, Korea's largest cinema chain, deploys "Checkbot" to provide contactless services. The robot is part of the system that has eliminated nearly all face-to-face contacts between customers and staff. Utilising touchscreen kiosks, QR code readers, and a smartphone app, customers can enjoy services without any contact with staff. The "Checkbot" robot scans tickets, answer questions, and give customers directions to the restroom or theatres.[80]

5.4.2 Digitalisation and AI

South Korea has been trying to make digital technology a showcase of its industrial prowess with AI a crucial element. The government released a R&D strategy for AI in May 2018, then a System Semi-conductor Strategy in April 2019, followed by the National Strategy for Artificial Intelligence in March 2020 centred on the opening up of data and their utilisation. More recently, the so-called Korean New Deal has designated AI an integral part of the ambitious proposal.

5.4.2.1 The Korean New Deal & AI

The government plans to convert the current government network to 5G and store 15% of its data on cloud servers. It will develop 5G and AI services for safety and public health, especially out of experience in dealing with COVID-19. As an action plan, the government will give out vouchers for AI solutions to roughly 600 SMEs and create a fund worth KRW 1 trillion (€ 712 million) to invest in AI start-ups. However, despite a rosy prospect, details have to be confirmed to assess the potential impact of the plan in regard to promoting AI.

[78] https://koreajoongangdaily.joins.com/2020/06/01/economy/newdeal-digitalnewdeal-greennewdeal/20200601193300201.html
[79] https://www.trtworld.com/life/south-korean-cafe-hires-robot-barista-to-help-with-social-distancing-36669
[80] https://www.upi.com/Top_News/World-News/2020/05/27/AI-robots-automated-popcorn-dispensers-Cinemas-in-South-Korea-go-contactless/5871590570096/

5.4.2.2 Korean Industry to Re-Double Effort to Develop AI Chips[81]

Taking advantage of being the world's top DRAM market leaders, Samsung Electronics and SK Hynix are leading in the AI chip development. To consolidate their leading positions, they have doubled down the development of neural processing units (NPU).

Samsung Electronics released its 2030 semiconductor vision in which the company anticipates the integration of memory and processors with technological maturity. Along with Samsung's plan to invest KRW 133 trillion (€ 94 billion) by 2030, the government also laid out a 10-year plan to support the AI semiconductor industry. Already, government-affiliated Electronics and Telecommunications Research Institute (ETRI) and SK Telecom have developed a coin-sized AI chip capable of processing 40 trillion floating-point operations per second with 15W power. It is worth watching the development of AI semi-conductor market trends as the market is expected to outsize the memory market in 10 years.

5.4.3 Climate Change

The aforementioned New Deal proposal includes "Green New Deal" as a sub-proposal. It aims to create 133,000 jobs through a KRW 12.9 trillion (EUR 9.2 billion) investment by 2022 – of which KRW 5.8 trillion (EUR 4.1 billion) will be directed to environmentally friendly infrastructure.

5.4.3.1 The Green New Deal

How widely GNSS will be adopted in the project remains to be seen. However, the possibility of GNSS application seems high, as the proposal laid out smart green cities and clean factories as core of the project. The 'smart green cities' will employ IT technology and Internet of Things for water management and fine dust monitoring. It is expected that these smart green cities will rely on a mixture of location-based applications and Earth Observation satellites. The promotion of renewable energy sources – solar, wind, and hydrogen, as well as and smart-grid will require extensive technological applications.

5.4.4 Silver Economy

5.4.4.1 SK Telecom to Introduce AI Caregiver for the Elderly

In April, SK Telecom – one of the three major telecommunication companies – signed an MoU with Aria Care Korea and Happiness Connect to develop a care-tech industry. Aria Care is a professional caregiving institution that provides visiting medical care services for senior citizens, while Happiness Connect is a CSR arm of SK Group that utilise IT devices to help the socially disadvantaged.

The objective of the agreement is to cooperate on developing customised senior care services using ICT including AI. To start off, SK Telecom and Happiness Connect will launch 'AI Care' pilot service for 200 households that subscribe Aria Care from May 2020. Part of it is to provide an integrated management app that can monitor the health conditions of senior citizens 24/7.

AI Care is an ICT-linked welfare service. SK Telecom monitors usage data of senior citizens collected through NUGU speakers (SK's equivalent of Amazon Echo) at ICT Care Centres. It also provides real-time responses when detecting abnormalities. AI Care can make an emergency call with its voice recognition function in a crisis/emergency situation.

For senior citizens unable to operate smart devices, nursing care providers (Aria Care) visit every household to guide them on how to use services. SK Telecom expects the system will give close monitoring and care services non-stop by utilising AI. [82]

[81] https://m.pulsenews.co.kr/view.php?sc=30800019&year=2020&no=462152
[82] https://m.boannews.com/html/detail.html?idx=87761

6 Japan

Japan's has a number of specific features compared to most other GNSS markets. The country has indigenously developed its GNSS constellation (Michibiki aka QZSS) as well as its SBAS named "MSAS". Its domestic electronics industries necessary for manufacturing receivers is largely self-sufficient and does not have strong technological motivation to import from overseas. As a result, market entry barriers are very high.

In order to identify what kind of products or services are accepted by the market, the recommended best way for foreign enterprises to access the market might be a "roundabout" approach described like "the longest way about is the nearest way to the destination." Therefore, this chapter concentrates on the historical context and underlying Japanese governmental policies which steer and regulate Japan's GNSS market.

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Segment		Key Trends
Upstream		One Year of Success for the Japanese GNSS Constellation
Market Trends	Road Transportation & Automotive	JRC Mobility Inc. Acquire German Automotive Onboard Device Developers
	Agriculture	GNSS-based technology Revealed the Importance of Rice Fields along Migration Flyways for Inland Waders
	Geomatics	Komatsu Ltd have launched their SMARTCONSTRUCTION Retrofit kit which includes GNSS correction services Topcon offers First in the Market RTK Thermal Mapper System for Paving
Macro Technology Trends	Robotics	Robotic Staff used at a Tokyo Hotel for COVID-19 Patients
	Digitalisation and AI	Daikin, a Leading AC Manufacturer have Invested USD 2 Million in an indoor positioning startup, Locix Inc.
	Climate Change	New Method of GNSS Analysis used to Study Heavy Rain Phenomena in Japan

6.1 Upstream Developments

6.1.1 One Year of Success for the Japanese GNSS Constellation

This May saw the announcement that a survey ran by the Satellite Positioning Research and Application Center has shown that the Japanese GNSS constellation 'Michibiki' has been performing well since going online at the end of 2018. Michibiki is also known as QZSS and it offers solutions such as high-accuracy positioning augmentation as well as short messaging for disaster mitigation. Michibiki is aiming to expand from four to seven satellites by 2023, to ensure independent satellite positioning and improved performance across the Asia-Pacific region.

Key results from the survey are as follows:

- The uptake of QZSS by business users has dramatically increased over this year
- Some businesses seem to be waiting for cheaper devices and service improvements to use QZSS

- Uptake is highest in B2B market segments such as construction and agriculture, and lowest in location-based services and disaster prevention and mitigation.
- SBAS users are expected to increase with the introduction of high accuracy and high integrity Dual Frequency Multiple Constellation SBAS Services
- The key to stronger market penetration is the production of cheaper receivers of QZSS services
- Business users' main concern is service reliability[83]

6.2 GNSS Market Trends

6.2.1 Road Transportation and Automotive

6.2.1.1 JRC Mobility Inc. Acquire German Automotive Onboard Device Developers

JRC Mobility Inc., a Japanese company who creates and develops communication solutions in the mobility field, including GNSS receivers to be used in their Electronic Toll Collection (ETC) Systems, have acquired RBI GmbH and LEAS GmbH. JRC mobility is now looking at using the engineering, assembly, and logistics experience of these two acquisitions to both strengthen their global business, as well as to develop their GNSS-based ETC solutions for the European Market.[84]

6.2.2 Agriculture

6.2.2.1 GNSS-Based Technology Revealed the Importance of Rice Fields Along Migration Flyways For Inland Waders

In a recently published academic paper, researchers in Japan have revealed the migration route, staging area, and wintering ground of the "Charadrius dubius" are rice paddy fields. They captured 19 little plovers along the Chikuma River in Nagano in 2017, attached GNSS loggers to them and released them, and then eventually retrieved 6 loggers from plovers returning in 2018. According to the recorded data, the plovers flew out of Japan in the fall, travelled three to four thousand kilometres to Luzon and Mindanao in the Philippines via the Chinese coast and Taiwan. Unlike the river environment for the breeding sites in Japan, the plovers mostly used paddy fields for staging and wintering. The researchers concluded that international effort to maintain rice fields is necessary in order to reduce the risk of future extinction of plovers.[85]

6.2.3 Geomatics

6.2.3.1 Accelerating the Digital Transformation of the Construction Industry

Komatsu Ltd have launched their SMARTCONSTRUCTION Retrofit kit, an add-on kit that is utilising GNSS correction services with information distribution to be used for 3D construction work. This is combined in a package that utilises commercially available tablets as monitors, meaning that it is a user-friendly solution that not only works with Komatsu models but also offer hydraulic evacuators. This retrofit kit provides much-needed functionality that is to be used in the 'i-Construction' projects promoted by Japan's Minister of Land, Infrastructure, and Transport.[86]

[83] http://qbic.eiseisokui.or.jp/media/pdf/council/International/3-01.pdf
[84] https://www.nisshinbo.co.jp/nish/english/news/pdf/e0a36b525f92cf3c4adfeaef4eaffeb671352650.pdf
[85] https://www.nature.com/articles/s41598-020-60141-z
[86] https://home.komatsu/en/press/2020/management/1205355_1840.html

6.2.3.2 Topcon Offers First in the Market RTK Thermal Mapper System for Paving

Topcon Positioning Group, a subsidiary of the Japanese Topcon, now offers a new Thermal Mapper for asphalt paving. It was developed to utilise real-time kinematic (RTK) positioning for a multitude of different functions at high accuracy. These range from tracking temperature segregation for minimisation of the risk of potential problems to meaning performance and providing accurate compliance reporting. During the process of paving, temperature readings behind an asphalt paver are being recorded and immediately converted into a visualised summary for operators.[87]

6.3 Macro Technology Trends

6.3.1 Robotics

6.3.1.1 Robotic Staff Used at a Tokyo Hotel for Covid-19 Patients

SoftBank Robotics robots such as Pepper, a talking robot used to greet guests, have been used to cater to mildly sick COVID-19 patients to free up beds at overburdened hospitals. These robots have been used to greet guests, clean common areas, and other daily tasks to reduce infection risks for human staff. These have been deployed at hotels where asymptomatic COVID-19 patients are staying, with five hotels with up to 2,800 rooms.[88]

6.3.2 Digitalisation and AI

6.3.2.1 Daikin, a Leading AC Manufacturer Have Invested USD 2 Million in an Indoor Positioning Startup, Locix Inc.

Daikin Industries, Ltd., Japans leading AC manufacturer has announced that they have underwritten USD 2 million (EUR 1.6 million) in the Silicon Valley-based startup Locix, Inc. Locix offers spatial awareness solutions that are utilised in; Warehouse and Distribution Centres to improve productivity and optimise staffing, in Factories to reduce downtime and to track raw materials, in Commercial buildings to increase occupancy and energy efficiency, and have offered solutions in the fight against COVID-19 to monitor social distance compliance and to visualise high traffic areas. Logic is set to achieve sub-metre accuracy in real-world environments through the utilisation of battery-powered, WiFi-based location devices.

6.3.3 Climate Change

6.3.3.1 New Method of GNSS Analysis Used to Study Heavy Rain Phenomena in Japan

Researchers from the Department of Natural History Sciences, Japan, and the Geospatial Information Agency, Indonesia, have utilised a new method using tropospheric delay gradient to study heavy rain phenomena in Japan using GEONET data. This was used to show the implementation of utilising tropospheric delay gradients, in addition to ZWD, to improve their understanding of water vapour dynamics during heavy rains. The conclusion of the study states that dense GNSS networks, such as Japan's, are able to be used to estimate the nowcast of heavy rain, and potentially even for forecasting of heavy rain.[89]

[87] https://www.topconpositioning.com/insights/topcon-expands-intelligent-paving-portfolio-thermal-mapper-system
[88] https://uk.finance.yahoo.com/news/robots-deployed-greet-clean-japan-130538185.html?guccounter=1&guce_referrer=aHR0cHM6Ly93d3cuZ29vZ2xlLmNvbS8&guce_referrer_sig=AQAAAKkY7EsKw7J9x4mdV19IwAcRgmvAqf2pGkSLODaafC1vF3D5nrMIwiA5liFVEzsWCw3EiIDesqCcweiDQJDZliofKK4TIuYS1-1cDvlXBJOnkjFtF9BhLQB8UEBO1-ca-evTYJGr6Yv7ICg1JdHNh-sduFphfJieIHmdA6GanM1d
[89] https://www.frontiersin.org/articles/10.3389/feart.2020.00182/full

7 Australasia

7.1 Introduction

Australasia is home to several countries that are rapidly developing their upstream and downstream industries, with developments across the region ranging from the development of a new domestic, multi-frequency, multi-antenna system in Australia, to smart rail management in the Philippines, and to updated Vietnamese drone regulations.

Segment		Key Trends
Market Trends	Consumer Solutions	ACSER awarded a grant to develop new domestic multi-frequency, multi-antenna receiver systems Multiple Singaporean 5G Trials for UAS Positioning Applications after the Success of Singapore's First Drone Delivery Service
	Road Transportation & Automotive	GNSS-enabled public utility Jeepneys that form a part of the Manila's mass transport system have been allowed to return to the road in Malaysia
	Drones	Vietnam have updated their drone regulations in the country making it illegal to fly drones and ultra-light aircraft in large areas of the country Drones used to enforce the Malaysian Movement Control Order Drones have been used in to measure limestone production
	Emergency Response	HERE Technologies and UNL Collaborate to Assist in Disaster Relief
	Rail	Smart fleet management system announced in the Philippines
	Agriculture	GNSS-tracking used to track over 1,000 buffaloes in Australia Drones Deployed to Reseed Burnt Land in Australia
	Geomatics	Australian-owned Position Partners Expands into Malaysia GNSS used to track wild elephants in Riau, Indonesia
Macro Technology Trends	Robotics	An Australian space robotics, automation, and AI centre has been opened in Perth aiming to support on-orbit robotic operations, , automation of robotic activities in space, servicing of satellites, and off–Earth base construction equipment

7.2 GNSS Market Trends

7.2.1 Consumer Solutions

7.2.1.1 Australian Space Robotics, Automation, and AI centre Funded in Perth

Karen Andrews – the Australian Minister for Industry, Science, and Technology – announced that Australian Centre for Space Engineering Research (ACSER) has been awarded a grant for the Advanced Global Navigation Satellite System Receiver for CubeSats, Rockets and Remote Sensing project.[90] This aim of the project is to improve their GNSS receiver from a single frequency receiver to be used in multi frequency, multi antenna systems in an attempt to improve the accuracy. This increased accuracy will have an impact on downstream application in areas such as maritime, logistics, geometrics, and agriculture amongst other areas, and it will aim to replace the existing imported receivers.

7.2.1.2 Multiple Singaporean 5G Trials for UAS Positioning Applications

The Maritime Port Authority of Singapore (MPA) is conducting 5G standalone trials in collaboration with Airbus and M1 Limited to assess whether they are suitable for providing enhanced positioning data for UAS flights.[91] If the trials are successful, the 5G technology is to be considered as a competitor to GNSS systems for Singapore's UAS operations in both urban and coastal areas. The trials are set to last one year starting from August 2020 and will be building on the successful shore-to-ship drone delivery trials that occurred this March.[92] It is unclear at this stage whether the 5G-based solutions will replace, or be used in combination with existing GNSS solutions.

7.2.2 Road Transportation and Automotive

7.2.2.1 GNSS Enabled Modern Jeeps Return to the Roads in Malaysia

The Land Transportation Franchising and Regulatory Board (LTFRB) announced that select public utility jeepneys (PUJs) were allowed to operate from 22 June. These PUJs form a significant part of the mass transportation system in Manila and are vital to the movement of people in the country. The COVID-19 regulations require the PUJs to be equipped with GNSS technology alongside having the ability to make cashless fares in order to return to the road.[93] It is believed that the GNSS technology is going to be used to track the vehicles and ensure that the travel route of each passenger is easy to identify.

[90] https://www.thefastmode.com/technology-solutions/17396-kts-satellite-operating-unit-to-launch-new-satellite-in-2024-to-cater-for-5g-demand
[91] https://www.porttechnology.org/news/mpa-partners-with-airbus-and-m1-to-conduct-5g-drone-trials/
[92] https://smartmaritimenetwork.com/2019/03/19/drone-deliveries-to-vessels-takes-off-in-singapore/
[93] https://www.gmanetwork.com/news/news/metro/743569/modern-jeeps-to-resume-operations-in-15-routes-starting-june-22/story/

7.2.3 Drones

7.2.3.1 No-Fly Zones Announced for Drones and Ultra-Light Aircraft in Vietnam

The Vietnamese Prime Minister Nguyen Xuan Phuc announced new regulations governing the use of drones in the country. It is now illegal to fly drones or ultra-light aircraft within 500 metres of any area that is designated an area of significant national defence and military importance by the Ministry of Defence. These areas include the offices of the government, ministries, diplomatic and consular missions, and international organizations in Vietnam, along with military stations, warehouses, factories, prisons and detention camps, and both military and civil airports. In addition to these area, flying drones near crowded gatherings and some border areas is now prohibited.[94]

7.2.3.2 Enforcing the Malaysian Movement Control Order to Fight Covid-19

The Malaysian authorities have been enforcing their Movement Control Order with the help of Aerodyne Drones who are providing real-time video and data streaming which is being used to enforce the lockdown in combination with the COVID-19 infection location data to enhance the authorities situational awareness during the pandemic. Aerodyne have deployed 23 teams of two aerorangers who hit a combined total flight time of 1,000 hours in April.[95]

7.2.3.3 Drones Used in the Malaysian Mining Industry for Monitoring And Surveying

Pens Industries Sdn Bhd (PSDB), a Singaporean quarry company has been utilising drones across their limestone quarrying business in their stockpile monitoring. This project been completed in combination with the Universiti Malaysia Perlis' (UniMAP) Centre of Excellence for Unmanned Aerial Systems (COEUAS), and it aimed to replace the existing measurement system of weighing each lorry and estimating the volume. The original measurement method was very labour intensive, expensive, and it was unable to provide the total volume of limestone quarried and how much stock was remaining. In order for PSDB to measure the stockpile they used to manually climb the stockpile to take measurements using GNSS receivers which provided the exact location. Instead, the project introduced the use of drones with machine learning, cameras, and the drone's position to estimate the stockpile volume at an accuracy of 99%.[96]

7.2.4 Emergency Response

7.2.4.1 Here Technologies and UNL Collaborate to Assist in Disaster Relief

HERE and UNL are collaborating on their Human Unlimited #tech4good foundation which is aiming to combine the unique verified addresses with geolocation data to ease the information flow between people and organisations. This foundation looks to support the fight against corona by providing data-backed technology solutions such as analytics dashboards based on self-reported COVID-19 case locations to assist policy makers in their decision making.

The foundation aims to create a platform that will allow the 4 billion people without addresses to obtain relief during emergencies, bypassing the traditional delivery address system.[97]

[94] http://www.xinhuanet.com/english/2020-06/16/c_139143773.htm
[95] https://www.geospatialworld.net/csr-initiatives/aerodyne-drones-completes-1000-flight-hours-in-covid-19-operations/
[96] https://www.nst.com.my/education/2020/06/603049/using-drones-monitor-stockpile
[97] https://www.themachinist.in/worldwidemedia/news/6512/-unl-launch-tech4good-initiative

7.2.5 Rail

7.2.5.1 Railway Fleet Management System Announced in the Philippines

GMV Technology has been awarded a contract by the Philippines National Railways (PNR) for the development of their first fleet management system to be deployed on the local commuter trains in Manila.[98] This project will provide PNR with SAE-R – a state of the art system covering the operation, management, and planning of the system from October 2020 – with the aims to initial cover the commuter lines and to expand to provide full coverage of all PNR services on Luzon Island.[99]

The fleet management system (SAE-R) will assist in resource planning, fleet monitoring, real-time management, and will provide information to passengers both on-board and at stations. SAE-R provides this capability using their rolling stock real-time positioning combining GNSS signals, information from RFID tags, open-door signals, and cabin signals, along with their multi-interface communication systems including TETRA, Wi-Fi, cellular, GSM-R and satellite communications.[100]

7.2.6 Agriculture

7.2.6.1 AUS 4 Million Spent on the World's Largest Satellite Herd-Tracking Program

This quarter has seen the launch of the Commonwealth Scientific and Industrial Research Organisation's (CSIRO) project to use GNSS-tracking tags attached the ears of feral buffalo and unmanaged cattle in order to track the 1,000 strong herd.[101] This live data is to be used to monitor the impact of the herd on the environment, with best practices being developed to protect the eroding native flora and fauna.[102]

7.2.6.2 Drones Deployed to Reseed Burnt Land in Australia

Xag, an Australian UAV player in the Agricultural industry is demonstrating the power of drones by assisting in projects to restore Australia after the devastating wildfires. The unique capabilities of the drones are transforming the recovery project, allowing hard to reach areas such as around Lake Cobrico – a swamp wildlife reserve in Southwest Victoria – where the peat swamp is difficult to access and any attempts to restore it by hand would damage the fragile environment.[103]

This application is particularly unique as it is the first time that commercial drone pilots can 'swarm pilot' drones – where the pilot controls up to five drones – allowing the cost to be massively reduced, allowing much more land to be reseeded than by using an alternative aerial solution such as expensive planes or helicopters.

The project is looking so successful that the authorities are now recommending this style of reseeding as a sustainable option for restoration. Xag is using its P Series drones equipped with granule spreading systems allowing an impressive 40 hectares of burnt land to be replenished with a blend of 12 seeds.

[98] https://www.gmv.com/en/Company/Communication/News/2020/02/SAErManila.html
[99] https://www.globalrailwayreview.com/news/96747/fleet-management-technology-manila-pnr/
[100] https://www.gmv.com/DocumentosPDF/Transporte/SAE-R_EN.pdf
[101] https://www.spatialsource.com.au/gis-data/worlds-largest-satellite-herd-tracking-program-to-kick-off-in-nt
[102] https://www.zdnet.com/article/csiro-using-gps-to-monitor-australias-wild-bovine-from-space/
[103] https://www.geospatialworld.net/news/xag-deploys-drones-to-seed-burned-land-for-australian-fire-recovery/

7.2.7 Geomatics

7.2.7.1 Australian-Owned Position Partners Expands into Malaysia

Position Partners, an Australian civil engineering and construction company with a focus on 3D GNSS positioning technology is announced their expansion into Malaysia offering greater coverage of the region.[104] This would allow for local support for their multi-constellation RTK GNSS positioning surveying tools, and showcases the brands further plans to expand throughout South East Asia.

7.2.7.2 GNSS Collars Used to Track Wild Elephant Herd in Riau

GNSS collars are being used to track a herd of eleven elephants in Riau, Indonesia where the Petapahan elephant group's migratory path overlaps with several residential areas. The tacking is being done by the Riau Natural Resources Conservation Agency (BKSDA Riau) and it in intended to be used to prevent them from getting close to villages by intercepting them with a specialist team who guide the elephants back to the forest.[105] This program may be expanded to cover other elephant groups with a side benefit of assisting in the fight against poaching.

7.3 Macro Technology Trends

7.3.1 Robotics

7.3.1.1 Australian Space Robotics, Automation, and AI Complex to be Funded in Perth

Federal Minister for Industry, Science and Technology Karen Andrews announced AUS 4.5 million (EUR 2.73 million) from the Commonwealth to build the Australian Space Robotics, Automation, and AI Command Control Complex (RAAICC) which aims to support start-ups, SMEs, and research in space robotics activities. RAAICC is intended to support and compliment AROSE seen in edition one of this report for remote operations on both Earth and beyond.[106] This funding is being provided to Fugro Australia Marine who are to provide additional funding in both cash and in-kind contributions to the project, and it is a two year project where Furgo will support activities including robotic operation of on-orbit space assets, automated command, control and management of robotic activities in space, on-orbit servicing of satellites, and assisting in the delivery of technology necessary for object handling, manipulation and assembly of satellite parts, and gateways or off–Earth base construction equipment.

[104] https://www.spatialsource.com.au/company-industry/position-partners-expands-into-malaysia
[105] https://www.thejakartapost.com/news/2020/01/25/riau-agency-puts-gps-collars-on-wild-elephants-to-prevent-conflicts-with-humans.html
[106] https://www.minister.industry.gov.au/ministers/karenandrews/media-releases/wa-space-project-drive-industry-growth

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