Market & Technology Trends

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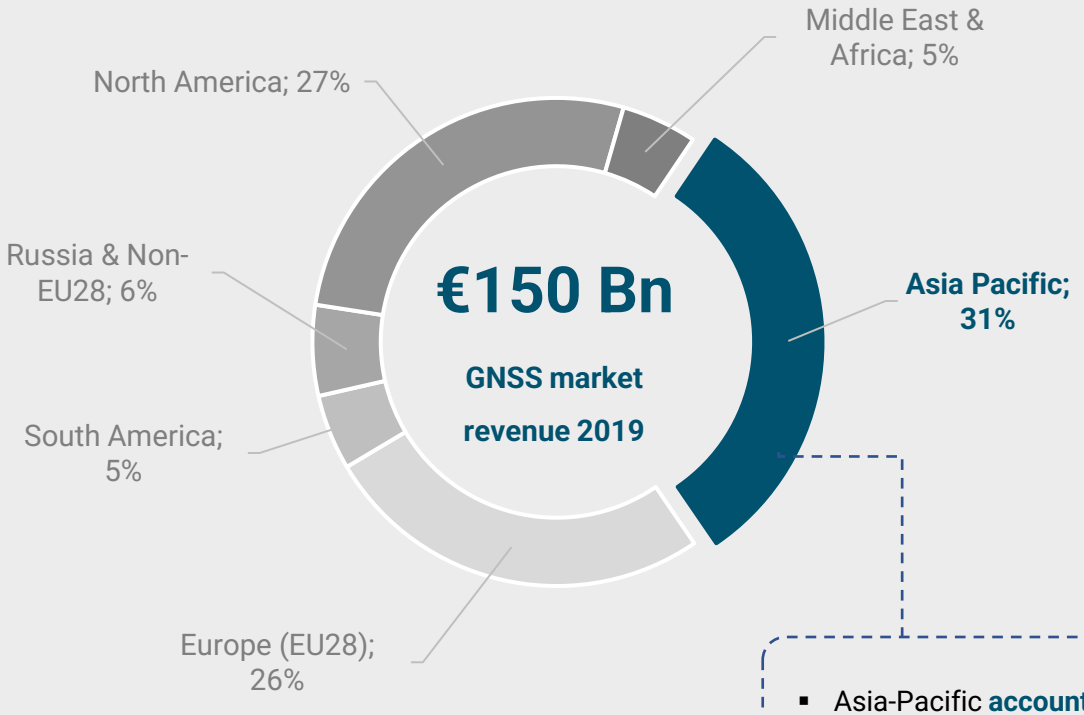
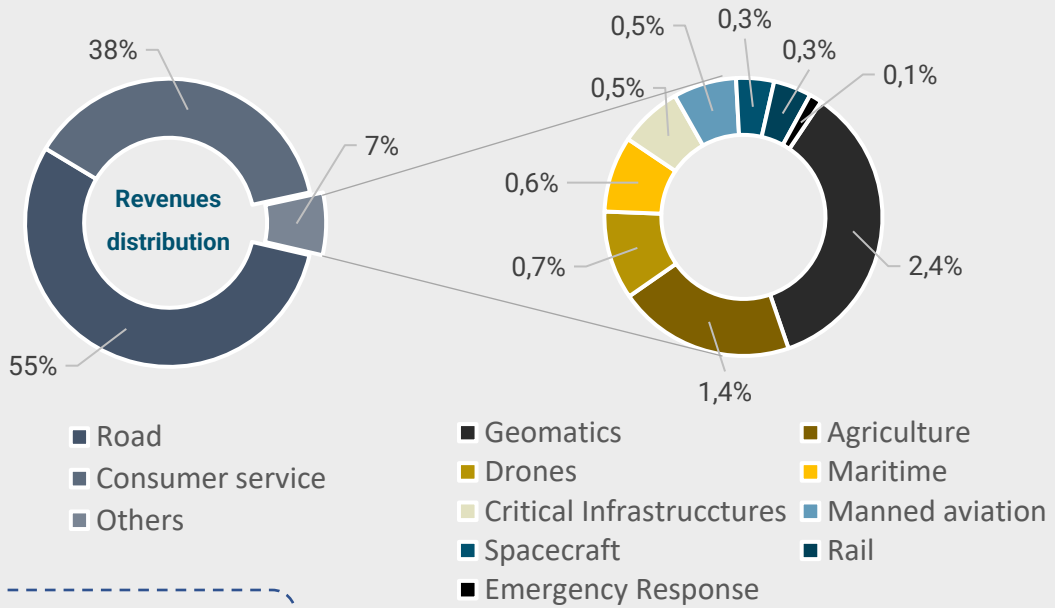
THE GNSS MARKET IN ASIA-PACIFIC IN A NUTSHELL





- Asia-Pacific **accounts for 53.5% of the global GNSS installed base in 2019**
- The market is €46 Bn in revenue in 2019 and it is expected to grow up to €106 Bn in 2029[1]

1: https://www.euspa.europa.eu/system/files/reports/market_report_issue_6_v2.pdf

KEY GNSS MARKET & TECHNOLOGY TRENDS IN ASIA-PACIFIC

UPGRADED STABILITY FOR QZSS' CLAS

Japan's National Space Policy Secretariat announced that from 30 November, the official broadcast of its centimetre-level augmentation service will be upgraded from IS-QZSS-L6-001 to IS-QZSS-L6-003, increasing the maximum number of augmented satellites to 17 for a more stable positioning accuracy.

BEIDOU-3 HAS OFFICIALLY LAUNCHED

July 2020 saw the official launch of BeiDou-3, with the launch of the 55th BDS system to complete the 30-satellite constellation, providing additional system redundancy, a short message capability and improvements to accuracy.

KPS INITIAL FEASIBILITY TESTS FAILED

The Korean Positioning System (KPS) failed its initial feasibility tests in July 2020 due to high costs and weak military support. However, the project will go through another round as the Korean New Deal is reliant on high accuracy GNSS-solutions.

TAIWAN FOCUS ON 5G SMART MANUFACTURING

Taiwan has increased its focus on 5G for IoT and smart manufacturing, including the setup of a 5G open laboratory in Taoyuan County, a 5G mmWave smart factory to be built , and a 5G-enabled smart manufacturing plant at Delta Electronics' production complex.

WORLD'S FIRST 22NM RECEIVER CHIPSETS

China's BDStar released the world's first 22nm chips that are one quarter of the size of the previous generation whilst only consuming one fifth of the power. New receivers and antenna were seen in Japan, with hardware released by Sony, Furuno Electric, and Komine Radio Electric.

SMART CITIES FOR ASEAN

An increase in funding for smart cities around the region, with Japanese companies supporting 26 smart city projects across ASEAN through funding from both Japan Oversea Infrastructure Investment Corporation for Transport & Urban Development and the Japan Bank for International Cooperation.

KOREA'S DEVELOPMENT PLAN FOR SPACE

The Ministry of Science and Technology has announced the Space Development Plan for the next three years (2020-2022), including projects for satellite navigation, communication, and even an indigenous launch vehicle.

LOW POWER, ANTI-SPOOFING HARDWARE

Taiwan saw GNSS receivers, modules, and trackers, including an ultra-lower-power GNSS module for IoT applications from Yuechung, and a new GNSS receiver with anti-jamming and anti-spoofing capabilities by Wintec.

INDIA TO USE GNSS-BASED TOLLING

India aspires to become "toll-booth free" with GNSS-based solutions within the next three years to reduce congestion and increase the tolling-related income. The GNSS-based tolling system is to replace the current electronic tolling system.

GNSS TO ENABLE AUTONOMY ON THE ROAD, RAIL, SEA, AND SKY

GNSS has enabled innovation related to autonomous buses in New Taipei City, drone mail delivery on Siaoliouciou Island, and autonomous collision avoidance and berthing for vessels on the Love River.

Autonomy was seen in several downstream markets, with a new smart driving innovation laboratory, and large-scale tests and launches of autonomous cars, trucks, and even road construction vehicles in China.

KEY GNSS STAKEHOLDERS IN ASIA-PACIFIC

	INSTITUTIONS	HARDWARE MANUFACTURERS	SYSTEM INTEGRATORS / PROVIDERS
Japan	内閣府 Cabinet Office, Government of Japan; JAXA; SPAC; INCJ; ENRI; MGA	FURUNO; HITACHI Inspire the Next; SEIKO EPSON; SONY; TOPCON	MITSUBISHI ELECTRIC; Panasonic; NAVITIME; clarion; ISEKI; Mapion; MSJ; KOMATSU; AISIN AW; KOKUSAI KOGYO CO.,LTD.
Korea	MOLIT; MOTIE; 해양수산부; KARI	TELAGE; DusiTech; ASCEN GPS Global GPS Leader AscenKorea Inc.	SAMSUNG; LG; SK; kt; NAVER
China	China Satellite	泰斗; Hwa Create; Qualcomm; 展讯通信 SPREADTRUM; 华大北斗 ALLYSTAR; 联星 OLinkStar	COSIC; NAVINFO 四维图新; UniStrong 合众思壮; 北斗星通
Taiwan	ITRI; NSPO; DOIT; TAITRA; TAIROA; TAPPI; TCIIC	MEDIATEK; SkyTraq; LOCOSYS; RoyalTek; REYAX	ADVANTECH; MiTAC; acer; AAEON; ASUS; PEGATRON; Wistron; WNC; htc; Apacer; COMPAL; 銓鼎科技 MAXWIN; THINKTRON; AthenTek
India	ISRO; NRSCC; SAC	TATA ADVANCED SYSTEMS; NAVIKA; Infineon; GEORAX; amdl	SatNav; Stesalit; MapmyIndia; trimetra; SECON; magnasoft
Australasia	ARSE; Australian Government Geoscience Australia; Australian Government Department of Agriculture; CSIRO	GPSat SYSTEMS AUSTRALIA; THALES AUSTRALIA; veripos	MiRTK; GLOBALPOS ASIA'S AN EXPERT; C.R.Kennedy GEOSPATIAL SOLUTIONS

Table of Contents

Overview of Indian Market Trends

- India is an emerging and open market with a **high number of start-ups** and **opportunities for significant modernisation of infrastructure.**
- Strongest predicted economic growth of a major economy in 2022, with an **estimated growth of between 8.2% and 11.8%** depending on the COVID-19 impact[2].
- Huge potential customer base for consumer solutions, a **predicted increase of smartphone users** from **250 million** in 2015 **to 970 million** in 2025[3].

Key Trends in Edition Three

- India's space industry is **increasingly opening up to the private sector**, with the Indian Department of Space **announcing a policy to allow foreign direct investment** in the sector with initial applications from OneWeb and KSAT.
- The newly created **IN-SPACe is creating public policy structures that allow for Indian firms to use existing IRSO infrastructure**, resources, and data, as well as allowing private players to set up launch offices and build private launch vehicles.
- **Toll plazas are to be replaced with GNSS-based solutions** within the next three years to reduce congestion and increase the tolling-related income.

2: https://www.reuters.com/article/us-india-economy-gdp-idUSKBN25Z0VF
3: https://www.business-standard.com/article/companies/news-in-the-age-of-fb-115061201153_1.html

Indian legislators are working to make the space more accessible to privates

INDIA'S NEW SPACE POLICY ALLOWS FOREIGN SPACE INVESTMENT

In late 2020 the **Indian Department of Space (DoS)** announced India's new space policy which is to open up the space sector to both foreign direct investment and to allow foreign companies to set up facilities in the country. The exact details of the policy are yet to be defined, instead, it is to be defined by the new Indian National Space Promotion and Authorisation Centre (IN-SPACe) when it is fully operational. The newly formed In-SPACe has already seen applications from companies such as **OneWeb** and **KSAT**, a Norwegian-based global telecommunications service provider.

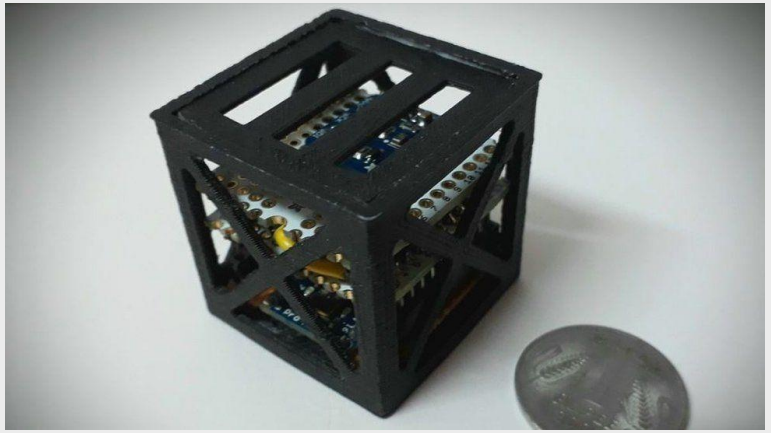
SPACE IS INCREASINGLY OPEN TO THE PRIVATE SECTOR

To spread the space sector and to boost the space economy, the Indian government launched the Indian National Space Promotion and Authorisation Centre (IN-SPACe). IN-SPACe will determine the needs and demands of private players, including educational and research institutions, and explore ways to accommodate these requirements in consultation with the **Indian Space Research Organisation** (ISRO). In order to allow them to carry out their space-related activities, existing ISRO infrastructure, both ground-based and space-based, scientific and technical resources and even data, are expected to be made available to stakeholders.

ISRO will permit the private players to set up their own launch office at Sriharikota that they can use for launching their spacecraft or rocket. The agency will offer such dispatches for free. ISRO will give them all the expertise they require to set up the facility, as ISRO has experience in operating two launchpads and two rocket gathering structures at Sriharikota. [3] In addition to the launch office, India's DoS has entered into its very first non-disclosure agreement with Agnikul Cosmos Pvt to build private satellite launch vehicles.

AN INDIAN STUDENT DESIGNED THE WORLD'S LIGHTEST SATELLITE

In December 2020, a Mechatronics Engineering student at **SASTRA University**, Riyasdeen, won the 'Cubes in Space' global design competition where he designed the world's lightest FEMTO satellite, a type of satellite with a mass lower than 100g. The design competition had approximately 1000 students participating from 73 countries, with Riyasdeen's designing the VISION SAT v1 and V2 at a size of 37mm with a payload of 30mm using 3D printing and polyetherimide thermoplastic resins. V1 is to be launched as part of the SR-7 NASA Rocket Mission and v2 shall be part of the NASA Balloon Mission RB-6, launching in June and August 2021 respectively.



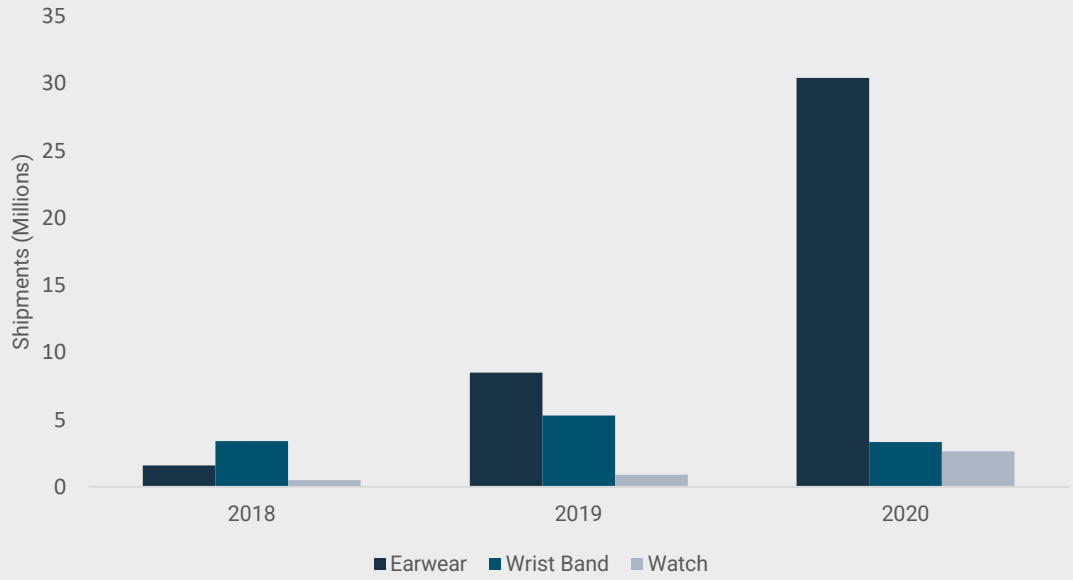
VISION SAT v1

Consumer solutions are a hot topic across India with smart devices and mobiles being commonplace

STRONG GROWTH IN INDIA'S WEARABLES MARKET IN Q3 2020

The average price of smart products has been heavily reduced in the last few years, with the price of a smartwatch being reduced by 37% between Q3 2019 and Q3 2020 which has resulted in a great increase in the market penetration. In addition to the reduced price, the ongoing COVID-19 pandemic has resulted in a growing demand for consumer solutions such as wireless headphones, smart bands, and smartwatches. These increases have been significant, with the whole wearable market growing 165.1% in Q3 2020[4].

The growth of India's wearable market 2018-2020[1]



4: https://www.statista.com/statistics/1118025/india-wearable-devices-shipped-by-product-category/

SMART WRISTBAND TO TRACK CORONA POSITIVE AND SUSPECTED PATIENTS

All India Institute of Medical Sciences (AIIMS), Nagpur, in collaboration with **IIT Jodhpur** and **IIT Nagpur** has planned and built a model for powerful tracking and monitoring of confirmed and suspected COVID patients. This device is in the form of a smart wristband, providing mobile free operation, using a geofencing technology that will provide a real-time alert on any breach in the quarantine zone. The wristband gives real-time, objective and reliable information such as the temperature, heart rate, respiratory rate, and oxygen levels, ensuring that the isolated individual will seek early clinical assistance.

STUDENTS DEVELOPED A NAVIC RECEIVER CHIP

The Indian Institute of Technology Bombay, a technical university in Mumbai, India, has developed an indigenous radio frequency receiver chip that will receive signals from NavIC, India's regional navigation satellite system. The chip itself was designed by students and researchers at IIT Bombay, with the project being funded by the Indian Ministry of Electronics and Information Technology (MeitY) and it is being supported by ISRO.

INDIA TO PURCHASE 1 MILLION NAVIC CHIPSETS

The **Indian Ministry of Electronics and Information technology** issued a request for proposal on 27 November 2020 to procure a total of 1 million NavIC chipsets as part of its plans to develop the downstream Indian GNSS markets. This proposal outlines that the objective is to set up and promote indigenous GNSS technology, with proposal itself covering the three phases below.

GNSS is enabling innovation throughout India's vast road network

NATIONAL HIGHWAYS IN INDIA TO REPLACE TOLL PLAZAS WITH GNSS WITHIN 3 YEARS

National highways in India are ready to say farewell to toll plazas, with the **National Highways Authority of India** (NHAI) preparing to replace them with GNSS-based tolling systems within the next two to three years. The project is aimed at reducing traffic congestions at toll booths and providing relief to motorists.

Tolling in India has already seen a vast change, with the Indian government finalizing the **FASTag** radio-frequency identification electronic toll collection system. FASTag worked by attaching a tag to the windscreen of a vehicle which is linked to either a saving or prepaid bank account which allows drivers to travel through tolls without stopping. FASTag began as a trial in late 2014 and by 1 January 2021, it was mandatory at every toll plaza in the country.

The exact details of a potential GNSS-based replacement are not yet known, but when taking a view of the wider market, a GNSS-based solution does have some advantages in that there is no need for any roadside equipment such as toll booths and would allow modifications to be made to the tolled road network with minimal effort.

SWOT analysis of a GNSS-based tolling system

Strengths ▪ No roadside equipment ▪ Highly flexible ▪ Easily expandable	**Weaknesses** ▪ High start-up costs ▪ Needs cell signal for communication ▪ Potential interference and signal issues
Opportunities ▪ Provision of other value—added services ▪ Interoperability with other systems ▪ Cost reduction once fully scaled	**Threats** ▪ Reluctance for a centralised system ▪ Data privacy legislation ▪ GNSS outages, spoofing, and jamming

GNSS TRACKERS ARE TO BE USED TO TRACK DELHI'S PUBLIC WORKS VANS

The government in Delhi is introducing GNSS-based systems to monitor the vans of its **Public Works Department**. The authorities can track where the vans are going in real-time, with geofencing options to create and send alerts as soon as the van leaves the geofenced area. The aim of this system is to improve the data available on the current workflow to improve the quality and scheduling of work, facilitated through a web and mobile application.

This development is linked to a previous fleet tracking solution presented in GNSS.asia's second edition of the market and technology trends where **Aeris Communication** had launched a smart fleet management platform in India in order to reduce accidents, thefts, and improve fleet efficiency.

MAPMYINDIA LAUNCHES AUGMENTED REALITY ENABLED "MOVE APP"

MapMyIndia Move, an Indian augmented reality (AR) application, has been developed with features to track and monitor locations, health, and status of both people and vehicles, even providing information on vehicle misuse and the driving behaviour of your cars. This application is powered by location data and it is intended to take a unique social community-driven approach allowing users to see and report local issues at particular locations. These local issues are relevant to their communities and can include traffic delays, potholes, waterlogging, fire burning, garbage dumps, broken streetlights, unsafe areas, and even accidents and crimes in order to provide information on areas and routes that are potentially hazardous and ones that should be avoided. This is combined with an innovative AR approach where the user can use their mobile phone camera by pointing it in any direction, allowing the user to see locations and destinations through the app itself in order to locate and quickly travel to interesting areas nearby.

India's regional SBAS is enabling innovation in the sky, land, and sea

INDIA TO PROVIDE TIDAL WAVE WARNINGS TO OCEAN CENTRES

The Indian Tsunami Early Warning Centre (ITEWC) was built up at **Indian National Centre for Ocean Information Services** (INCOIS), Hyderabad, a self-sufficient body under the Ministry of Earth Sciences.

The ITEWC gives tidal wave administrations to 25 Indian Ocean nation centres as a component of the Intergovernmental Oceanographic Commission (IOC) of the UNESCO system. INCOIS was built using Global Navigation Satellite System solutions as well as Strong Motion Accelerometers in Andaman and Nicobar Islands to address the rising difficulties in giving exact and early tsunami warnings.

GAGAN INTRODUCED ON INDIAN RAILWAYS

The **Center for Railway Information System** (CRIS), the innovation arm of the Ministry of Railways, has teamed up with ISRO to execute the Real-time Train Information System (RTIS) project. Indian Railways has introduced a GNSS aided geo-augmented navigation system (GAGAN) based system to gain train development and train-related information. With the assistance of the new framework, railways will be capable to track the movement of trains like arrival and departure and run through timings at the station, improving the efficiency of train operations.

ENGINE-POWERED DRONES TO COMBAT LOCUSTS

The Haryana government has been using drones to combat the spread of locusts, the efforts of which have been appreciated by the **United Nation's Food and Agriculture Organisation** (FAO), especially in the fight against the spread of desert locusts in the western and central states. As locusts are mostly inactive after sunset, the agriculture ministry has made the decision to approve drone operations at night, and even to allow the use of engine powered drones where possible due to their ability to carry heavier payloads than battery-operated models, resulting in a greater volume of pesticide being deployed.

WORLD BANK BACKED DRONES USED TO FIGHT COVID-19

DronaMaps, a Gurugram-based Tech30 start-up that captures geospatial data to create 3D maps from captured images, has been helping state governments by using their platform to track COVID-19 hotspots. DronaMaps offers an end-to-end platform that assists in the collection, processing, visualisation, and dissemination of drone data, providing the information to key decision-makers in order to increase the significance of the data used in mapping.

The start-up has been working with Aditya Birla and SAP to create a command-and-control centre to be used for volumetric analysis from drone-based maps. DronaMaps was part of the Tech Emerge Resilience programme ran by the World Bank and have received funding from ACT, an initiative set up by the Indian VC ecosystem in order to fight against COVID, and they have deployed a coronavirus solution in Rajasthan, Punjab, Chhattisgarh, and Haryana, with further deployments planned for the near future.

IMO RECOGNISED NAVIC AS PART OF WORLD-WIDE RADIO NAVIGATION SYSTEM

On 8 December 2020, the **International Maritime Organisation** recognised NavIC as part of the World-Wide Radio Navigation System (WWRNS) in the 102nd meeting of its Maritime Safety Committee. This recognition came as the committee stated that NavIC met the operational requirements to assist ships in navigating ocean waters.

India is the fourth country to have its satellite navigation system recognised, and it is able to be used instead of GPS up to 1,500 kilometres from the Indian boundaries. This is a marked first as it is the first regional system to be recognised, with the other systems being the USA's GPS, Russia's GLONASS, and China's BeiDou systems.

NavIC itself consists of four satellites in a geosynchronous orbit and three satellites in a geostationary orbit, each of which is at an altitude of 36,000 kilometres, providing two levels of service, a standard positioning service open to civilians and a restricted service open to authorised users such as the military.

India puts increased efforts in GNSS-enabled land surveying and monitoring

GNSS AND HIGH-RESOLUTION SATELLITES USED TO MONITOR USE OF GOVERNMENT LAND

The government of Odisha launched the **Bhubaneswar Land Use Intelligence System** (BLUIS), a web and mobile-based solution that would alert the local government of any attempts to misuse or change the use of government lands. BLUIS was announced by Chief Minister Naveen Patnaik, who announced that all the government lands in the city will be monitored using space data, including both high-resolution images and GNSS.

The idea of BLUIS is to create a geo-tagged repository to safeguard the land, with the system being able to notify government authorities of any new construction on the land in real-time, providing an improvement over the current systems which do not have the required transparency and accountability. The satellite imagery will be used to not only identify the changes, but it will also support the legal actions against the encroachment through the litigation management system and act as a smart technology solution that assists with tasks from appointment to providing evidence in legal cases.

ANDHRA PRADESH ARE TO RESURVEY LAND USING DRONES TO UPDATE RECORDS

In Andhra Pradesh, a state in the southeast of India, the government have announced that they are to undertake the largest resurvey of its lands in almost a century. The government are to plan to map lands in 17,000+ villages by August 2023 as part of a plan to update its existing databases in collaboration with the Survey of India. This mammoth task begins with over 14,000 surveyors being deployed across the state, with aid being provided by a range of devices such as drones and mobile workstations.

The last detailed survey was done between 1928-1931 using traditional methods, but this new and updated survey is utilising one drone per district to mark land parcels in order to make the records tamper-proof, beginning with agricultural areas and villages before moving onto cities.

GNSS-R USED IN AN EXPLORATORY FLOOD MAPPING RESEARCH PROJECT

In late 2018, the Indian region of Kerala was hit by the worst floods it has experienced in over a century, displacing over 5 million people and shutting down the state's airport. This is a symptom of a larger problem, with over 12% of India's area being prone to flooding, a statistic that is only going to get worse due to climate change.

In order to combat this, researchers at **IITB-Monash Research Academy**, a joint academic venture between IIT Bombay and Monash University in Melbourne, have used near-real-time satellite data to identify and map surface water across the country, which is then used to model and record flooding in order to help the authorities warn local communities of threats due to intense rainfalls. This technique utilises Global Navigation Satellite System – Reflectometry (GNSS-R), which is where passive sensing is used to take advantage of the signal delays between each satellite in order to obtain geophysical information and it is used in many applications from soil monitoring to oceanography.

PROMISING RESEARCH FINDINGS FOR THE USE OF NAVIC IN SURFACE SOIL MONITORING

Chamoli et al published '*Capability of NavIC , an Indian GNSS Constellation, for Retrieval of Surface Soil Moisture*', a paper that investigates the use of India's regional satellite navigation constellation, NavIC, for the study of soil moisture. The researchers analysed the sensitivity of soil moisture by comparing the results obtained from NavIC multi-path data with in-situ measurements and observed that the results were in good agreement with the observed soil moisture measurements. This is expected to be beneficial for applications such as groundwater estimation, flood forecasting, and for agricultural applications.

Overview of Chinese Market Trends

- China was the **first to be affected by the COVID-19 pandemic**, but it was also the first to apply GNSS-based solutions to assist in its recovery and is even considering additional infrastructure investment to offset covid's economic impact
- China released the **14th Five-Year plan in which the innovation and development of industries that are related to BeiDou are promoted**
- Strong customer base for consumer solutions due to the **high penetration of mobile devices** with **over 1 billion monthly users of WeChat**, a multi-purpose application that acts as a social media, messaging, and payment app

Key Trends in Edition Three

- The **final BeiDou-3 satellite has been launched** to complete the 30-satellite constellation, **providing improvements to accuracy, short message service capability, and additional system redundancy**
- The **latest generation of GNSS positioning chips have been released**, these are the **world's first 22nm chips** and are **one quarter of the size** of the previous generation whilst only consuming **one fifth of the power**
- Autonomy was seen in several downstream markets, with a **new smart driving innovation laboratory**, and large scale tests and launches of **autonomous cars, trucks, and even road construction vehicles**

Upstream developments include the launch of BeiDou-3 and China's first IoT Constellation

BEIDOU-3 OFFICIALLY LAUNCHED

Chinese President Xi Jinping announced the official launch of the BeiDou-3 (BDS-3) global satellite navigation system on 31 July. The satellite is a geostationary orbit satellite, offers high-precision GNSS navigation timing services, as well as satellite-based augmentation, short message communication (RDSS), precision single-point positioning and other special services.

The BeiDou-3 system consists of 35 satellites, including three geostationary satellites, three inclined geosynchronous orbit satellites, and twenty-four medium Earth orbit satellites. In addition to acting as a GNSS, BDS-3 also features a satellite-based augmentation system similar to the European EGNOS. BDS has adopted the BeiDou Coordinate System which complies with the standards of the International Earth Rotation and Reference System Service, with BeiDou also adopting the BeiDou Navigation Satellite System Time (BDT) as its time reference. The BeiDou Signal In Service document also provides details of the user alarm signal which specifies that the up and down-link signals are compliant with **COSPAS-SARSAT**.

IMPROVED SATELLITE CLOCK PRECISION ANALYSIS

There are two main methods for evaluating the precision of satellite clocks, a single-satellite method (SSM) and a multi-satellite method (MSM), both of which provide a solution to the problem of timescale differences between satellites. Each of these methods has different strengths, with SSM using a reference satellite and MSM using an estimation of the timescale difference which is then removed.

This is of importance to BDS as BDS consists of three types of satellites in different orbits which each have a different level of orbital accuracy. Researchers from several Chinese institutes published a paper investigating a new and improved MSM to evaluate the timescale differences using three International GNSS Service analysis centres over two months and found that the assimilated orbital errors have a large impact on the estimation of MSM timescale differences. This new method improved upon the traditional MSM by between 0.07 and 0.16 nanoseconds and proved that the improved method is accurate, with the best precision for the MEO clock products, and that the MSM has overcome some of the problems associated with the single-satellite method.

BEIDOU PROMOTION AND IMPLEMENTATION PLANS SEEN IN MANY DOWNSTREAM INDUSTRIES

Apart from 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 smart Winter Olympics, environmental protection, and smart transportation which will create a benchmark for smart cities in China.

Apart from this, other BeiDou+ demonstration projects are now announced to be applied to the Hangzhou Asian Games. On 7 September 2022 Hangzhou Asian Games power supply area six power transmission projects through the power BeiDou augmentation system design and construction plan evaluation, which marks the history of the Asian Games will be the first use of power BeiDou augmentation system.

CHINA'S FIRST IOT SATELLITE CONSTELLATION

On 25 July, the Tianqi 10 low-orbit Internet of Things satellite was successfully launched at the Taiyuan Satellite Launch Centre and is expected to provide Internet of Things data communication services from two weeks from the launch.

The Tianqi constellation, as China's first IoT constellation to achieve data applications, will provide data services and is the seventh in-orbit IoT data service satellite, aiming to further improve the global real-time communication service capability of the constellation to meet the narrowband data communication needs of applications such as IoT, mine hydrology monitoring, marine ranching, intelligent container, ecological environment monitoring, forest fire-prevention, green mining, and smart agriculture, enhancing China's global data acquisition capability.

Boom in GNSS hardware, including the world's first 22nm positioning chip

WORLD'S FIRST 22NM NAVIGATION CHIPSET TO ENTER MASS PRODUCTION

The Zhongguancun BeiDou and Spatial Information Service Industry Forum was held on 27 August 2020 in the Haidain District, the forum showcased the latest independent BeiDou-3-based innovations, including the latest generation of BDS high-precision navigation chips, pace-based satellite measurement, control transceivers and the BeiDou+ Remote Sensing global application service platform.

One highlight of the forum was the demonstration of **BDStar**'s latest 'high-precision positioning chipset' which was demonstrated for the first time in 2020 and was to be released in late 2020. This new chip is the world's first 22nm positioning chip and it is a quarter of the size of the previous generation of chips whilst only consuming a fifth of the power when it enters mass production in 2021.

HARDWARE MANUFACTURERS TO PRODUCE NEW HIGH PRECISION RECEIVERS

Chinese companies are launching new high precision multi-frequency receivers able to consistently provide centimetre-level accuracy even in complex environments. Real-world testing shows that the positioning usability, continuity, accuracy, and reliability in obstructed environments of these new products is comparable with the established ones. In addition, several new IMU-enhanced GNSS RTKs are available on the market, combining GNSS positioning data with high-performance, six-axis IMUs to provide accurate location in challenging environments such as tunnels, in city centres, and in heavy forestry.

GNSS TO HELP FIND MISSING CHILDREN AND PREVENT BULLYING

China's **Child Safety Emergency Response** (CCSER) platform signed a strategic cooperation agreement with Onetwothree, a national high-tech enterprise and a subsidiary of the location-based service provider **NAVINFO**. The two parties will rely on CCSER's child protection practice and Onetwothree's powerful location services and smart wearable experience to develop wearable smart devices to prevent missing children, school bullying, child sexual assault, and increase protection for children.

BEIDOU SCHOOL BAG RELEASED IN FUZHOU

Fujian Questing Technology Co., Ltd. released the first BeiDou positioning schoolbag in Fuzhou. The positioning schoolbag uses FindNow, the world's first BeiDou accelerated positioning service, and FindM Pro, a sub-meter high-precision positioning service provided by **Qianxun Spatial Intelligence Inc**. (Qianxun SI), to build the location service cloud platform based on cloud computing and data technology through the integration and construction of the BeiDou ground-based network. Users can obtain real-time, fast and accurate positioning through the mobile phone APP, which enables electronic geofencing and tracking for up to 6 months.

Autonomous driving innovation is boosted throughout China, including testing and launches

AUTONOMOUS DRIVING TO BE BOOSTED BY AN INDUSTRY EXCHANGE LABORATORY

August 2020 saw the official launch of the 'Smart Driving and High Precision Map Industry Innovation Laboratory' at the Global Geographic Information Developers Conference 2020 (WGDC 2020).

The innovation laboratory is off to a good start with the first batch of partners including **Didi**, **Huawai**, and **Baidu Maps**,. The laboratory will connect partners to build a platform for industry exchange in the field of autonomous driving to promote the collaborative development of China's intelligent driving and high-precision mapping industries. These high precision maps play a crucial role in achieving a true autopilot by improving the vehicle's perception and high-precision positioning capabilities.

SAIC MOTORS LAUNCHED LEVEL-4 AUTOPILOT HEAVY-DUTY SMART TRUCKS

SAIC Motors has launched a group of intelligent heavy-duty trucks with L4 autonomous driving capabilities, allowing the trucks to perform precise stopping parking and close queuing manoeuvres. This technology has many benefits, such as improving the capacity in passing the Donghai Bridge which can now be crossed at a speed of 60 km/h with only 20 metres between each vehicle, which is only a fraction of the 150 metre distance needed for safe manual crossing at that speed.

The decreased distance is not the only improvement, they have also seen other great success, achieving a 100% stopping in place success rate which improves the efficiency of loading and unloading the vehicle as even the most experienced driver would not be guaranteed to stop exactly in place. The trucks themselves achieved the Shanghai Smart Networked Vehicle Open Road Test License last year and have been on the job for almost a year and a half. The trucks themselves are equipped with FindAUTO, the intelligent driving service of **Qianxun Spatial Intelligence** which is based on BeiDou satellite and ground-based augmentation system and it can provide centimetre-level positioning, vision laser perception system and high-precision map, helping heavy trucks to stop in 15 seconds, regardless of the weather, light sources and other influences, and it can ensure the safety of driving in complex environments.

AUTOPILOTED BUS LANE OPENED IN ZHENGZHOU

Zhengzhou recently opened its autonomous bus lane one, featuring buses that are able to change lanes, stop at stations, and detect traffic lights. The buses obtain centimetre-level positioning data by integrating Find AUTO, an intelligent driving service of **Qianxun SI**, which is combined with other sensors, radars, and cameras in order to correctly locate the bus position, identify which lane it is in, and guide the driving system to make the best possible driving decisions.

LARGE-SCALE ROAD TESTING OF HIGH-PRECISION POSITIONING FOR DRIVERLESS CARS

Qianxun Spatial Intelligence launched the first large-scale road test of high-precision positioning for autonomous driving. The tests are set to last approximately a year, with a test vehicle being equipped with Qianxun's spatial-temporal intelligent algorithm and BeiDou's high-precision positioning service. The vehicles have been tested on half of the major urban expressways and highways across the country in different scenarios under a range of weather conditions and at different altitudes to continuously verify and iterate on the algorithm and service. Previously, **Qianxun SI** has completed 300,000 km of high-precision positioning road tests.

According to the test results, the real-time dynamic positioning accuracy of the test vehicle can reach up to a 2 centimetre-level positioning, which meets or exceeds the extensive needs for the deployment of L3-level autopilot, car-roadway collaboration, and lane-level navigation solutions. Road trail results also show that in complex road conditions, the combination of satellite + inertial guidance algorithm can still ensure the effect of high-precision positioning.

Strong development in China's skies thanks to GNSS

SUCCESSFUL ELECTRO-MAGNETIC INTERFERENCE TESTING FOR BDS-BASED AIRCRAFT

On July 13, the Beijing Capital International Airport (PEK) completed an in-flight test using BeiDou. The test was to simulate whether there is electromagnetic interference between the aircraft and the BeiDou equipment on the flight.

Since the vast majority of current civil aircraft in China is produced in Europe and the U.S., the use of the BeiDou positioning and tracking equipment on current civil aircraft should first solve technical incompatibilities. After continuous trials, it was concluded there is no compatibility problem between BeiDou and current civil aircraft during the flight.

DRONES USED TO REDUCE MEDICAL SAMPLE DELIVERY TIME BY 95%

Medical samples in hospitals traditionally needed to be manually delivered for examination, taking at least 20 minutes. Tan Jialong and his team at the studio of **Hunan Curis Intelligent Technology Co., Ltd**, in Hunan, have developed a UAV-based solution to deliver blood and other medical samples to the pathology building of the Second Affiliated Hospital of Nanhua University. The drones have shortened the delivery time from 20 minutes down to 70 seconds, a reduction of approximately 95%. The medical samples are now taken to the roof and loaded onto the drone, which then has the route set so the samples automatically arrive at the target.

The research team behind this have been developing the second generation of drones featuring upgrades to components such as parachutes, airbags, positioning devices, battery life, and much more. The development of this system was funded by the sale of civilian drones and by performing aerial photography, with the testing processes crashing nearly 30 drones before the team were awarded new type patents as well as 13 computer software copyrights. The future plans for the team involve upgrading the regional network of medical logistics drones and the building of a command centre at municipal, provincial, and national levels in order to expand this to other hospitals, as well as to leverage the solution to fight fires and much more as the technology matures.

5: https://www.chinadaily.com.cn/a/201902/25/WS5c732fb4a3106c65c34eb180.html

TESTING AND INSTALLATION OF THE BDS-SBAS MONITORING STATIONS

The BeiDou Satellite Based Augmentation System (BDSBAS) Civil Service Platform Monitoring Station passed the project acceptance test and completed the installation of the first two Xinjiang stations (Urumqi station and Qiemo station). It will be built to provide satellite-based augmentation services in accordance with the requirements of ICAO standards and specifications. The monitoring station is an important infrastructure of the BDSBAS civil service platform, providing high-precision and reliable observation data support for its services.

EU-CHINA AVIATION SAFETY AGREEMENT

The EU-China Bilateral Aviation Safety Agreement (BASA) went into effect on 1 September, giving a boost to the regions' aviation manufacturers by simplifying the process of gaining product approvals from the European Union Aviation Safety Agency (EASA) and the Civil Aviation Administration of China (CAAC), while also ensuring high safety and environment standards will continue to be met.

CHINA'S DRONE MARKET FORECASTED TO GROW 60% P.A.

In recent years, China's civilian drone industry has developed rapidly, playing an important role in many fields such as plant protection, aerial photography, surveying and mapping, and inspection.

Affected by aviation control, network security, privacy and personal safety, the global civilian drone development has now lagged behind the pace of the industrial drone industry. Currently, there are more than 6,000 UAV enterprises in China and the largest market for civilian drones lies in the provision of government public services, such as security, firefighting, meteorology, etc., accounting for 70% of the total demand. The market with the greatest potential for drones in the future is expected to appear in the civilian sector, with new market demand appearing in agriculture, cargo transportation, airborne wireless network data acquisition and other fields. It is predicted that by 2023 China's civilian drone market is expected to reach 96.8 billion-yuan, military drones about 35 billion yuan (4.5M EUR), the overall market size of the drone industry will be more than 100 billion yuan (12.8M EUR), with a compound annual growth rate of more than 60%[5].

Improved safety in both maritime navigation and for emergencies including landslides

BEIDOU'S SHORT MESSAGE FUNCTION IS MONITORING VESSELS

Since China announced "the Special Plan for the Application of BeiDou Satellite Navigation System in the Transport Industry", Shanghai Port has achieved full coverage of BeiDou telemetry for public trunk beacons. In addition, the BeiDou short message function can be used to monitor the real-time position, luminous status, light quality and battery efficiency of all the beacons in the waters in the Shanghai Port area, and can provide all-weather, round-the-clock, high-precision and highly reliable navigation services to ships.

BEIDOU TO POWER SMART LIGHTHOUSES AT THE QINHUANGDAO PORT

All public navigational facilities including lighthouses, land guides, sea buoys, etc. in Qinhuangdao Port have been fully covered by the BeiDou system, greatly improving the navigation security capability. BeiDou's lighthouse monitoring system sets up a series of functions such as status monitoring, lighthouse remote control, route tracking, etc., which can provide remote real-time monitoring and management.

By applying the BeiDou system, not only can more comprehensive and accurate navigation assistance information be provided, but the greater integration of the information of each port can be used to serve more port enterprises and ships. In particular, the BeiDou system's unique short message communication function can be transmitted directly through the satellite when there is no base station or mobile phone signal in the sea area, realising real-time information interaction between terminals.

BDS FOR EMERGENCY LANDSLIDE WARNINGS

The Chinese government has used BeiDou to monitor and warn of geological disasters, including landslides, in many parts of the country due to continuous heavy rainfall, using BeiDou to both monitor the hazards and to provide a timely warning to citizens to reduce the harm caused by these disasters.

On July 11, the BeiDou Cloud Monitoring Platform's artificial intelligence warning system in Aba, Sichuan, issued a landslide warning after a sudden heavy rainfall, enabling locals to avoid the dangerous areas. The AI system uses BeiDou's high precision technology for monitoring, with the sensors in the area detecting ground movements and displacement before the disaster occurs. The system then uses this in a big data-based AI system in order to achieve an automatic online monitoring and warning system that works in all weather.

BEIDOU HIGH-PRECISION SERVICE TO NAVIGATE DRONES FOR EMERGENCY SITUATIONS

Qianxun SI uses BeiDou high-precision service drones in order to position drones in the dike area in real-time to restore the situation following the disaster and to provide a scientific basis for disaster relief. The aerial images from the drones are used to assess the scope of the disaster, to accurately measure the location and length of the dike, and to provide data on flooded high-voltage towers and homes in the area.

The drones are used to provide a 3D reconstruction that is used to predict the inundation area of the homes following the water level rises and to calculate the amount of earthwork that would be needed to fill the breach of the dike. In addition, this Qianxun has built more than 2,600 BDS ground-based augmentation stations across the country, allowing the Qianxun-based drones to achieve real-time centimetre-level positioning, eliminating the need to build base stations on-site and to increase the success of the rescue operations by providing additional time.

Industries such as rail benefit from the completion of BeiDou-3

BEIDOU+5G TO INCREASE TRAIN-LINE TRANSPORT CAPACITY BY 30%

China National Railway Group Corporation recently issued the "New Era Transportation Powerful Railways First Planning Outline", to be implemented until 2035, aiming to be the first to build a modern railway network. Trains will integrate BeiDou satellite navigation technology, 5G communication technology, and other components of the air-world integrated control system.

The train will use a control system supported by BeiDou positioning to replace the traditional track circuitry and will use 5G technology to achieve direct communication between trains with more accurate positioning and better security. The new control system will shorten the train's tracking interval from the current minimum of three minutes to about two minutes and increase the line transport capacity by more than 30%.

BEIDOU'S POSITIONING EARLY WARNING SYSTEM IMPROVES RAIL EFFICIENCY AND SAFETY

BeiDou communication antenna is to be installed on rail locomotive control systems to enhance the wireless data transmission between the train and the ground. When trains are in motion, the onboard system is to collect real-time data such as status, safety, and monitoring information, which is in turn transmitted to the dispatching command centre via BeiDou. This solution even works when the locomotive power supply is disconnected, with the driver still being able to send positional information, amongst other data, to the command centre via the BeiDou short messaging system in order to improve the emergency capabilities. This is enabled via the BeiDou Positioning Early Warning System, developed by China's Railway Electronification Bureau, a platform to provide accurate and efficient real-time safety protection, as well as enabling the remote monitoring of both vehicles and operators who are on-site to improve overall safety.

CRRC LAUNCHED THE WORLDS' FIRST AUTOMATED MINI MAGLEV TRAM

CRRC Corporation Limited, the world's largest rolling stock manufacturer by revenue, has recently launched the world's first automated MINI maglev train, announced at the annual '2020 Fifteenth Shanghai International Rail Transit Exhibition (Rail+Metro China 2020)', hosted at the Shanghai International Convention Centre.

The vehicle is to be part of the medium-traffic public network in Lingang and it is a re-design of the traditional low-floor trams. It is guided by photoelectromagnetic, digitally guided low-floor train with rubber wheels. The vehicle is guided using a digital orbital guidance method that primarily uses electromagnetic markings which are supplemented by satellite and visual navigation methods. The vehicle has a capacity of 302 people, with a maximum speed of 70km/hour, with an extremely fast charging time of only 12 minutes, allowing it to travel up to 30km at a time. The technologies also enable functions such as speed limit controlling, an obstacle alarm, body posture corrections, and can provide additional information to the driver such as target speed, automatic stopping, and lane deviation. Reports suggested that the Dishuihu Station of the T1 Demonstration Line in the Shanghai Lingang New Area is to be completed by the end of 2020, after which the tram will be put into use.

UNMANNED CONSTRUCTION MACHINES USE BEIDOU TO IMPROVE SAFETY AND ACCURACY

2020 was the first time that sections of the Jingxiong expressway were operated with unmanned construction machinery. These unmanned intelligent equipment clusters were comprised of three pavers and six rollers, completing the paving and compaction of the highway stabilised soil. The innovative unmanned road construction equipment is equipped with BeiDou powered positioning systems that collect information about the surrounding environment via a sensor device that can be retrofitted to the vehicles. The BeiDou system allows for optimal planning of the operational pathing according to the local environment, as well as providing automatic warnings, emergency stopping functionality, and automatic obstacle avoidance, amongst other protections, providing the ability to control the construction vehicle with an accuracy of 2-3cm, an improvement of 50%.

BeiDou is enabling everything from sheep herding through to construction and farming

BEIDOU TO BE USED TO REMOTELY HERD SHEEP IN INNER MONGOLIA FOR FREE

In Inner Mongolia, the government has installed a grassland intelligent monitoring system for herders free of charge. Sheep and cattle are fitted with collars based on the BeiDou system which are then used to locate and track the position of the sheep. The BeiDou system transmits the position to the information centre and then to the grazing personnel's handheld terminal. Herders have realised that remote herding can not only locate the position of cattle and sheep in real-time and report on the recent movement history but it can also be used in an alerting system when the animals leave the predefined geofenced areas and can even recommend the best route to herd the animals.

INTELLIGENT WEEDING SYSTEM TO REDUCE PESTICIDE USE

August 2020 saw the successful demonstration of a smart weeding machine in rice fields by the **Jiangsu Academy of Agricultural Sciences** in Qiaoli Village, Xiaoshan District, Zhejiang Province. Professor Zhang Ruihong from Yangzhou University leads the research team behind the project which uses BeiDou positioning data in order to accurately eliminate weeds, leading to both healthier seedlings as well as reducing the number of pesticides needed.

This advancement is important as the weeds grow rapidly in the humid and warm rice fields in southern China, resulting in fewer nutrients being available for farming. The traditional method of solving this would be to use herbicides, which would result in both soil pollution for a long time and damaged rice. In addition to the environmental benefits, the BeiDou-based system improves efficiency whilst reducing labour costs.

EXHIBITION BEIDOU EQUIPMENT USED IN SKYSCRAPER CONSTRUCTION

In the exhibit area of China Construction First Bureau, the CSCEC-HC-5, a BeiDou high-precision positioning solution was displayed. The CSCEC-HC-5 was the first application of the BeiDou system in the civil engineering industry in China as it was used in both the construction and safety monitoring of the 600 metre Shenzhen Ping An Finance Centre project. BeiDou was used to determine the deformation caused by temperature differences, wind, and much more in the construction of super high-rise buildings.

The data collected by this system was used to provide timely warnings and correctional information during construction, enhancing the stability and accuracy of the construction in real-time. This solution offered benefits compared with the traditional methods using lasers and precision levels. These benefits include improved data quality and data signals, and it provides the ability to observe high-rise buildings above 200 metres, even in complex, obstructed environments.

ALIBABA-CREATED SOLUTION USES BEIDOU TO MONITOR ELEPHANT HERDS

Alibaba Group has formed a preliminary solution to solve the problem of human-elephant conflict in Yunnan where BeiDou's high-precision positioning technology and short message capability will be used for elephant conservation. In order to better monitor the movements of these herds, positioning collars will be worn on the herd's head and dromedary elephants, enabling real-time, accurate monitoring of areas where Asian elephants are active. In addition, using the BeiDou system, the monitors can know exactly where they are in the forest without relying on a mobile communication network and can communicate with the outside world through the BeiDou short messaging system, with text, voice, images, and other types of content being supported in the transmission.

AI, 5G, and Robotics are hot topics seen in China for this edition

FACIAL RECOGNITION IS BEING USED TO PAY IN THE GUIYANG PUBLIC TRANSPORT SYSTEM

In Guiyang, Metro Line 1 and the Guiyang Bus Rapid Transit system are now equipped with face recognition devices. Passengers who use face recognition to travel need to register their identity information on the app and link it to their chosen payment method. The driving force behind Guiyang's face recognition comes from the Shanghai-based AI unicorn, **Etu Technology**.

In the global face recognition authoritative test held by the U.S. National Institute of Standards and Technology, Etu's algorithm has won first place for three consecutive years, with a false alarm rate of one in a trillion. It is reported that the Guiyang face recognizing bus has been in trial operation for half a year before, completed more than one million facial authentications. The payment system has completed transactions of millions of yuan without an error. In the future, the scene of using recognition will be extended to different public places such as scenic spots, communities, business districts and central business districts.

GERMANY'S KUKA PRESENTED THE MOST PRECISE INDUSTRIAL ROBOT AT CIIF

On September 15, the 22nd China International Industry Fair (CIIF) opened in Shanghai. In this exhibition, Germany's **KUKA** brought an industrial robot with the highest precision, smallest footprint and largest arm span in the market. It is mainly used in the field of consumer electronics including applications such as the assembly of rechargeable batteries. After scanning work tags and work orders, the robots can automatically tell workers how to complete the assembly, allowing unskilled operators to get up to speed quickly. The robot can work side by side with the worker throughout the assembly process, forming a perfect human-machine interface to complete the assembly of a complex network device.

CHINA'S SERVICE ROBOTS ACCOUNT FOR A QUARTER OF THE GLOBAL MARKET

In 2019, the size of China's service robot market reached 2.2 B U.S. dollars (1.8 M EUR), accounting for about 23% of the global market[6]. The market size increased 33.3% year-on-year, higher than the growth rate of the global service robot market. Liu Qian, Chairman of the Board of FN Robotics, said: "In the future, the field where most robots will be used is no longer the automotive industry, but the medical industry. With increasingly aging population, the demand for medical robots is increasing, and surgical robots have been widely used. In the next 50 years, the market size of medical robots will be larger than that of automotive robots."

AI IS INCREASINGLY BEING COMBINED WITH 5G IN THE MEDICAL INDUSTRY

More than 80% of the typical application scenarios of 5G and AI are overlapping, with the two being deeply integrated resulting in the joint promotion significant changes in socio-economic production relations and modes of production. The scale of 5G network coverage provides a ubiquitous carrying space for AI, solving the huge pain point of the lack of carriers and channels for AI technology to land, and greatly promoting the development and prosperity of the AI industry. AI is present in many application scenarios of health care, for example, virtual assistants have already been carried out in many hospitals in China, applied to intelligent guidance and intelligent consultation.

Big data and information construction in medical service outreach is increasing in function, for example, artificial intelligence diagnosis in lung cancer lung nodules, which has brought great help to young doctors and the simplification of a large number of workloads. Artificial intelligence medical imaging research is also important, for example, in the gastrointestinal endoscopy AI-assisted diagnosis and treatment model, where the AI can identify what type of polyps are present and how much risk of malignancy there is based on a large amount of data, thus providing good guidance for subsequent treatment.

6: https://ifr.org/case-studies/collaborative-robots/stihl-opens-up-new-

BeiDou to support global megatrends such as climate change and the rise of the sharing economy

BEIDOU USED TO MONITOR ECOLOGICAL AND CLIMATE CHANGE IN UNINHABITED AREAS

Recently, researchers from the **Chinese Academy of Sciences** and engineers from Beijing Huayirei Technology Co., Ltd. built a standard enclosed sample plot in Cocosili and completed the set-up, installation, and commissioning of the instruments. The third-generation BeiDou system was put into use to achieve real-time transmission of monitoring data in uninhabited areas.

Since 2017, with the support of the Sanjiangyuan National Park Administration, researchers have established the same monitoring sample plots, together with the application of technologies such as the Internet of Things, cloud computing and model simulation, to investigate a wide variety of scientific issues. These issues include the interaction mechanism between ecological and hydrological changes and human activities as well as climate change in the Sanjiangyuan area, and provide data products for the scientific, intelligent and precise management of the National Park.

JIMI'S IOT SMART BADGES TO ASSIST IN REMOTE CARE OF THE ELDERLY

According to the global trend of an ageing society, elders are increasingly living alone. They are not able to ask for help after accidents and their family members cannot remotely interact with the elderly. The smart badge developed by **Jimi IoT** solves the problem of care for the elderly. By receiving the satellite timing signal, the built-in positioning terminal can make the positioning error control within 1 meter. With the easy to operate elderly badge, their family members can learn about the elderly through the mobile app. If the elderly in danger, they can press the SOS button to contact children, relatives, nearby hospitals, etc. Children can view the location of the elderly through the mobile phone once they are lost.

SUPPORT PLATFORM DEVELOPED TO IMPROVE V2X CYBERSECURITY

Zhao Zhiguo, director of the **MIIT**, revealed that more than 2.8 million malicious attacks related to connected car systems were detected in China this year and auto companies are currently not well aware of the importance of network security.

To enhance the overall information security capabilities of intelligent networked vehicles, **China Automotive Technology Research Centre** led the automotive enterprises and research institutions to build the automotive industry networked vehicle mutual support platform. The platform mainly applies digital certificate and cryptographic algorithm technology to provide services of security certificate issuance, unified identity authentication and secure message encryption for V2X communication.

BEIDOU'S HIGH-PRECISION POSITIONING USED FOR BIKE SHARING MANAGEMENT

Shenzhen has launched a high-precision fixed-point parking pilot project for sharing bikes, aiming to use the BeiDou system's high-precision positioning to achieve the management mode of "fixed-point parking and payment" for shared bicycles and to reduce the random parking of bicycles.

In the area, bicycle-sharing enterprises installed BeiDou system positioning terminals on bicycles. In accordance with the high precision parking frame position data provided by the authorities, bicycle-sharing enterprise delineates the virtual electronic fence and determine whether the vehicle parked in the designated area. After the implementation of the new model of bike management, users can only lock the bike and make payment when they park the bicycle in the designated parking area.

Overview of Taiwanese Market Trends

- World leader in **chip manufacturing** and **semiconductor board integration which** means that **Taiwan is driving multi-GNSS adoption**
- Strong foundation in **hardware manufacturing** has resulted in companies moving on to **integrate hardware and software**, combining megatrends such as **5G** and **AI**
- **Swift reaction to market trends** has resulted in consolidating opportunities in **consumer solutions, smart transportation, electronics,** and **IoT**

Key Trends in Edition Three

- An **increased focus on 5G for IoT** and **Smart Manufacturing**, including the setup of a **5G open laboratory** in Taoyuan County, a **5G mm wave smart factory** to be built, and a **5G-enabled smart manufacturing plant** at Delta Electronics' production complex
- **New GNSS receivers, modules, and trackers** have been released, including an **ultra-lower-power GNSS module for IoT applications** from Yuechung, and a **new GNSS receiver with anti-jamming and anti-spoofing capabilities** by Wintec
- GNSS has enabled innovation related to **autonomous buses** in New Taipei City, **drone mail delivery** on Siaoliouciou Island, and **autonomous collision avoidance and berthing for vessels** on the Love River

Taiwan's involvement in satellite and satellite component manufacturing

THE RISE OF LEO MEGA-CONSTELLATIONS

Taiwanese companies play important roles in the Low Earth Orbit (LEO) mega-constellations, including both Starlink and OneWeb. Taiwan-based NewSpace companies provide satellite components, satellite high-frequency components, satellite ground stations, radio-frequency (RF) modules, and PCB factories.

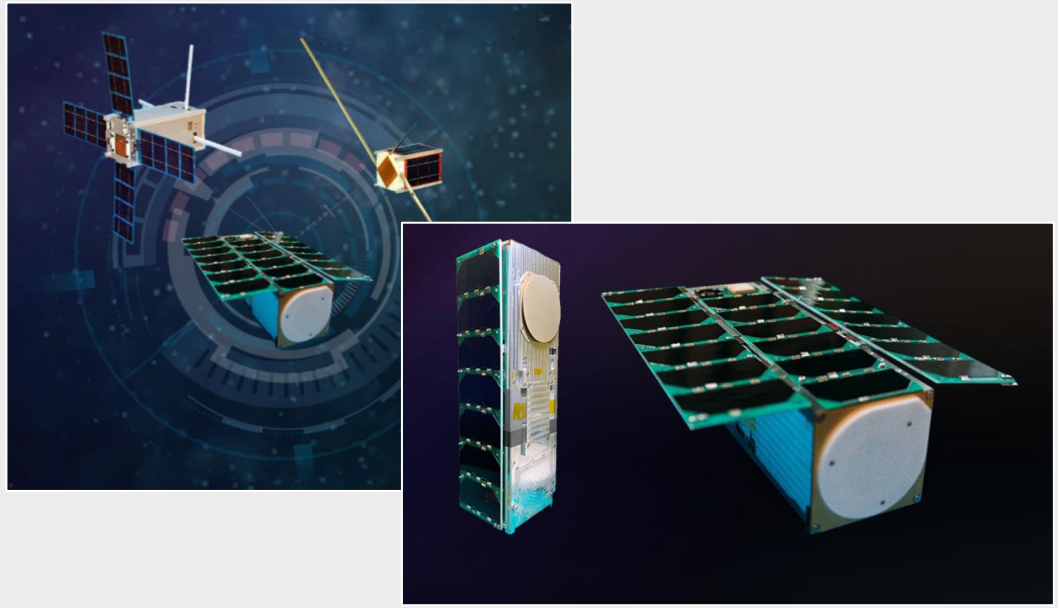
Amongst them, MTI and UMT have deployed 5G and satellite communications for many years and are the most important players. MTI, a company under Foxconn Group, has entered the international LEO supply chains, and works with SpaceX, OneWeb, and Kymeta, with MTI developing and manufacturing high performance Very Small Aperture Terminal (VSAT) RF equipment for satellite broadband or private networks applications. The complete product range includes C, Ku and Ka-band VSAT Transceivers and ODUs, as well as a series of Ku-band BUC (Block Upconverters) available with output power levels ranging from 0.25 ~ 4Watts. UMT continues to invest in the 5G application market, with European and American satellite communication customers, and are looking to expand into the aerospace industry.

Category	Taiwanese Manufacter
LEO satellites operators	SpaceX, OneWeb, Kymeta, Facebook, Amazon
Satellite components	Gongin Precision
Printed circuit board (PCB)	Elite Material, Compeq Manufacturing, Ventec International
Satellite high-frequency components	Universal Microwave Technology (UMT)
Ground stations/terminals	Microelectronics Technology Inc. (MTI), Kinpo electronics Inc.
RF modules	Tong Hsing Electronic Industries (Theil)

SPACE INDUSTRY DEVELOPMENT INITIATIVE

In order to build a sustainable Taiwanese space industry, the National Space Organisation (NSPO) executed the Taiwan Space Industry Development Initiative – a micro-satellite development programme that is to include a CubeSat programme.

The purpose of this CubeSat programme is to cultivate new talent for space technologies and to generate CubeSat commercial products. This CubeSat programme launched in 2017 and aimed to launch 3 CubeSats by the end of 2020, all of which are to be launched in a circular orbit with altitudes between 450 and 600km. The manufacturing of these CubeSats and the launch services are executed by universities and domestic companies in Taiwan, with three CubeSats being launched, IDEASSat (3U), NutSat (2U), and YUSAT (1.5U).



7: https://www.nspo.narl.org.tw/inprogress.php?c=20030402&ln=en

Taiwan's leading the way in the design and development of consumer solution hardware

NEW GNSS HARDWARE RELEASED

Customers increasing expectations lead to the release of improved versions of existing hardware. Current trends want to address problems related to power consumption, information protection and IoT functions integration.

Recently several products have been released from companies such as Yuechung International Corp. and Wintec. In particular, new receivers are designed to be less power demanding to improve the operating times of IoT applications such as trackers, wearables, and portable devices; and more resilient to interference, supporting message integrity protection, anti-jamming, and anti-spoofing, to provide reliable positioning in difficult environments.

New receivers could also integrate additional sensors to report the current overall status of systems in which they are integrated such as cars or boats.

EXPANDING THE CAPABILITIES OF WEARABLE DEVICES WITH GNSS

A TAIWANESE CASE STUDY

The most common wearable devices in Taiwan are smartwatches, smart glasses, smart fabrics, and tracking bracelets. Most wearables focus on sport and entertainment purposes, but medical wearable devices are also gaining more traction due to the increasing demand from Taiwan's ageing society.

Taiwan's IT industry is one of the most important for the consumer solutions market, with extensive experience in both the supply chain and in research and development being present throughout the region.

For examples, **LOCOSYS Technology** provides OEM/ODM services from both hardware and software in GNSS and Wireless Communication to Embedded System and Consumers electronics, including GPS watches and loggers. Another example is **RiTdisplay Corporation** who built several PMOLED lines to produce mini panels for smartwatches, sport bands, and heartbeat detectors.

Taiwan's well-known textiles industry is another important sector for wearables. An example of a textile-based innovation is the rise of smart cloth-textile material with wearable devices embedded into the material itself.

Large textile producers have adopted the new technology over the last few years, with companies such as **AIQ Smart Clothing Inc** focusing on a washable smart cloth with inbuilt heart rate monitors.

Read more about this in our innovation blog article.

Innovation seen in the road transportation market, with autonomous buses and GNSS-tracked goods

FREE TRADE ZONES TO USE GNSS-MONITORING SYSTEM

Taiwan's **Customs Administration of Ministry of Finance** plans to establish a GNSS monitoring system to improve the control mechanism for goods transportation in the Free Trade Zone.

The "Cross-regional tracking system for the Free Trade Zone cargos" will integrate cargo delivery time and designated delivery route data for real-time monitoring of cargo delivery status. The Customs Bureau is testing the system with truck fleet operators and is scheduling the launch for late 2020.

AUTONOMOUS BUS TESTING AT SPEEDS OF UP TO 50 KILOMETRES PER HOUR

Since the introduction of the **Unmanned Vehicles Technology Innovative Experimentation Act**, WinBus became the first locally developed autonomous minibus and is now entering the trial period. **Automotive Research and Testing Centre** (ARTC) supervised the whole process of design and production of the vehicle which is capable of accommodating up to fifteen passengers. Other specifications of the minibus include the maximum speed of fifty kilometres per hour and the maximum range of seventy kilometres.

SAME-DAY DELIVERY SHIPMENT USING GNSS

TV and online retailer Momo.com Inc has set up a new logistics subsidiary, Fu Sheng Logistics Co. to oversee the company's extensive shipping operations. Leveraging Momo's 23 satellite warehouses and distribution centres nationwide, Fu Sheng is in charge of executing the retailer's same-day shipment plan for deliveries in Taipei, New Taipei City, Taoyuan, Taichung, Tainan and Kaohsiung. The company is to set up another seven satellite warehouses and distribution centres by the end of the year. Fu Sheng has also installed GNSS trackers on its vehicles to monitor risks and collect data relevant to shipments.

ESTABLISHMENT OF INDUSTRY STANDARDS FOR IOT CARGO MONITORING

The Customs Administration contracted the **Taiwan Telematics Industry Association** (TTIA) to establish industry standards for IoT cargos monitoring equipment. It has gone through several industry public hearings and group workshops, participated by stakeholders such as vehicle-mounted devices producers, seal equipment suppliers, system integrators, telecommunications operators, and land transporters such as container semitrailers and bonded trucks to discuss the equipment's technical specifications and procedures.

After discussion of practical issues and collecting opinions, the drafts of "On-Board Unit Industrial Standard for Container and Truck Cargo Transportation" and "On-Board Unit and Peripheral Device Industrial Standard for Container and Truck Cargo Transportation" were published

TAMSUI HAS OPENED AN AUTONOMOUS C-V2X BUS LANE

A self-driving bus service of a short 600-meter ride has opened to the public in Tamsui, New Taipei City with C-V2X technology since September. This is the first autonomous bus in Taiwan to incorporate cellular vehicle-to-everything (C-V2X) technology, allowing it to communicate with roadside detectors, an online monitoring network, and other vehicles. The project was commissioned by New Taipei City's transport bureau and supported by the **Ministry of Transportation and Communications**.

Satellite navigation controls the skies with developments related to both planes and drones being seen

A NATIONAL UAV CONTEST AND FUNDING FOR DRONES

The **Ministry of Transportation and Communications** (MOTC) is launching a national UAV contest as part of the nation's strategy of tapping into the drone market as the technology is applied in new ways in an increasing number of fields worldwide. Taiwan government has allocated NT$4.2 billion (US$145.76 million) to a smart transportation system project to fund drone applications. The Directorate-General of Highways plans to use drones to facilitate bridge inspections, while **Chunghwa Post** expects to use drones for mail delivery.

CHUNGHWA POST TO BEGIN USING DRONES TO DELIVER MAIL

Chunghwa Post might begin testing unmanned aerial vehicles (UAVs) to deliver mail to Siaoliouciou Island from March 2021. The move is part of the **Ministry of Transportation and Communications**' push to increase the commercial use of drones. The postal company previously tested UAVs for mail delivery in Tainan's Zuojhen District and on Alishan mountain. Although drones could help the post office overcome troubles delivering to isolated areas, they can only carry 20kg at a time.

INTELLIGENT AND AUTONOMOUS DRONES SHOWCASED

CIRC joined the Commercial UAV Show in London on 10-11 November to showcase its commercial intelligent drone solutions and 5 autonomous drone models with onboard edge AI, a nest for charging and protection from the elements and a flight management system for scheduled or fast response click and fly missions. CIRC also launched the world's first autonomous navigation solution featuring 3D LiDAR SLAM.

AN OVERVIEW OF THE DEPLOYMENT OF ADS-B

The **Air Navigation and Weather Services, CAA**, MOTC performs its function in accordance with the rules and regulations of ICAO and relevant international standards thereby providing all information on air traffic control, flight information, aeronautical meteorology, aeronautical telecommunication, ground-based navaids for all civilian and military aircraft inside the Taipei Flight Information Region.

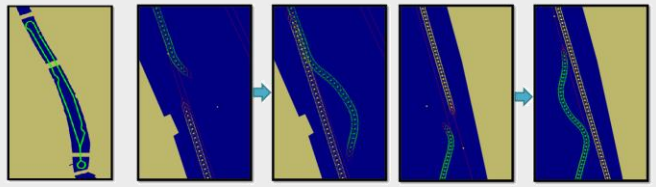
Amongst the surveillance equipment applied by the office, there are 11 sets of Automatic Dependent Surveillance–Broadcast (ADS-B) as seen in the image below, which shows the equipment at airports in gold and the equipment outside of airports in blue.

GNSS has enabled autonomous river navigation and surface deformation modelling

AUTONOMOUS NAVIGATION AND COLLISION AVOIDANCE

The **Ship and Ocean Industries R&D Center** (SOIC) in collaboration with **Kaohsiung City Shipping Co.,** Ltd., Dapeng Bay Yacht Co., Ltd., Tachou Ship Building Co., Ltd., and **Information and Communications Research Laboratories** (ICL), ITRI, has initiated testing of a solar ship autonomous navigation.

The experiment has been taking place on the Love River channel in Kaohsiung City with the help of Solar Ship No. 3. The focus is on assessing various advanced developments including intelligent collision avoidance technology and automatic berthing technology, with images of the route and vessel seen below.



GNSS DATA HAS BEEN USED IN SEMI-KINEMATIC REFERENCE FRAME RESEARCH

A recent research project presented its result of establishing the Taiwan Semi-Kinematic Reference Frame based on surface deformation model derived from GNSS Data.

The researchers observed 437 continuous GNSS stations from January 2003 to December 2019 to estimate the horizontal velocity fields in Taiwan. They also integrated twelve horizontal velocity fields between 2003 and 2018 from 785 campaign-mode GNSS sites surveyed by the Central Geological Survey to derive the horizontal grid velocity models using the Kriging spatial interpolation method. Independent GNSS observations of 1400 stations collected by the National Land Surveying and Mapping Center (NLSC) between 2013 and 2018 were also used for exterior checking on the accuracy of the surface deformation model. In addition, the network-based RTK system in Taiwan established by NLSC, named e-GNSS, is proposed to be used for assessing the accuracy of the velocity model and for the decision on the timing of velocity model renewal.

E-GNSS COORDINATE SYSTEM TO BE FIXED ON TWD97

e-GNSS, Taiwan's high-precision real-time dynamic positioning system, is set to be replaced with a new coordinate system on 1 May 2021. The system had previously referenced the **Surveying and Mapping Centre** in Tiachung City, LGB0, but from 01 May the whole of Taiwan is to use the relevant tracking centres of TWD97.

The table below shows the coordinate frame definition with more information being available **here**.

International Coordinate Reference Frame		ITRF94	
Starting Date [JP Time]		01 May 2021	
Fixed Station Name	X-Coordinates	Y-Coordinates	Z-Coordinates
Survey and Mapping Centre (LSB0)	-2,967,207.333 m	5010439.297 m	2593842.976 m
Velocity	Vel_N	Vel_E	Vel_U
LSB0	-0.0042 m/yr	0.0000 m/yr	-0.0022 m/yr

An increased focus on 5G in combination with IoT, Industry 4.0, and smart manufacturing

NEW 5G OPEN LABORATORY FOR TELECOM EQUIPMENT DEVELOPMENT

Taiwan established a new 5G "open lab" in Taoyuan County to provide Taiwanese manufacturer with access to Cisco's cloud-based mobile network to develop their own 5G telecom equipment, such as small-cell base stations, and modems, as well as various Internet of things (IoT) hardware. This move is designed to democratise the historically oligopolistic market dominated by several firms including **Nokia Oyj**, **Ericsson AB**, and **Huawei**.

5G CELLS DEPLOYED ACROSS THE COUNTRY

Nokia will provide Taiwanese mobile operator, **Chunghwa Telecom** (CHT) with a range of products from its innovative small cells portfolio to support CHT's initiative to deliver comprehensive 5G coverage. CHT is the first operator in Taiwan to deploy a 5G non-standalone (NSA) small cells solution enabling instant 5G coverage in specific areas such as business as well as tourist districts. Nokia has already commenced deployment and has installed 140 5G small cells to date.

TAIWAN'S FIRST 5G MMWAVE SMART FACTORY

Chunghwa Telecom, **ASE**, and **Qualcomm Technologies**, Inc. are planning to jointly build Taiwan's first 5G mmWave enterprise private network smart factory. It is expected to serve as a catalyser for three major areas: artificial intelligence and automated guided vehicles smart transportation, remote augmented reality assistance and green technology. The initiative is supported by the **MOEA**'s 5G office which expects that the facility will be completed by the end of 2020.

SMART FACTORY SOLUTIONS SHOWCASED AT THE INDUSTRIAL AUTOMATION EXHIBITION

TECO Electric & Machinery showcased its smart-factory solution during Taipei Int'l Industrial Automation Exhibition 2020. The smart-factory solution consists of many self-developed key components, including digital electric meter, inverter, motor, and PLC (programmable logic controller), coupled with visualized detection technology and sensors, capable of exhibiting visualized data on display.

The solution has been applied in smart production lines in TECO's plants, materializing automated control and digitalized management. The solution also boasts big-data and AIoT technologies, provided by TECO subsidiary ITTS, enabling information visualization and interactive analysis, as a result of which management can have a firm grip on the latest information for decision making.

Another highlight of the smart-factory solution is DC-servo smart vehicles on a rail, with maximum load reaching 600 kilos, for smart warehousing, applicable in logistics and IC plants. IoT products also figure prominently in the solution, which furnishes key machinery and equipment such smart functions as vibration and temperature detection, remote control, and cloud functions.

DELTA'S PRODUCTION COMPLEX TO USE 5G FOR INDUSTRY 4.0

Far EasTone Telecommunications (FET), **Delta Electronics**, and Microsoft Taiwan have joined forces to establish the first 5G-enabled smart manufacturing plant at Delta's production complex in Taoyuan. The aspiration is to combine IT, OT, and CT technologies to vividly showcase the full potential of cross-domain Industry 4.0 synergies in the age of 5G. The new concept is expected to considerably boost efficiency at all production stages and increase the per capita output by 300-500% percent[8].

8: https://www.digitimes.com/news/a20200609PD202.html

Digital governance is ensuring advancements in AI and other technologies to assist the public

AUTOMATED AI VALET PARKING SYSTEM

oToBrite and the **National Center for High-performance Computing** (NCHC) of **NARLabs** have joined hands to develop an AI perception and recognition system using the **Taiwan Computing Cloud** (TWCC), creating a memory-type automated valet parking system and taking Taiwan to level 4 (1) of driving automation. By using TWCC for deep learning, the time it takes to model each individual intelligent driving training exercise was halved, while technical upgrades will be at least four times faster.

NEW AI CHIP DEVELOPMENT LABORATORY

The **Industrial Technology Research Institute** (ITRI) and **Synopsys** are to set up a joint artificial intelligence chip laboratory in Hsinchu.

The AI Chip Design Lab aims to provide Taiwanese IC design houses with access to advanced design tools and design and verification services, lowering the barrier of entry to AI. The lab is scheduled to officially start operations in October 2021.

FULL-SCREEN FINGERPRINT SCANNERS

Egis Technology Inc, a leading provider of fingerprint biometric will co-work with FocalTech Systems Co., a leading developer of human-machine interface solutions, in developing the next-generation full-screen fingerprint technologies and applications (also known as “fingerprint touch display driver IC, or FTDDI”).

INDUSTRY AND ACADEMIA TO PROMOTE SOFTWARE AS A SERVICE

Big data collection, modelling, prediction, transmission, storage and information security protection all require the establishment of Infrastructure as a Service, Platform as a Service and Software as a Service systems in addition to joint efforts by members in software and hardware ecosystems. Taiwan’s **National Center for High-Performance Computing** at the **National Applied Research Laboratories** teamed up with academic and industrial segments to strengthen these services, as well as to promote them to industry.

TAIWAN’S FUTURE DIGITAL DATA GOVERNANCE

Taiwan’s future digital data governance focuses on smart healthcare offerings including generic drugs, new pharmaceuticals, medical supplies, and health and well-being promotion, and the strategy for biomedical big data concerning disease prevention, diagnosis, medicine, nursing and long-term care services should be even more comprehensively formulated.

Taiwan’s current "**Digital Government Program 2.0 of Taiwan (2021-2025)**" focuses on the three major goals: "accelerating the release and reuse of government data", "Utilize people's livelihood information to create a new public governance" and "Using digital technologies to improve public service". The programme goals and promotion strategies are presented below.

The programme is based upon the following basis’:

Basis 1: Create high-security data transfer facilities

Basis 2: Support measure for complete digital transformation

Overview of Korean Market Trends

- Increasingly ambitions, with **large upstream projects** and **comprehensive downstream market development** – Korea is investing in projects such as **launch vehicles**, a **regional satellite navigation system**, and even a **lunar exploration programme**
- The **Korean New Deal**, including both a Digital and Green New Deal, is to **embrace megatrends** such as **Digitalisation, Data, AI, and Climate Change**, all of **which rely on GNSS-powered solutions** such as autonomous driving, shipping, and smart cities
- Government-led projects, both upstream and down, may **generate critical investment and demand for the ICT and digital sectors**

Key Trends in Edition Three

- The Korean government announced in July 2020 the "Digital New Deal initiative" centred on AI, 5G, and Big Data. **GNSS is expected to play an essential role in Cooperative Intelligent Transport System** (C-ITS)
- The Ministry of Science and Technology has announced the **Space Development Plan for Next Three Years (2020-2022)**, a three-year plan that **includes projects for satellite navigation**, communication, and even an indigenous launch vehicle
- **Non-contact technologies are gaining momentum in Korea**, with a surge in usage being seen during COVID – increases were seen for AI-speakers, **drones, and autonomous driving**, which also benefits from SK Telecoms partnering with Uber

Korea is utilising upstream government projects to catch up with more advance space players

KOREAN POSITIONING SYSTEM FAILED FEASIBILITY TESTS

Korea's ambitious plan to build its own satellite navigation system by 2034 failed to pass the preliminary feasibility test in July 2020, however, the project has been selected to go through a feasibility study again. The Korean Positioning System did not pass the study because of its massive cost at € 2.1 billion, competition with other high-priority projects, and weak support from the military. The project gets a second chance to challenge the preliminary feasibility study, as the Korean government has recently laid out the digital "New Deal" policies where autonomous cars, drones, and location-based services would play a critical role.

Demand for high-precision precision, navigation, and timing information will increase to support all these devices and platforms. China's recent completion of the BeiDou system has also triggered public interest in an independent satellite navigation system. Thus, it seems likely that the KPS project will pass the study.

Once approved, the first inclined geosynchronous orbit satellite will be launched in 2027, and a total of 8 satellites (3 GEOs & 5 IGSOs) will constitute the system. By 2034, the KPS will provide six services – i.e., Open Service, Satellite-based Augmentation System complimentary service, metre-level service, centimetre-level service, Search and Rescue service, and a Public Regulated Service.

KOREA'S THREE-YEAR SPACE DEVELOPMENT PLAN

On 23 July 2020, the **Ministry of Science & Technology (MIST)** announced the Space Development Plan for Next Three Years (2020-2022) to complement the Basic Plan for Space Development Promotion in 2018. The plan identified several outstanding items including the Nuri, a Korean indigenous launch vehicle project with four 75-ton engines clustered in the first stage which will undergo a special inspection. The rocket is scheduled for launch in February and October 2021.

LAUNCH FOR KOREA'S LUNAR EXPLORATION PROGRAMME

On 25 September, the **Korea Aerospace Research Institute** (KARI) announced the schedule of Korea's first lunar exploration project that started in 2016.

The country's first lunar orbiter will be launched atop the Falcon 9 rocket of Space X, from Cape Canaveral Air Force Base in Florida in August 2022. The project has so far suffered multiple delays and cost overruns due to weight problems. Now, the launch schedule is on track as the first step in the project to a moon landing in 2030. KARI is preparing the project with NASA and Space X.

SOLID-FUEL ROCKETS NOW ALLOWED

On 28 July, South Korean Deputy National Security Advisor, Hyun-chong KIM, announced that the restrictions on its use of solid-fuel rockets were lifted following the revision of the missile guidelines agreed between South Korea and the United States.

The original guidelines had restricted Korea's ability to develop solid-fuel rockets as part of the US policy to control Korea's weapons development out of concerns for a regional arms race. After a series of revisions that extended the maximum range allowed for Korea, restrictions on maximum weights for warheads were lifted in 2017. The additional revision in July has effectively unlocked Korea's potential for space vehicles as well as long-range missile capabilities. It is expected that South Korea will launch numerous military satellites and build more powerful missiles in the years to come

A rise in smart, consumer solutions has been seen as non-contact technologies gain momentum

HEAVY RELIANCE ON IMPORTED VEHICLE PARTS

The 10th Automotive Industry Development Forum took place on 21 October. In addition to discussing market outlook, participants pointed out that South Korean industries are heavily reliant on imported electric and autonomous driving car parts. Korean industries lead in battery management systems for electric vehicles (EVs) and fuel cell stack for hydrogen vehicles.

However, they are far behind in areas of battery pack, converter technologies, hydrogen storage, and hydrogen charging components. In case of the self-driving cars, foreign reliance is especially concerning.

In the meantime, the **Korea Automotive Technology Institute** is making efforts to localise critical components for self-driving vehicles. The institute has tested an autonomous shuttle of its own development using domestic products including a battery drive motor, LiDAR, radar, and camera sensors. The institute is advancing its design technology for autonomous vehicles and components and is working on level 3 critical technologies.

SURGE IN SMART DEVICES AND DIGITAL SERVICES

Due to the COVID-19 pandemic, digitalisation and non-contact business technologies are gaining momentum. In South Korea, location-based consumer solutions have already been around, but they are cultivating more users and expanding service areas. In September, the **Ministry of Science & ICT** reported that smart devices and digital services have significantly grown with rising demand due to the COVID-19 pandemic.

Specifically, cumulative sales of AI-based speakers increased nearly 46% in March year-on-year. Whilst internet-only bank accounts grew to 24 million or 50% surge, devices that require high-precision location data saw considerable growth. The number of drone registrations spiked to 13,234 units (41.7% growth) and 93 autonomous vehicles were tested from 62 in the previous year.

MOLIT CONDUCTED LARGE SELF-DRIVING TESTING IN DECEMBER 2020

The **Ministry of Land, Infrastructure and Transport (MOLIT)** conducted a large self-driving bus road test in early December. The tests included the level 3 tests where the bus operated autonomously in a normal driving situation at a speed of 50km per hour. The test also saw the bus make a precise stop at the designated posts and the bus also demonstrated its ability to drive and stop as it receives road information from preceding vehicles. With more companies expressing interest in self-driving cars, **LG UPlus** announced that it signed a MoU with multiple local and international partners in November, aiming at developing autonomous driving technology using V2X and 5G.

KOREAN TELECOMS GIANT, SK TO PARTNER WITH UBER

SK Telecom, a telecommunication giant in South Korea, announced on 16 October that it would spin off its mobility platform and form a partnership with Uber Technologies. The separate entity, T Map Mobility, would take over SKT's mobility services and set up a joint venture with Uber in the first half of 2021. SKT expects the partnership would create synergy as Uber brings in advanced taxi-hailing service and its global experience combined with T map, SKT's navigation service platform.

Drones are one of the eight industries designated and supported by the government

SUCCESSFUL DRONE TAXI TESTING FOR K-UAM

On 11 November, a drone carrying 80kg of rice as a dummy payload flew seven minutes over Yeouido, a financial district in Seoul, and safely landed near the Han River. It was the first drone test in a downtown area as part of preparing South Korea's urban air mobility (K-UAM) system by 2025.

The government is determined to take an initiative in drone transportation as seen its tight timeline for K-UAM operation. However, critics pointed out that a domestic drone qualified for testing has not been released and that the test drone was made in China. The test both illustrated the possibility of urban air mobility in Seoul and the gap between the government's goal and the reality of the drone industry.

SOUTH KOREA'S DREAMS OF A DRONE FUTURE

INSIGHTS INTO THE KOREAN URBAN AIR MOBILITY (K-UAM) ROADMAP

Drones have been heavily used by the South Korean military whist being viewed by many citizens as futuristic toys. However, over the past few years there has been a significant expansion of the use of drones into civilian applications by both industry and the Korean government. Between 2015 and 2020, the commercial and civilian drone markets had an annual growth of 19%, with the total shipments of drones being expected to reach 2.4 million units by 2023.

Our GNSS.asia Project Manager for Korea has provided an analysis of the drone policies of the Korean government, including the Korean drone roadmap, regulations and frameworks, and the Korean Urban Air Mobility roadmap that was announced in June 2020. In addition to the government policies, the analysis also covers industry initiatives from key stakeholders such as Hyundai Motors and Doosan Mobility Innovation.

Read our analysis in the GNSS.asia innovation blog post on the Urban Air Mobility Roadmap here

HYUNDAI MOTOR TO BUILD UAM INFRASTRUCTURE IN THE UK

On 6 August, **Hyundai Motor** announced that it would partner with Urban Air-Port, a British mobility company, to develop urban air mobility infrastructure in two cities in the UK. Noting the importance of UAM infrastructure, Hyundai Motor aims to balance its focus on flight vehicles with UAM facilities. Hyundai Motor already showcased its new business structure centred on smart mobility and unveiled an electric VTOL vehicle at CES 2020 in January.

HYDROGEN-POWERED DRONES DEPLOYED FOR SAR TESTING

Doosan Mobility Innovation (DMI) introduced the DS-30 type drone, equipped with a fuel-cell power pack and a hydrogen tank. It can fly for 2 hours up to 80km and carry a payload of 5kg, whereas regular drones that operate on batteries often struggle to fly over 30 minutes.

Its ability to stay airborne longer and carry a decent payload makes it suitable for emergency response. The drone was tested for a SAR operation in November where it successfully carried out a mission to search and spot a person in distress at sea, drop a life vest, and transmit the persons GNSS coordinates to rescuers.

Rising interest in unmanned ships and vessels, as well as the integration of GNSS into agriculture

GO-HEUNG COUNTY TO SET UP A DRONE CENTRE FOR AGRICULTURE BY 2023

Go-heung County, South Jeonlla, announced in July that it had finally won the “Smart Farming Demonstration & Diffusion Project Using the 5G-based Drone” through a competitive process managed by the Ministry of Trade, Industry and Energy.

The four-year project involves the **Korea Aerospace Research Institute** (KARI), the **Korea Institute of Optical Technology**, the Korea Drone Industry Promotion Association, and Sunchun University. It will first set up a 5G network and a drone commercialisation demonstration centre at Go-heung Aviation Centre by 2023. Once established, the project will help prepare manuals for the cultivation and management of crops using 5G drones. The county expects the project to provide means to address the labour shortage and subsequent productivity decrease.

N. GYEONGSANG’S POLICIES TO SUPPORT UNMANNED VESSELS AND EQUIPMENT

The government of North Gyeongsang Province, in the south-eastern part of Korea, announced policies to support marine industries related to the East Sea / the Sea of Japan. In particular, the provincial government would focus on marine equipment and machinery suitable for use in the deep part of the East Sea. Some of the candidates included unmanned vessels operated either by remote control or by autonomous navigation. This marks a change from the usual method of controlling the vessels and ships from land control centres using GNSS information to confirm their location. The province’s plan also included information and communications infrastructure and a control system.

GNSS-BASED SMART PEST CONTROL ROBOT DEVELOPED TO REDUCE PESTICIDE WASTE

On 7 September, the **Rural Development Administration** announced that an unmanned "smart pest control robot" has been developed, which moves inside an orchard and accurately sprays pesticide on its own. The robot is a caterpillar-tracked vehicle equipped with a GNSS receiver and a gyroscopic motion sensor. It also uses LiDAR sensors, which measure the distance to objects with laser-type light sources, to identify the presence and shape of trees. Based on the data obtained through LiDAR, the smart control unit manages the application amount of pesticide. Moreover, it is designed to tell trees apart from buildings and pipes which will allow the robot to only spray pesticides on the areas which require it.

SAMSUNG HEAVY INDUSTRIES DEMONSTRATED A REMOTE-CONTROLLED TUGBOAT

Samsung Heavy Industries (SHI) announced on 19 October that it has demonstrated remote-controlled ship operations.

The test ship was a 38-metre long and 300-tonne tugboat and it was operated from SHI’s land control centre. The ship was equipped with the Samsung Autonomous Ship (SAS), an autonomous navigation system developed by SHI. The demonstration included collision avoidance, remote control methods, and autopilot functions. The SAS collects information from both radar and GNSS signals to find optimal routes and it controls steering and propulsion system based on the information.

Korea is securing its infrastructure to protect it from interference, spoofing, and jamming

SAFER NAVIGATION BY COMBINING GNSS WITH ELORAN

The eLoran system is required to safeguard the region from GNSS jamming attacks, with the system being designed to provide an accuracy equal to or better than 20m. These jamming attacks threaten to disrupt shipping and air movements through disruptions on the L1, L2, and L5 bands. In order to mitigate this risk, the Korean government decided to enhance the previous Loran-C system to avoid any reliance on foreign infrastructure and systems.

South Korea's eLoran Transmitter Stations

AN OVERVIEW OF THE ELORAN SYSTEM

In the past, there were incidents in which timing signals from GNSS had been blocked by jamming from North Korea. Now, the **Korea Research Institute of Ships and Oceans Engineering** (KRISO), together with the **Korea Ministry of Oceans and Fisheries** (MOF), is developing the capability of its eLoran system to provide PNT information.

KRISO chose **UrsaNav** of Billerica, Massachusetts as the prime contractor in July 2020 to install the eLoran system near Inchon, a port city close to Seoul. Two existing Loran-C transmitter sites will be upgraded to the eLoran standard, and one new eLoran site will be added. Two differential eLoran correction stations have already been deployed as part of the eLoran testbed.

eLoran is an advanced terrestrial navigation system that can stably provide PNT services without radio disturbance by using a terrestrial transmission tower rather than a satellite and the eLoran services will be available in South Korea from 2021 with developments in GNSS integrity and correction information services up to a 10-cm accuracy being expected to be available by 2023.

The eLoran system itself will have 43 differential eLoran stations across the country which shall be used along with the five eLoran transmitter stations as seen in the image on the left-hand side of this page. The system itself is not intended to replace GNSS in the country, but instead act to improve the robustness of PNT services for maritime, road transportation, and infrastructure including television broadcasts throughout the country.

DAPA'S PROJECT ON SECURED SATELLITE COMMUNICATION SYSTEMS WAS COMPLETED

Korea's Defense Acquisition Program Administration (DAPA) has completed the satellite communication system project in the rear area of Korea in August, using the Mugunghwa-6 commercial satellite. The rear areas include the middle and southern parts of the Korean Peninsula from the demarcation line with North Korea. The completion of the project will provide the military with the continuity in command, control, communication, computer & intelligence (C4I) as the satellite could complement communication disconnection on landline and weak signals in a military communication network.

Korea's €120 billion mega-development plan includes both a Digital New Deal and a Green New Deal

DATA POLICIES IN THE DIGITAL NEW DEAL

The Digital New Deal, in particular, aims to build a digital economy and promote growth in promising non-contact industries (in Korea, the local English term 'untact' is often used). It heightens the competitiveness of Korea and its industries by establishing digital infrastructures in areas such as data, network and artificial intelligence (DNA for short). At the same time, major infrastructures including those for transportation, water resources, urban planning, and logistics will be digitised.

The 'data ecosystem,' which involves the collection, utilisation, disclosure, integration, and distribution of data will be reinforced. A data control tower will be established for the integrated management of public and private data. Specific policies are as follows:

- Disclosure of 142,000 public data; and the expanded collection and utilisation of data in fields such as manufacturing and medical industries
- Establishment of big data platforms for different sectors, and the introduction of vouchers for data purchasing and processing to 8,400 companies
- Collection of additional data for AI-learning (1,300 types of data), and the introduction of vouchers on processing the data for AI-learning for 6,700 SMEs

AI AND 5G IN THE DIGITAL NEW DEAL

Policies are categorised into two areas: (1) the integration of 5G and AI into industries; and (2) policies for a smart government that utilises 5G and AI.

(1) Integration of 5G and AI

- Production of 195 immersive contents in areas such as culture, sports and
- transportation; the construction of 160 smart museums and galleries based on ICT; and the development of technology to commercialize self-driving vehicles and self-navigating vessels
- Construction of 12,000 smart factories; the provision of AI-based home services (e.g., indoor purification of fine dust); and the implementation of leading projects that integrate AI with other technologies in areas close to people's lives.
- Support for 1,000 start-up businesses providing 'untact' (non-contact) services; the creation of a new 'Smart Korea Fund' worth KRW 6 trillion; and the provision of vouchers for AI solutions to 3,400 SMEs, and smart service solutions to 1,350 SMEs

(2) Making a smart government that adopts a smart working environment by utilizing 5G and cloud networks

- Implementation of pilot projects based on blockchain technology (e.g., to prevent duplicate claims on welfare benefits) and the provision of customized information on government subsidy and pension plans
- Phased establishment of 5G at all government complexes; and the transition to cloud computing of public information system

DIGITALISATION OF SOCIAL OVERHEAD CAPITAL

This subsection of the Digital New Deal is more related to potential GNSS application. Digital technologies and AI will be deployed to create a Cooperative Intelligent Transportation System (C-ITS) on major roads and IoT sensors will be installed on all railways and three national fishing harbours. Regarding the geographic information system, a precise road map and a comprehensive 3D map will be prepared on 15 types of underground structures; measuring instruments will be installed on 120 km of the underground utility-pipe conduit; and a digital platform will be set up at 29 harbours. For safer water management, real-time monitoring and remote controlling systems will be set up for national rivers (73 rivers, 3,600 km), 27 reservoirs, and 37 nationally managed dams. Regarding disaster management, 510 early-warning systems will be installed for slope land and other areas with high risk for disasters and additional flood warning systems will be set up in 180 parking lots located near high water levels.

Korea is also focused on other mega-trends including robotics, cyber, and climate change

Korea is accelerating its efforts to become the world's fourth-largest player in the robot industry by 2023. According to the government's five-year Third Robot Basic Plan in August 2020, the country set a goal to promote 20 key robotics companies and deploy 700,000 industrial robots by that year. Meanwhile, private companies have introduced diverse service robots with self-driving/moving capability.

SK TO DEVELOP 5G MOBILE EDGE COMPUTING POWERED SELF-DRIVING ROBOTS

On 4 August, **SK Telecom** announced that it has signed an MOU with **Robotis**, a domestic robot company, to develop autonomous robots based on 5G mobile edge computing (MEC), which enables cloud computing capabilities and an IT service environment at the edge of cellular networks.

Both companies are aiming to obtain a head start in the self-driving robot market. Robotis is already an established robot company in Korea offering modularised and standardised solutions to robotics technologies. SKT and Robotis agreed to improve the self-driving performance by taking advantage of 5G in transmitting large amounts of visual and sensor information.

DIGITAL EFFICIENT ENERGY MANAGEMENT

Turning public buildings into energy-efficient buildings by way of employing high-performance insulation and building an AI and IoT based water management system are key to the transition plan. For efficient energy management, a smart grid will be built with advanced metering infrastructure. The plan also laid out the promotion of electric vehicles (EVs) and hydrogen cars as well as renewable energy sources.

BAEMIN LAUNCHED SELF-MOVING ROBOTIC CARTS FOR OUTDOOR FOOD DELIVERY

Baedal Minjok (short for Baemin), South Korea's leading food delivery app service provider, started to test five delivery robots inside an apartment complex in August 2020. The delivery robot named Dilly Drive rolls at the speed of 4-5km per hour and operates up to 8 hours once charged, delivering 6 packages of food per trip. Customers place orders and check the current location of Dilly Drive via the Baemin app, with the robot sending notifications 100m before and upon its arrival.

The outdoor delivery robot requires advanced technology as they need to detect the movement of people, cars, bicycles, and even animals while being able to operate on bumpy roads and diverse weather conditions. From June, **Woowa Brothers**, Baemin's parent company, has been testing the system with SK Telecom to improve its performance.

AN INCREASE IN US PRESSURE TO AVOID HUAWEI EQUIPMENT

In 2020, the world has seen a serious deterioration in US-China relations. Against the political backdrop, the two countries have spatted over the Huawei equipment and its potential backdoor issues. In South Korea, LG UPlus, one of the three big telecommunications companies, relies on Huawei for its base station equipment.

Moreover, Huawei's networking equipment is reported to be widely used in large corporations and financial firms other than **LG UPlus**. Considering the cost-effectiveness, Huawei has been providing the best option so far meaning that it is hard to find networks that do not use Huawei equipment.

LG UPlus is not considering migrating away from its current equipment as it would mean rebuilding its network from the LTE communications grid. However, its political cost keeps rising as the US is campaigning for a Huawei ban more explicitly than before. For instance, on 21 July, Robert Strayer, the US deputy assistant secretary of state, commented during a video conference that companies are urged to migrate to trusted vendors. It remains to be seen how Korean companies will react to US pressures and Chinese counter-threats.

Overview of Japanese Market Trends

- **Japan's aging population and increased urbanisation** means that its highly-subsidised **agricultural industry is turning to GNSS-driven technology solutions**
- QZSS, Japan's satellite-based augmentation system is **driving innovation across many downstream application domains as its uptake increases**
- **Significant government investment** into both space and space-enabled businesses, including **spearheading R&D throughout the Asia-Oceania region**

Key Trends in Edition Three

- Japan's National Space Policy Secretariat announced that from 30 November, the official broadcast of its **centimetre-level augmentation service will be upgraded** from IS-QZSS-L6-001 to IS-QZSS-L6-003, **increasing the maximum number of augmented satellites to 17 for a more stable positioning accuracy**
- **An increase in funding for smart cities** around the region, with **Japanese companies supporting 26 smart city projects across ASEAN** through funding from both Japan Oversea Infrastructure Investment Corporation for Transport & Urban Development and the Japan Bank for International Cooperation
- **New receivers and antenna** from Sony, Furuno Electric, and Komine Radio Electric

Upstream developments in Japan include international collaboration and improved augmentation systems

MICHIBIKI SUPPORTED THE RETURN OF HAYABUSA-2

The **Japan Aerospace Exploration Agency**, JAXA, succeeded in recovering the return of the spacecraft Hayabusa-2 in Woomera, Australia. Hayabusa-2, which was launched in 2014, took two samples from a c-type asteroid in the search for more information about the history of the solar system and the origin of life.

Michibiki was essential in the recovery mission, as it was used to locate the landing location of the return capsule in the desert. The return capsule deployed a parachute on the way down, meaning that the landing point estimation was not accurate as JAXA have no control over the wind strength and direction. JAXA worked with the Australian Five Directional Search Stations to set up an area in which to search for the capsule, with a Michibiki compatible receiver being used to find and locate the position, achieved using a precise position fixing method called MADOCA, which allowed the return of the capsule to Japan on 8 December.

MOU BETWEEN JAPAN'S NSPO AND THE US SPACE FORCE

The **US Space Force** and Japan's **Office of National Space Policy** signed a Memorandum of Understanding to launch US payloads on Japan's Quasi-Zenith Satellite System. The Department of the Air Force's Space and Missile Systems Center is developing the payloads, which feature Space Domain Awareness optical sensors and will launch from Japan's Tanegashima Space Center in 2023 and 2024, respectively.

The MoU intends to secure capabilities from GNSS to communications satellites and much more, serving as a document to increase the space partnership in alignment with both allies' national space policies, with them intending to deepen and expand space cooperation.

QZSS LAUNCHED THE UPGRADED VERSION OF THE CLAS SYSTEM

November 2020 saw the announcement from the National Space Policy Secretariat that from 30 November the official broadcast of the augmentation information compliant with IS-QZSS-L6-003 from all the Quasi-Zenith Satellites (QZS-1, 2, 3, and 4), which increased the number of augmented to a maximum of 17 for more stable positioning accuracy.

CM-CLASS AUGMENTATION SERVICE

Global Positioning Augmentation Service Corporation (GPAS), launched the commercial-based distribution service of its centimetre-class precise GNSS augmentation service worldwide from August 2020.

ONE YEAR OF SUCCESS FOR QZSS (MICHIBIKI) IN JAPAN

UNIQUE INSIGHTS FROM THE QZSS BUSINESS INNOVATION COUNCIL

In June 2020, the Quasi-Zenith Satellite System Business Innovation Council, QBIC, authored a guest innovation blog article analysing the results of the first year of operation of the Japanese satellite constellation.

This article uses the results of a survey launched by QBIC on the uptake of QZSS in different downstream market segments, with the article covering the current uptake by market segment, the demand for different types of services, the barriers to entry, and the business priorities.

In addition to the analysis, conclusions were presented that would be beneficial to European stakeholders including lessons learned and possible market entrance opportunities.

Read the article by QBIC on the uptake of Michibiki in our innovation blog here.

New GNSS hardware has been developed and released, including CLAS antenna and a SLAS tracker

MULTI-FREQUENCY GNSS LOW POWER HARDWARE RELEASED

High-precision GNSS receivers for IoT and wearable devices should come with low power consumption to improve the overall system's battery life. Positioning solutions could be now available with a required power as low as 9mW. Significant progress has been also made for what concerns antennas. Advancements include the reduction in internal board size whilst ensuring a significantly reduced noise due to the lack of a metal shield on the rear of the case

HONDA R&D DEVELOPED AN SLAS-COMPATIBLE TRACKER FOR SCHOOL CHILDREN

Honda R&D, a research and development division of the Honda group has developed an SLAS terminal that is intended to reduce the number of accidents that occur when children are walking to school. The terminal is named Ropot, and it is to be fixed upon the children's schoolbag. This solution marks the areas in which extra attention is required, such as at busy crossings, and it will work in conjunction with a smartphone to remind the child to take special care when crossing the road.

The accuracy of this is ensured by combining 4G LTE with Michibiki's SLAS, providing improved performance when compared to the previous GNSS-based solutions. The Ropot will take measurements every second, and it is to provide location data once every ten seconds, as well as providing the data to the cloud once every 100 seconds to save battery consumption.

OCG'S STANDARD ON MOVING FEATURES ENHANCES TIME-VARYING OBJECT TRACKING

The **Open Geospatial Consortium** (OCG) announced that the OCG Membership approved the Moving Features Encoding Extension – JSON as an official standard. The OCG is an international consortium of more than 500 businesses, government agencies, research organizations, and universities driven to make geospatial (location) information and services FAIR - Findable, Accessible, Interoperable, and Reusable. The framework provides an encoding for OGC Moving Features as an alternative to XML or CSV. The moving features contain a location that continuously changes over time, as well as dynamic attributes whose values vary with time. The ability to attribute time-varying properties to an object has utility and value in many application areas, including COVID-19 tracking, traffic congestion, and air pollution monitoring.

There has been a heavy focus on autonomous driving, with testing, developments, and type designations

TOMTOM JOINED THE EU-JAPAN BUSINESS ROUND TABLE

April 2020 saw Alain de Taeye, a member of TomTom's management board was confirmed as the 55th member of the EU-Japan Business Round Table (BRT). TomTom is joining the BRT's Working Party on Digital Innovation & Mobility, with Alain sharing his expertise in high definition mapping for autonomous driving. TomTom has been targeting the Japanese market and has been collaborating with major Japanese companies.

Examples include Bridgestone Corporation acquiring a provider of TomTom Telematics in 2019, Denso and TomTom cooperating in R&D software for autonomous vehicles, and TRI-AD, the Toyota Research Institutes of Advanced Development joining TomTom in R&D for advanced map making for autonomous driving.

TYPE DESIGNATION FOR HONDA'S L3 AUTONOMOUS DRIVING

In November 2020, **Honda Motor Co., Ltd** announced that it had received the required type designation for level 3 autonomous driving from the **Japanese Ministry of Land, Infrastructure, Transport, and Transport** (MLIT). Level three autonomous driving is seen as a substantial leap in terms of technology, where vehicles are to have environmental detection capabilities and they can make informed decisions for themselves, for example moving past slow-moving vehicles, with the ability for humans to override the tasks.

SOFTBANK SUCCESSFULLY VERIFIED THE WORLD'S FIRST ON-SITE MERGING VEHICLE ASSISTANCE

SoftBank Corp. and **Subaru** successfully verified the world's first on-site merging vehicle assistance utilising 5G and cellular V2X in August 2020. Both companies have been jointly researching use cases related to safe driving assist and autonomous driving control since 2019.

The first use case saw **SoftBank** and **Subaru** verifying the possibility of safe merging assistance for autonomous vehicles driving on a highway, with each vehicle sending various types of the vehicle information to a MEC server via 5G. This is intended to be used to calculate the future collision between vehicles, preventing accidents through the use of warning and deceleration command messages, with the test showing that vehicles could safely merge.

The second use case saw that **SoftBank** and **Subaru** verified safe merging assistance in situations where there wasn't enough space to merge, for example, in a traffic jam. The request was sent using vehicle-to-vehicle communication and it allowed the vehicle to send an entry request to allow the vehicle to merge in the immediate future.

SENSIBLE 4 PROVIDES FULL-STACK AUTONOMOUS DRIVING SOFTWARE TO TOYOTA

April 2020 saw a newly signed contract between Ruter, Holo, Toyota Motor Europe, and Sensible 4, who worked together to pave the way for Toyota's vehicles to be retrofitted with Sensible 4's autonomous driving software in the next phase of Ruter's self-driving vehicle trials.

Sensible 4 is providing its all-weather autonomous driving system in Oslo, with the aim to launch a new service in Nordre Follo, Oslo. The purpose of this partnership is to explore the ways in which autonomous vehicles can be integrated into Oslo, with S4 being able to enable self-driving in all weather conditions and environments such as snow, rain, and fog. Sensible 4 is a Finnish self-driving technology company developing full-stack software for autonomous vehicles. Their technology combines information from multiple sensors, allowing self-driving cars to operate even in the most challenging of weather conditions. In 2020, Sensible 4 raised 5.8 million euros from Japanese technology investors in their Series A round, after winning best start-up at the Dubai World Challenge for Self-Driving cars in 2019. Sensible 4 has already seen investment and support from Japan, with **Itochu**, one of the largest trading companies in Japan who have participated in the aforementioned Series A funding as well as **SB Drive**, a subsidiary of SoftBank, who has announced a collaboration with Sensible 4 by providing Dispatcher, a centralised operation management system for self-driving vehicles.

Enabling aerospace innovation, both on the ground and for urban air mobility

JAL AND VOLOCOPTER SIGN AN AGREEMENT ON AIR MOBILITY SERVICES

Japan Airlines (JAL) and Germany's **Volocopter GmbH** entered into a cooperation agreement to promote the development of urban air mobility. This follows the development seen in February 2020, when JAL's innovation fund invested in Volocopter with the aim to create and develop the next generation of electrically powered air taxis and heavy lift cargo drones as part of their Series C funding round. The agreement is intended to promote the commercial operations of air taxis in Japan by establishing local partnerships and working on increasing market demand and social acceptance. Volocopter has seen great success in the region, with examples including Voloctoper's successful test flights over Singapore's Marina Bay and their current focus on receiving commercial certification from the **European Union Aviation Safety Agency** (EASA).

In addition to Volocopter, JAL has had a long-term business strategy that involved entering the urban air mobility ecosystem. In January 2020, JAL began delivering unmanned test vehicles in the city of Yabu, in February they JAL signed a cooperation agreement with Bell for Asian urban mobility that includes a feasibility study on air taxis. Later in the year, JAL continued to transport goods around Japan and increase its participation in studies for drone deliveries and sign an agreement to explore medical delivery services by drone.

JAL CONTINUES TO BRING INNOVATION TO THE URBAN AIR MOBILITY LANDSCAPE

All Nippon Airways, Japan's largest airline by revenue and passenger numbers, partnered with **Toyota Industries** to test and develop robotic baggage loaders and autonomous towing tractors at the Kyushu Saga International Airport where they have been conducting tests to improve the efficient and safe optimisation without human inputs. These tests are intending to be demonstrators which would be further rolled out across Japan.

ANA IS THE FIRST JAPANESE AIRLINE TO USE A ROBOTIC LOADER AND AUTOMATED TOWER

SKYDRIVE CONDUCTED THE FIRST DEMONSTRATION OF ITS SD-03 FLYING CAR

SkyDrive Inc., a major developer of urban air mobility solutions successfully conducted the first public demonstration flight in Japan with its new SD-03 flying car at the 10,000 m2 Toyota test field where SkyDrive has its development centre.

The SD-03 is a single-seat vehicle, designed to be the world's smallest electric vertical take-off and landing model. The dimensions are 2m x 4m x 4m and it occupies the equivalent space of two parked cars.

The intention is to continue flight tests under a range of different conditions including weather as part of their drive to comply with the safety provisions of the Civil Aeronautics Act.

QZSS driving innovation in the Maritime, Emergency Response, and Agriculture markets

JAPAN MARITIME DAILY DELIVERED SEMINARS ON CLAS FOR AUTOMATIC BERTHING

The **Japan Maritime Daily**, a specialist shipping and logistics newspaper, held a webinar on 31 August to introduce automatic ship manoeuvring technology that applies Michibiki's CLAS. The webinar was on 'moving a ship from space', where New Japan Marine Kyushu Co., Ltd., which was adopted for 'demonstration experiment using Michibiki', as well as conducting a demonstration of the automatic berthing of small pleasure boats using CLAS.

President Yamamoto, of **New Japan Marine Kyushu**, introduced the company and provided an overview of how the automatic berthing system works to position, orientate, and attitude by using a set of three antennas and receivers. This technology is expected to be used in crowded sea areas such as Tokyo Bay, where there are already pilots who teach the crew of large merchant ships how to manoeuvre in crowded waterways.

AI AND ML ENABLED-FRUIT PICKER MATCHES THE PICKING SPEED OF A HUMAN

Japan's **National Agriculture and Food Research Organization** (NARO) has developed a prototype of a robot that automatically harvests fruit including apples and pears using machine learning and AI that automatically identify characteristics. The machine learning model was fed using 1,500 pictures of pears, enabling it to identify fruit by its ripeness to allow for pears to only be picked when they were ripe. The robot is fed by a camera in combination with a V-shaped tree by using a grafting technique and the robot itself is based upon an adapted golf-cart design.

THE SUCCESS OF A QZSS-ENABLED MOBILE APP FOR BUSHFIRES AND TSUNAMI WARNINGS

The results of the Australia-Japan 2020 QZSS Emergency Warning System trial project was presented in a paper by Choy et al., which aimed to evaluate and demonstrate the feasibility of utilising QZSS to support emergency warning and response in Australia. The dedicated mobile application was developed to decode the warning messages and to visualise the relevant information on a map. The trial was successful, with emergency warning messages being received and decoded using the QZSS enabled receivers and the dedicated application.

MICHIBIKI'S CLAS TO AUTOMATE TEA HARVESTING

Michibiki's centimetre level augmentation services to be used in a public demonstration where crawler-type autonomous vehicles are to be used to autonomously running a tea plantation with high accuracy. CLAS has also been used in other agricultural applications, with drones being used to measure tree growth and to minimise the deviation and improve the spraying precision of fertiliser.

Acquisitions, investment, and knowledge sharing has been seen in geomatics and critical infrastructures

MITSUBISHI CORP AND NTT ACQUIRE 30% OF HERE

Mitsubishi Corporation and **Nippon Telegraph and Telephone Corporation** (NTT) announced that they have completed the acquisition of a 30% stake in **HERE Technologies** in May 2020 through a Netherlands-based holding company. HERE is the world's leading company in the location-based services field, expanding its platform from automotive through to other sectors such as logistics, urban transportation, retail, and finance.

HERE has the world's largest and most accurate location information database to visualise vehicle locations and operation conditions. MC and NTT are jointly working on developing services to optimise routes in logistics by using HERE's expertise and database. Both companies are studying alliances for last-mile delivery and truck line transportation. MC and NTT have already started to partner with local transportation operators in smart cities by integrating HERE's location technology.

ZENRIN TO JOIN THE HERE MARKETPLACE

ZENRIN Co., Ltd., possesses a strong market share in mapping software, in-car navigation and IT services, and technologies, and they have built many standards of maps from autonomous driving, car navigation, and much more by adapting to the complicated Japanese traffic environments.

As of June 2020, HERE and ZENRIN announced that ZENRIN will use the HERE Marketplace as a new data distribution channel, which is one of the key components of the entire HERE platform, a one-stop solution for the creating and licencing of location-centric products and services. This partnership marks a strong point in the long-term growth strategy for HERE in the Asia Pacific region.

CORE CO., LTD. HELD A WEBINAR ON USING CLAS FOR DRONE SURVEYING

Core Co., Ltd. held a webinar on introducing Michibiki-enabled GNSS receivers for drone surveying in civil engineering and construction sites. The webinar was jointly held with Jan de Turck from **Septentrio**, who are co-developing the GNSS receivers. The **Geospatial Information Authority of Japan** stipulated that a mark is known as a 'control point' needs to be placed upon the ground within the range of the aerial photograph.

Not only is it normally time-consuming for the workers to install and recover via walking around the site, but it is also difficult in mountainous areas, cliff-faces, and disaster areas. This is achieved through the use of Michibiki's CLAS at the shooting site, then it uses positioning correction data from the reference station via WiFi which sends a commercially available drone via RTK positioning. This solution should solve the problems faced by walls in the immediate vicinity of the positioning point, removing signals including multipath in open sky areas.

NTT DOCOMO INC. INVESTED IN MAAS

NTT DoCoMo Inc., one of the three main mobile carriers in Japan have announced an investment of approx. 150 million euros into the taxi dispatch application service provider **Mobility Technologies Co., Ltd** (MoT)., which has seen investment from companies such as **Toyota Motor Corporation** since 2017.

Japanese institutions and companies are at the forefront of smart city development in ASEAN

SUPPORT FOR SMART CITIES

The Japanese government is to encourage Japanese companies to join 26 smart city projects across the ten ASEAN member countries including Hanoi, Ho Chi Minh, Jakarta, Bangkok, Singapore and Kuala Lumpur.

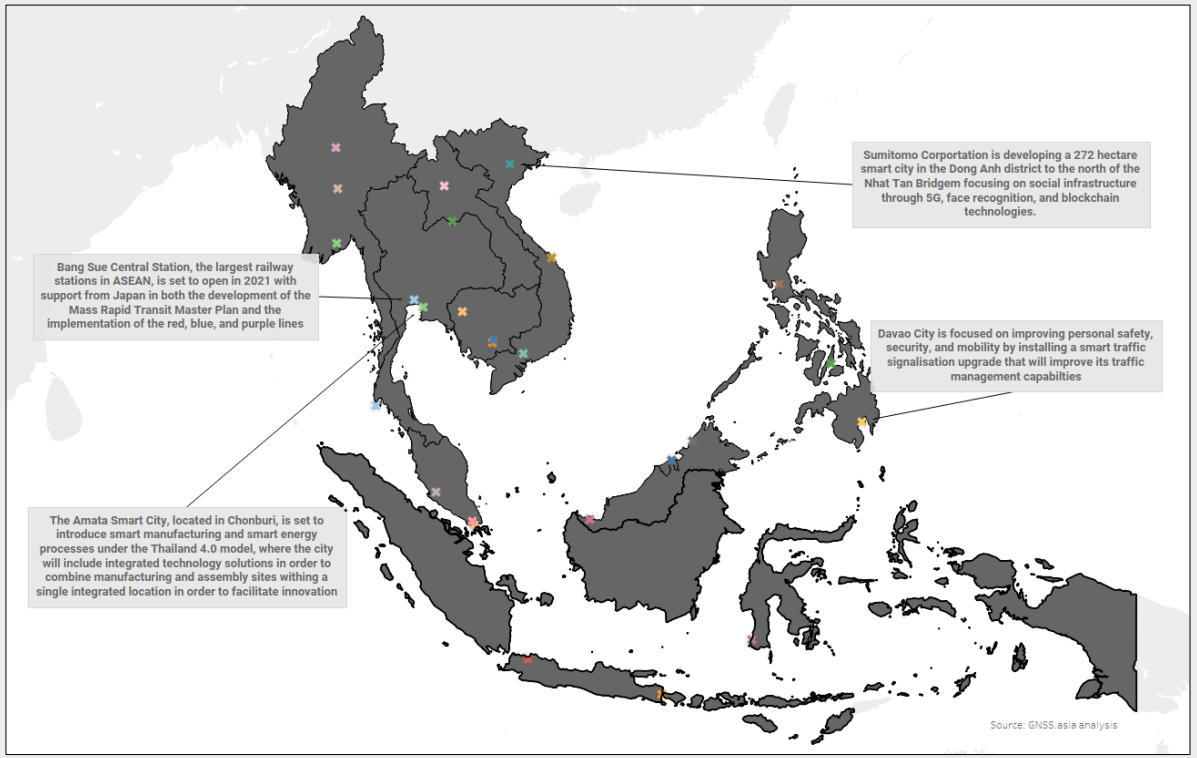
The Japanese government is to encourage Japanese companies to join 26 smart city projects across the ten ASEAN member countries including Hanoi, Ho Chi Minh, Jakarta, Bangkok, Singapore and Kuala Lumpur.

This funding is intended to stimulate Japan's competitiveness in the region, with the **Japan Oversea Infrastructure Investment Corporation for Transport & Urban Development** (JOIN) allowing Japanese companies to form joint ventures with local companies and the **Japan Bank for International Cooperation** (JBIC) extending credit lines to environmental programmes that aim to reduce greenhouse gas emissions, increasing the use of renewable energy and preventing air and water pollution.

As part of the smart city project, there are three main areas measures for overseas smart city developments:

- Implement a concrete smart city project foundation
- Promote financial support for smart city proposals
- Strengthen support and mutual cooperation

Japan-Asean Smart city mapping



Strong push towards smart technologies from both the government and industry

SBI CRYPTOCURRENCY MARKET MAKER

July 2020 saw Japanese financial conglomerate, **SBI Holdings**, buy a minority stake in B2C2, a London-based cryptocurrency market maker for 25 million euros. B2C2 currently provides liquidity to banks, hedge funds, and exchanges, and is intending to use SBI's resources to launch a full prime brokerage for crypto and other asset classes, with SBI looking to use B2C2's liquidity to support clients trading cryptocurrencies.

JAPAN-ASEAN TO PROMOTE THE DIGITALISATION OF TRADE PROCEDURES

According to Japan's Kyodo News, Japan is promoting blockchain technology as a trade digitalisation enabling in ASEAN. **NTT Data Solution** is leading an 18-member consortium of Japan's largest companies, including **Itochu Corporation**, **Kanematsu Corporation**, **Marubeni**, **Mitsubishi Corporation**, **Mitsui & Co**, **Sojitz Corporation**, **Sumitomo Corporation**, **Toyota Tsusho Corporation**, K Line, **NYK Line**, ONE, **Nippon Express**, **Mizuho Bank**, **MUFG Bank**, **SMBC**, **Mitsui Sumitomo Insurance**, **Sompo Japan Insurance**, and **Tokio Marine & Nichido Fire Insurance.**

This consortium, **TradeWaltz**, began using blockchain in Vietnam in 2020, and it will aim to use blockchain to identify bottlenecks in the supply chain

GNSS OUTAGES THROUGHOUT ASIA, INCLUDING THE SEA OF JAPAN

There has been an increase in the cases of GNSS outages throughout the world, with interference and jamming resulting in the loss of GNSS signals which have affected vessels' navigation and communication equipment. September 2020 saw one outage in the Sea of Japan as part of a wider series of outages. These outages are just one of the examples of the problems that the QZSS system is intended to resolve, as QZSS will include a range of jamming and spoofing protection.

THE 14TH GPS/QZSS ROBOT CAR CONTEST IN JAPAN

UNIQUE INSIGHTS FROM THE ORGANISERS OF THE CONTEST

In January 2021, the Institute of Positioning, Navigation, and Timing of Japan (IPNTJ) wrote an innovation blog post for GNSS.asia on the 14th GPS/QZSS Robot Car Contest in Japan that provided unique insights into the Japanese competition with a long legacy of promoting the development and adoption of GNSS.

The GPS/QZSS Robot Car Contest is a competition for robot cars to drive autonomously with satellite positioning. The contest is organised by the Institute of Positioning, Navigation, and Timing of Japan (IPNTJ) and has been held every year in late October or early November at Tokyo University of Marine Science and Technology (TUMSAT) in conjunction with the GPS/GNSS Symposium convened by IPNTJ.

The articles covered the history of the contest, its rules and expectations, the technological developments and spill-over effects, the new format, and the results and highlights of the competition itself.

IPNTJ announced that this new format could be a great opportunity to collaborate with GNSS innovators around the globe, with the 2021 contest being potentially expanded overseas under the new name of GNSS/QZSS Robot Car Contest .

Read IPNTJ's insights on GNSS/QZSS Robotic Car Contest in the GNSS.asia innovation blog post here

Overview of the Australasian Market

- **Positioning technologies** for location-based services and intelligent transport services (road, rail, maritime and aviation) **usage is growing year on year along with the number of users who expect** real-time, accurate, high-integrity services
- **Australia and New Zealand are in a partnership to jointly deliver components for the Southern Positioning Augmentation Network** (SPAN), the first Satellite-Based Augmentation System (SBAS) in the Southern Hemisphere
- The already existing 200 ground station Australian network will be **increased with over 500 third-party operated new multi-GNSS stations**[9]

Key Trends in Edition Three

- Australia is **upgrading and expanding its GNSS ground station network**, increasing the number of stations from **130 to 200 stations** in a bid to improve capabilities
- GNSS is **increasingly being used to enable smart cities in Australasia**, with GTT, a leader in smart traffic signal control systems, adding **GNSS capabilities to increase its performance in urban canyons with high levels of interference**
- The **world's first satellite-based augmentation system enabled phone** has been **successfully demonstrated**, with the aim of it being to **showcase** what **services** would be available for the **upcoming SouthPAN Australasia SBAS system**

9: https://newsroom.ngis.com.au/positioning-australia-for-the-future

Exciting upstream developments, including SouthPAN, the upcoming AUS-NZ SBAS system

AUSTRALIA IS UPGRADING ITS GNSS GROUND STATIONS

Positioning Australia, a national program of Australia that aims to ensure that accurate and reliable positioning data is available anytime and anyplace, is set to establish a network of 200 GNSS ground stations by both upgrading the existing 130 stations and creating 70 new stations across the country This programme is run by Geoscience Australia, a geoscience agency of the Australian government, and it is to develop precise positioning capabilities to improve communication, productivity, and foster innovation[10].

AUSTRALIA'S NEW SBAS SYSTEM NAMED

The upcoming Australia-New Zealand Satellite-Based Augmentation System has now been officially named the South Positioning Augmentation Network, or SouthPAN. The development of SouthPAN is being led by Geoscience Australia and Land Information New Zealand under the Australia New Zealand Science, Research, and Innovation Cooperation Agreement.

SouthPAN is intended to augment the positioning capabilities presented, improving the accuracy of the positioning from 5-10 metres to 0.1 metres without the need for any mobile or internet coverage. Testing and independent reporting has previously shown that the improved accuracy has both economic benefits and that it will improve safety and productivity across the region once it is fully operated and certified by 2025.

SBAS SIGNALS SUCCESSFULLY RECEIVED IN WESTERN AUSTRALIA

The first signals from the SouthPAN have been successfully received by Thales Australia in October 2020 at the Optus Satellite teleport in Western Australia. Thales has been conducting the tests using special equipment that has been specifically manufactured for customers close to the equator rather than the existing Eurocentric solutions from Thales. The testing itself is being done using signals from NIGCOMSAT-1R, a satellite typically covering Africa, but the signals just about reach the western coast of Australia.

NEW GNSS CORRECTION SERVICE

Position Partners, an Australian provider of positioning and machine controls, has launched MiRTK, an open architecture correction service for GNSS equipment. MiRTK aims to offer an alternative to the existing solutions with ultra-high-frequency radio correction services that enable high-accuracy location data. MiRTK is based upon a small modem that is attached to a tripod and it using a signal to connect it to the base station, this modem is connected to the internet and it provides service across the Telstra network, Australia's largest mobile network. This solution offers many benefits over existing solutions including that it is not limited by range from the GNSS base station and it does not require a line of sight with the survey machine.

AUSTRALIA SHUT DOWN ITS DIFFERENTIAL GLOBAL POSITIONING SYSTEM

AMSA, the Australian Maritime Safety Agency, announced that it has discontinued its differential global positioning system (DGPS) on 1 July 2020 due to it being no longer needed for safe navigation.

This is to have no impact on the accuracy of satellite navigation, nor the safety of navigation, but it will affect any GNSS receivers that have an integrated DGPS receiver. The exact effect differs depending on the model and year, but if you have a model from before 2003, ASMA recommends switching to a multi-constellation receiver that includes Receiver Autonomous Integrity Monitoring (RAIM) if you want integrity monitoring, or to switch to an SBAS capable GNSS receiver to take advantage of the upcoming SBAS system.

POSITION PARTNERS' NEW GNSS CORRECTION SERVICE LAUNCHED

Position Partners has launched MiRTK, an open architecture correction service for GNSS equipment. MiRTK aims to offer an alternative to the existing solutions with ultra-high-frequency radio correction services that enable high-accuracy location data. MiRTK is based upon a small modem that is attached to a tripod which is then connected to the base station via a single cable, this modem is connected to the internet, and it offers many benefits over existing solutions including that it is not limited by range from the GNSS base station and it does not require a line of sight with the survey machine.

10: https://www.ga.gov.au/news-events/news/latest-news/seeking-expressions-of-interest-for-global-navigation-satellite-system-gnss-ground-station-site-hosts

GNSS enabled hardware applications have been developed and deployed including drones and rovers

GNSS TO TRACK DOMESTIC OFFENDERS

A trial began in 2020 in Western Australia where the McGowan Government has begun a two-year trial that was launched to track up to 100 high-risk offenders who had already breached restraining orders.

These devices are used in combination with additional police officers, correction staff, and increased rehabilitation treatment to reduce offences and is yet another example of the wide range of GNSS applications for the security and safety.

WORLD'S FIRST SBAS ENABLED PHONE SERVICE DEMONSTRATED

The world's first smartphone that used data from a satellite-based augmentation system (SBAS) dual-frequency multi-constellation (DFMC) was demonstrated in a collaborative project between Frontier SI and the Royal Melbourne Institute of Technology. This service was developed within the Australia-New Zealand SBAS Test-bed and it combined the precise correction service from DFMC SBAS with data from the Android Raw GNSS API.

The project itself is intended to be a commercial demonstration of the improved services available with the upcoming SouthPAN SBAS system.

FUNDING TO DEVELOP INDIGENOUS GNSS RECEIVERS

Over 500 thousand Euros have been awarded to the University of New South Wales Engineering researchers over 10 grants which aim to develop and build the capacity and capability of Australia's space sector, businesses, and research organisations. Professor Andrew Dempster, the Director of the Australian Centre for Space Engineering Research, will manage a grant for the project 'Advanced GNSS Receiver for CubeSats, Rockets, and Remote Sensing'. Professor Dempster's senior research associate, Dr Eamonn Glennon, is to use the grant to upgrade Kea, their existing single-frequency GPS receiver, to be able to use multiple frequencies, antennas, and systems to use the receiver for new applications such as GNSS reflectometry, as well as monitoring the Earth's ionosphere. Kea is one of only two flight-proven receivers that have been manufactured in Australia or New Zealand.

GNSS is improving emergency response on ground and sea

TRIALS OF GNSS REPEATERS FOR EMERGENCY SERVICES TO USE IN TUNNELS

September 2020 saw the Australian Communications and Media Authority (ACMA) announce that it is to facilitate a trial of GNSS repeaters to transmit signals underground in locations such as tunnels. These devices have previously been prohibited as they can cause interference when not operated properly, but that is an issue that should be resolved in the tests being conducted in Sydney and Melbourne.

SYNTONY TO PARTNER WITH RFI FOR TUNNEL POSITIONING

One of the key players in the underground GNSS repeater industry, Syntony-GNSS, have partnered with RFI to bring underground PNT solutions to Australasia. Syntony's SubWAVE is an underground GNSS positioning solution that helps saves lives and reduce accidents in subway tunnels and stations by providing accurate location data to emergency and rescue services.

GNSS TO IMPROVE SMART CITY TRAFFIC MANAGEMENT

Global traffic technology, the global leader in smart traffic signal priority control systems, has added GNSS capabilities to its Opticom solutions to improve the reliability of the signal priority for connected vehicles. The addition of GNSS is to combat the poor performance of GPS in urban canyons and to reduce the multipath effects that negatively impact the accuracy and performance.

GNSS will also help to provide more consistent, reliable priority control in dense urban areas around bridges, tunnels, and tall buildings to reduce performance issues around intersections and assist the emergency services in navigating the city.

FURUNO RELEASED NEW A SURVEY AND MULTIBEAM SOUNDER

Furuno released the WASSP S3r, a cost-effective, professional survey and mapping multibeam sounder that aims to create an accurate bathymetric map of underwater features for various survey situations at a 10x faster rate than a single-beam sounder. To achieve this rapid speed, the device needed a solution for RTK + INS to ensure that the 3D representations were accurately placed. This required a dual antenna system supported by the SBG Ellipse-D Inertial Navigation System. The Ellipse-D is the smallest RTK INS on the market that provides that level of performance and it is intended to be integrated into a wide variety of products.

UNCREWED SURFACE VESSELS TO COLLECT OCEAN DATA

Fugro, a leading geo-intelligence and asset integrity solution provider, are to deploy uncrewed surface vessels in the area within the Gulf St Vincent and Investigator Strait, the major waterway for the approach to Port Adelaide. This data is to be used to update the nautical charts to support traffic, fishing, tourism, and recreational boating, and it will be used to improve the gulf's oceanography and to support the development of an accurate tide model for future traffic.

LOCATION TECHNOLOGY DEPLOYED TO ASSIST EMERGENCY RESPONDERS

December 2020 saw the deployment of advanced mobile location technology into Australia's emergency service telephone number calls. The advanced mobile location technology reportedly uses GNSS to provide the precise location of those in need to the operators when an emergency call is made. This GNSS-based method is 4000 times more accurate than the previous cell tower triangulation solution, allowing first responders to find the person in need much faster.

GNSS is a key enabler of geomatics applications such as climate monitoring and mines exploration

RECEIVER DEPLOYED BY AIR NZ TO IMPROVE NASA'S CYGNSS

GNSS constellations are being used as the transmitter half of radars by adapting them to measure the signals that are scattered from the surface back into space. The use of GNSS-R as part of a Bistatic Radar is beneficial due to their very low cost and power when compared to traditional solutions, and that the receivers can also be accommodated on small, low-cost spacecraft. This solution is beneficial for areas such as floor inundation mapping and is being developed by a joint project between the New Zealand Space Agency and NASA who are to deploy a new IIP receiver on commercial aircraft to improve collaboration on GNSS-R. The new IIP Receiver will enhance the capabilities of the CYGNSS, which is a satellite system that aims to improve hurricane forecasting by understanding the interactions between the sea and the air, with enhancements including 4x better temporal and spatial sampling, a 5x better vertical resolution, and better canopy correction.

Original Capability	Enhanced Capability
GPS L1 C/A	GPS L1/L5 and Galileo E1/E5
4 parallel channels	20 simultaneous channels
Co-pol only	Co-pol and X-pol

As noted in the previous edition of the market and technology trends, Air New Zealand is the world's first passenger airline to partner with NASA for an earth science mission. In this scenario, aircraft are used as they are typically much closer to the land and sea than satellites which allows for an enhanced resolution and quality of information. The data is to be collected and processed at the University of Auckland with the receivers being developed by the University of Michigan.

GNSS-BASED SOLUTIONS REPLACING TRADITIONAL LEVEL CROSSING IN MELBOURNE

C.R. Kennedy, a geospatial solutions provider, released a case study on the Level Crossings Removal Project, a project aiming to monitor rail movement across 300 metres of rail in two sites using an automated system. The case study outlines how the Leica GeoMoS monitoring system was able to deliver real-time alerts and data, which not only improves efficiency but also vastly improves safety as personnel do not have to enter the rail corridor, leading to a reduction in the administrative burden by removing the need for safety permits and Track Force Projection Coordinators. The GeoMoS monitor was combined with the GeoMoS Now which allowed the generated alerts and data to be analysed and displayed graphically.

NEW CADASTRAL SURVEY GUIDELINES

August 2020 saw the release of the Government of South Australia's latest Cadastral Survey Guidelines, guidelines that professional surveyors will use to establish and re-establish true property boundaries. These guidelines are built using information gathered from coordination data, with information from surveyors being provided to the survey operator to Geoscience Australia.

GNSS USED IN EXPLORATION OF GOLD MINING SITES

Newcrest, Australia's leading gold mining company, published their inferred mineral resource estimate for various sites across Australia. This is part of an exploration to estimate the quantity, grade, shape, and physical characteristics of the mineral resources to best plan the drilling and mining of resources. In the modern exploration process, handheld GNSS receivers are used to obtain the location of drill collar locations, often combined with RTK technology.

About GNSS.asia

WHO ARE WE?

Since 2012, GNSS.asia has been **bridging GNSS industries from Asia-Pacific and Europe**. Its objective is to facilitate industrial cooperation between the two regions, to support institutional relations, and to maximise Galileo adoption. The project, offers a series of services to EU industry and institutions, ranging from market analyses and stakeholder mapping, to business matchmaking, local marketing opportunities and the latest technology trends.

Our **team members** in Japan, South Korea, India, Taiwan, and China keep their ground presence and their fingers on the pulse of local GNSS market developments..

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Facilitate industrial cooperation on GNSS across continents

WHAT ARE OUR OBJECTIVES?

Via a network of local representatives across Asia, supplemented with expert knowledge of technology trends, GNSS.asia has three objectives:

- **Leverage industrial cooperation across continents:** GNSS.asia aims to stimulate the creation of partnerships through industrial matchmaking and outreach events. These include workshops, industry seminars, delegation visits and roundtables
- **Support institutional relations:** Via a network of local institutional partners, GNSS.asia can support EU and Asia-Pacific civil institutions in their aims of cooperation and standardisation
- **Drive EGNSS adoption:** GNSS.asia promotes the benefits of Galileo and EGNOS as service enablers and performance enhancers in the multi-GNSS hotspots of Asia-Pacific

WHAT CAN GNSS.ASIA DO FOR YOU?

GNSS.asia promotes the benefits of Galileo and EGNOS to industrial and institutional stakeholders in Asia-Pacific providing a series of services:

- **Networking & Matchmaking Support:** Personalised interviews to identify your organisation's priorities; Introduction to key stakeholders including our institutional and industrial partners; Organisation of moderated matchmaking sessions to assist in your networking
- **Dissemination & Marketing Support:** Key speaking slots at our GNSS.asia workshops and seminars; Distribution of your promotional material at international events; Demonstration and exhibition of your products/services; The ability to showcase your company through our innovation blog
- **Market Entry Support:** Information on market trends via our Market and Technology Trends report; Access to the latest GNSS-related news via our newsletter; Identification of business opportunities for your organization; Access to local teams with in-depth market knowledge and other key stakeholders

ANNEX: METHODOLOGY

Methodology

The **Market and Technology Trends Report** is released by GNSS.asia to monitor the development of the Global Navigation Satellite System markets in the Asia-Pacific region.

The GNSS downstream component is made by all the entities which rely on signals and infrastructures provided by the upstream component of the GNSS value chain to enable their application and services. This downstream industry can be broken down into three segments: **manufacturers** of GNSS components such as receivers, chipset, antennae; **system integrators**, which enable GNSS in larger systems such as vehicles; **service providers**, which offer GNSS enabled services such as maps, health tracking, etc.

The **Market and Technology Trends Report** covers different application areas in which GNSS finds use. They are divided into Six priority areas: Digital, Agri-Food, Mobility-Transport, Raw materials, Renewable energy, Construction; and eight other areas: Aerospace & Defence, Textiles, Electronics, Health, Retail, Proximity & Social Economy, Tourism, Creative & Cultural Industries.

Sources

This report makes use of publicly available data and information, stakeholder consultation, and reports published by private publishers. Sources used include:

3SNEWS, Analytics India Magazine, ASE Global, Autohome, Aviation Voice, BeiDou, Bridgestone, Business Today, BYNAV, CAS, CDAC, CGTN, China News, Civils Daily, CNBC, Coretronic-Robotics, CPC People, Digitimes, DNAINDIA, EGISTEC, EMCTW, ESA, EUJC, EUSPA, FEG, Financial Express, Furuno, GARMIN, Gongin, GPS World, GSC-Europa, Guancha, Hangzhou, Harvard, ICAO, Indian Express, ISRO, Kinpo, Komiemusen, Ledger Insights, Mitsubishi Corp, MLIT, Monash, MTI Group, Nature, NCHC, NDTV, New Indian Express, Nikkei, NSFC, NSPO, OGC, QXWZ, Reuters, Sensible4, Sina, SOHU, SOIC, Sony, SpaceChina, Statista, Subaru, Synopsys, Taipei Time, Taiwan Today, Taiwanese Customs, Teco, The ASEAN Post, The Hindu, Theil, Times of India, TomTom, UMT TW, Ventec Group, WinTec, Xinhuanet, Xinmin, ZeeNews, and Zenrin amongst other sources.

GNSS.asia relies on local teams of experts based in Japan, South Korea, India, Taiwan, and China. Each team, supported by the European team, put significant effort in selecting the most relevant trends and news coming from their selected region. This research involves obtaining input for key stakeholders in industry, institutions, event-specific news, and the translation of articles and reports that are not available in the English language.

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