GNSS-based Real-time Positioning

NAVSYS

NAVSYS
TECHNOLOGY INC
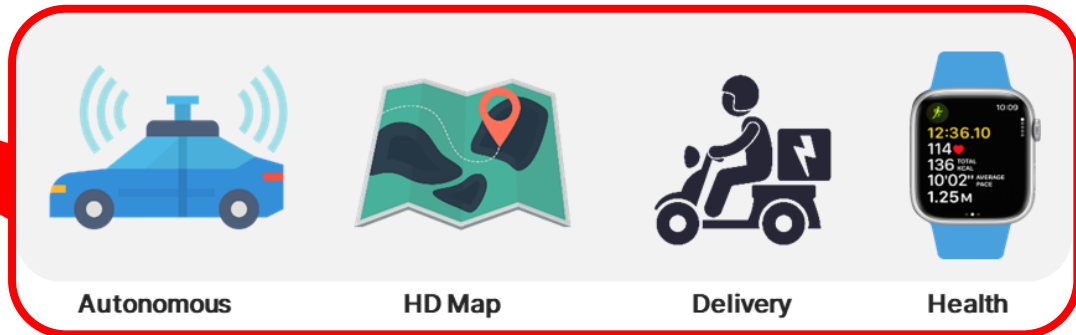
What level of precision can we truly expect from GPS as we know it?

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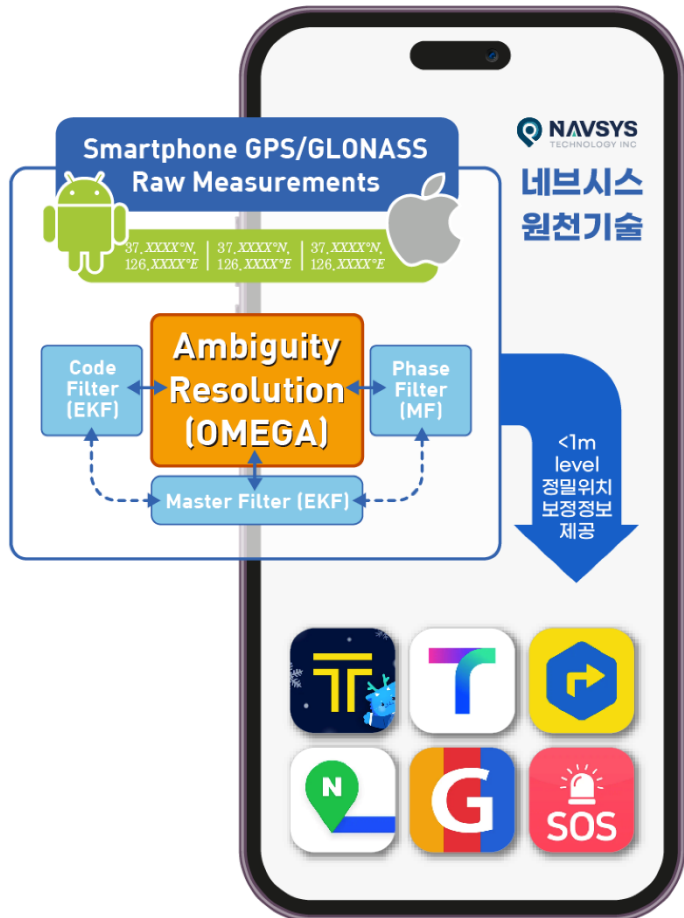
RTK-OMEGA

cm accuracy

✓ Enabling **centimeter-level** positioning data on smart devices through an **app(lane-detector)**, **without** the need for additional hardware

✓ Applicable to autonomous driving, HD mapping, and shared mobility industries.

Autonomous   HD Map   Delivery   Health

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1-1) Market Trends in Location Information Services

NAVSYS
TECHNOLOGY INC

- ✓ The location accuracy of smartphones is **5~10m** on open roads and over **20~100m** in urban areas, leading to significant errors.
- ✓ To improve the GNSS location precision of smartphones, **adding various devices** causes **inconvenience** for users.
- ✓ While the demand for **mobility services** is increasing, smartphone-based location information remains limited in its usage.

<Correction Device for Smartphone Positioning Accuracy>


<Smartphone Positioning Accuracy>

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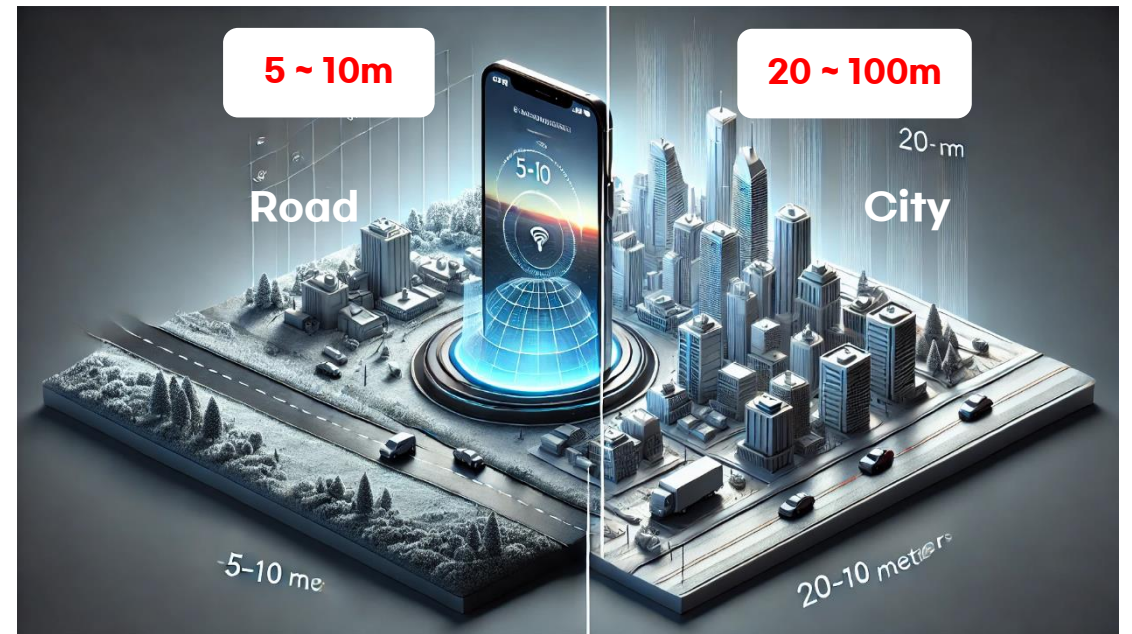
1-2) Collaboration with $LG\ U^+$ (Device Free) - App

NAVSYS TECHNOLOGY INC

- ✓ **LG U^+** has launched the ' U^+ Ultra-Precision Positioning Project,' **cm level**
- ✓ Autonomous driving, HD maps, drones & mobility
- ✓ **200** reference stations have been **established**
- ✓ The lack of technology imposes **limitations** on the scalability of the business

NAVSYS TECHNOLOGY INC

- ✓ Currently developing an App (experimental stage) based on RTK-OMEGA technology to provide **cm level** precision
- ✓ Aiming for **cm level** precision using **LG U^+** & **National Geographic Information Institution** reference stations
- ✓ **No additional devices** beyond mobile devices are required

At least 10 million users
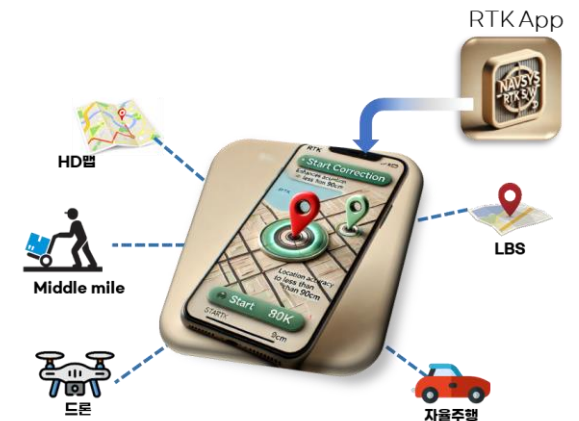
1-3) Lane-detector (Device Free) - App

✓ Daily average driving distance: **50 miles**

✓ Average fuel efficiency: 25 MPG (25 miles per gallon)

✓ Fuel price: $5.00/gallon

< Time and Cost Comparison (One vehicle) >

Category	NAVSYS TECHNOLOGY INC	Without Optimal Routing	Difference
Annual Driving Time	304.05 hours	319.35 hours	15.3hrs additional
Annual Fuel Cost	$3,650.00	$3,832.50	$182.5 additional

< **Nevada's 2.7 million** vehicles >

$493 million	CO$_2$ 1.4 billion pounds

* Fact of the Week #1332, U.S Dept of Energy
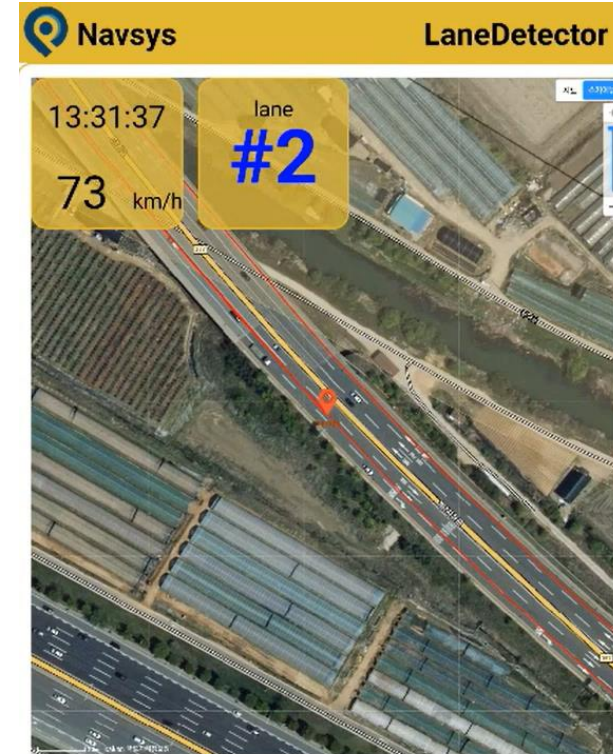
RTK-OMEGA + $mmTR^®$ FILTERING

mm accuracy

- ✓ **RTK-OMEGA** technology is applied to public infrastructure and areas prone to natural disasters, providing **millimeter-level precision**
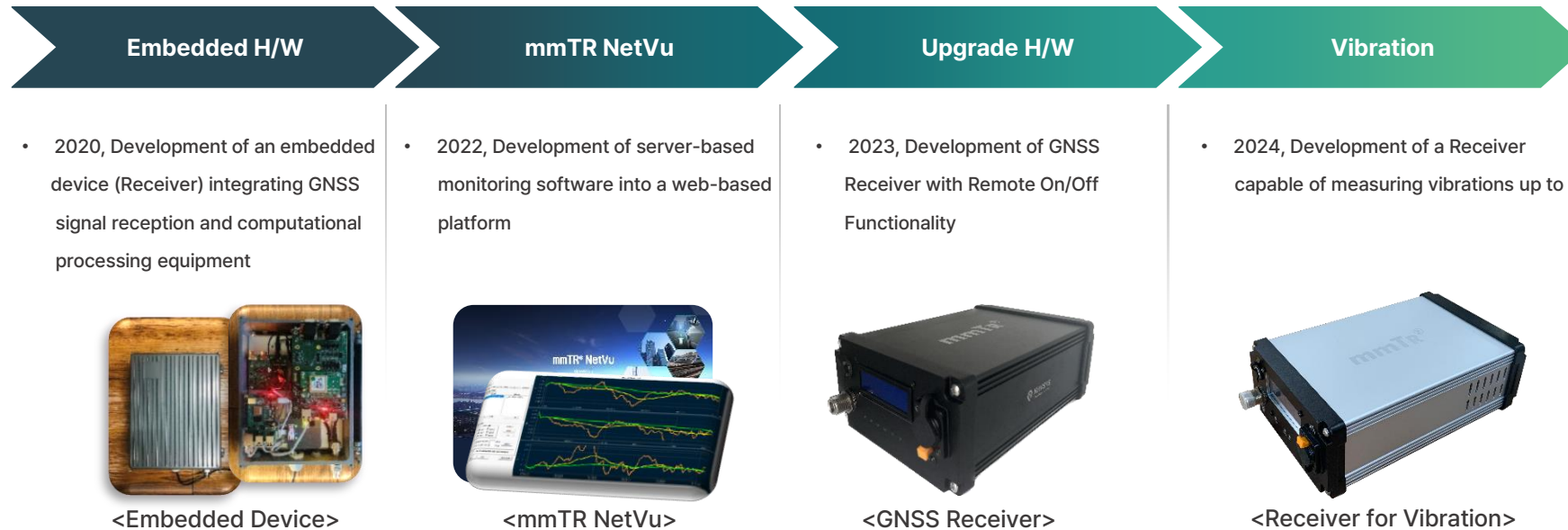- ✓ Real-time displacement data can be monitored through the web-based monitoring system, NetVu

Infrastructure

Natural Disaster

2-1) Product Development Status

Embedded H/W	mmTR NetVu	Upgrade H/W	Vibration
• 2020, Development of an embedded device (Receiver) integrating GNSS signal reception and computational processing equipment	• 2022, Development of server-based monitoring software into a web-based platform	• 2023, Development of GNSS Receiver with Remote On/Off Functionality	• 2024, Development of a Receiver capable of measuring vibrations up to 20Hz

<Embedded Device>

<mmTR NetVu>

<GNSS Receiver>

<Receiver for Vibration>

<Patents>

#	Classification	Legal Applications	Filling Country	Status	Registration Number	Subject
1	Patent	Navsys	South Korea	Registration	102458817	High-Performance, Embedded Multi-GNSS Receiver
2	Patent	Navsys	South Korea	Registration	102480741	GNSS Reference Station Position Change Monitoring System
3	Patent	Navsys	South Korea	Registration	102538541	Multimode GNSS Reference Station System
4	Patent	Don Kim	United States	Registration	8818568 B2	Satellite-based automatic steering system

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2-2) GNSS system

✓ $mmTR®-S$ Receiver enables precise displacement measurements within 1mm horizontally and 2mm vertically at frequencies of **up to 100Hz**

✓ Using displacement data, it is capable of simultaneously measuring structural **vibration** frequencies within **20Hz**

✓ A real-time monitoring solution through the $mmTR®\ NetVu$ system, designed with user convenience
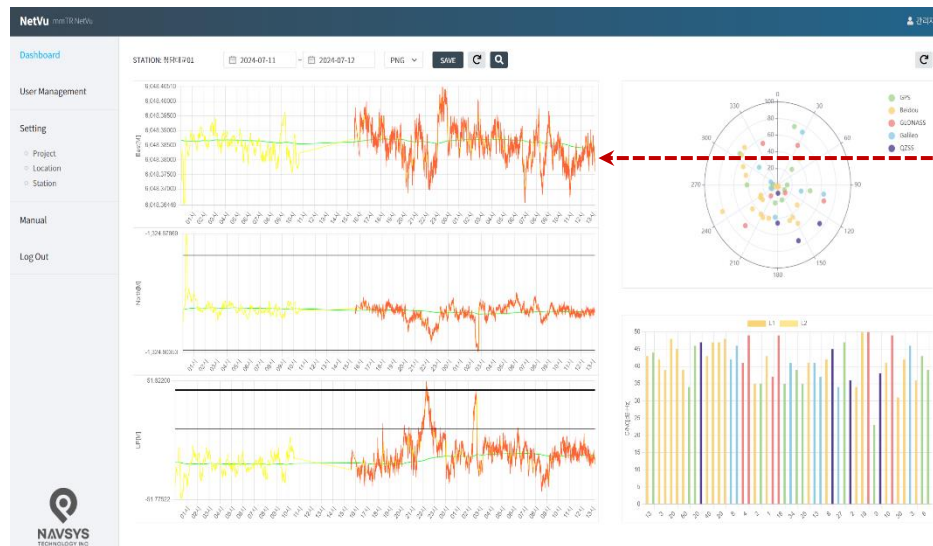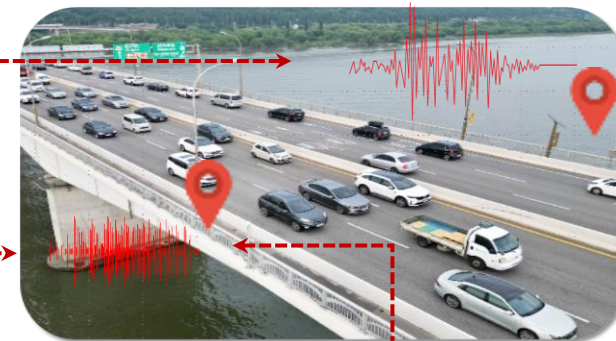
Displacement(100Hz)
Vibration(20Hz)

$mmTR®-S\ Receiver$

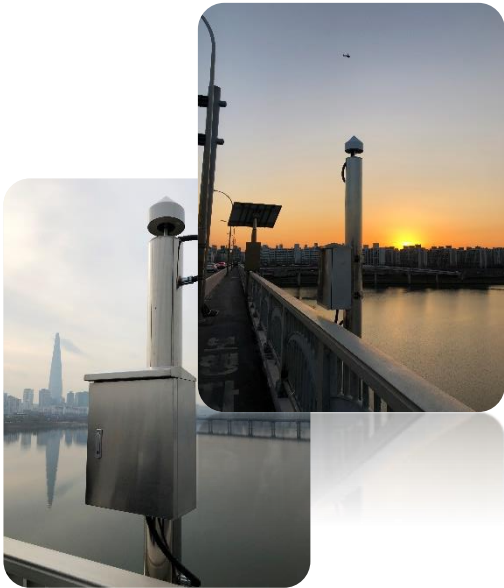<Monitoring using web-based $mmTR®\ NetVu$>

<Han river GNSS system>

2-3) Reference in South Korea

Han River

- ✓ Seoul City Testbed Project (8 units)
- ✓ Displacement monitoring on Gayang Bridge (6 units)
- ✓ Seoul City Road Maintenance Platform Technical Service (4 units)

<Han River>

## Cut slope early warning system

- ✓ 160 observation and reference stations installed
- ✓ Monitoring of landslide risks on slopes
- ✓ Operated by the Ministry of Land, Infrastructure and Transport

Rover

<Cut slope>

Railroad facility monitoring

- ✓ Seowonju~Hoengseong & Moongyeong~Icheon
- ✓ Displacement monitoring for collapse risks in KTX operational sections
- ✓ Operated by Korea Railroad

<KTX tunnel>
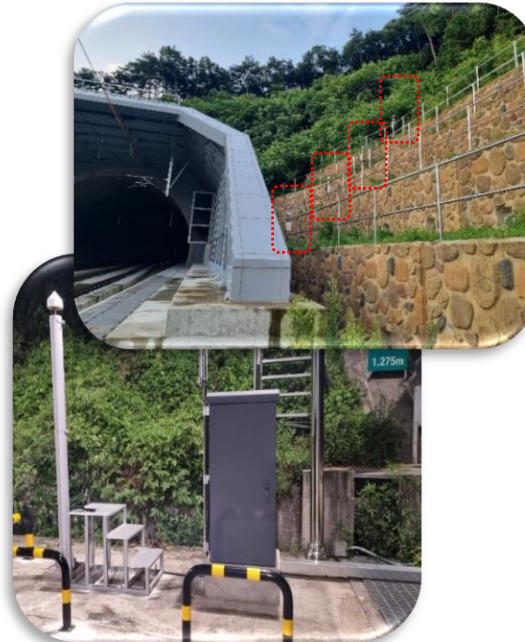
Construction

- ✓ Shape monitoring during the construction period of bridge
- ✓ Providing accurate displacement data up to 20Hz

<Top of the bridge>

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2-4) Cost-effectiveness

Traditional Method

✓ Conducts regular inspections 2 to 3 times a year

✓ $3,000 per 100 meters of bridge & minimum of 10 experts

$180,000/yr
(**Two inspections**)

10 Experts

<Bridge Safety Inspection Costs>

	Length	Cost
Magok Bridge	2,930m	$3,000*30 = $9,000 (3km)

Navsys System

✓ The number of receivers varies depending on the length

✓ Real-time monitoring with a single monitor

$228/yr + $25,200/once

Only one person

	Price pre unit	Cost
4 Receivers	$6,300	$25,200
4 Receivers	168w	121kWh/month
	$6 (60kWh)/m	$13 (62kWh)/m
	$228/yr	

* Based on the Ministry of Land, Infrastructure, and Transport's periodic safety inspection data

Navsys Proprietary Tech

- ✓ Navsys possesses core technologies for RTK, PPP & mmTR Filtering (the only company in Korea)
- ✓ Provides static precision of **1mm Horizontal & 2mm Vertical** and dynamic precision of **< 10cm**
- ✓ Developing software applicable to various RTK devices and apps based on essential core technologies for improving positional accuracy

GNSS RTK Engine
(OMEGA : Optimal Method for Estimating GNSS Ambiguities)

1. Ambiguity resolution algorithm
2. Computational efficiency
   - A few milliseconds CPU processing time
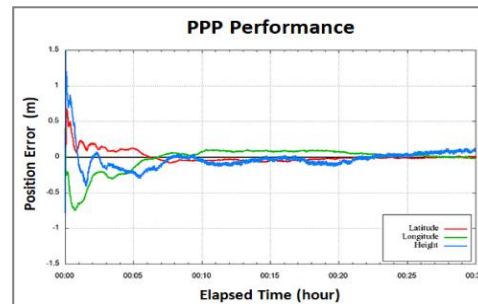   - 100Hz output rate using

<OMEGA performance graph>
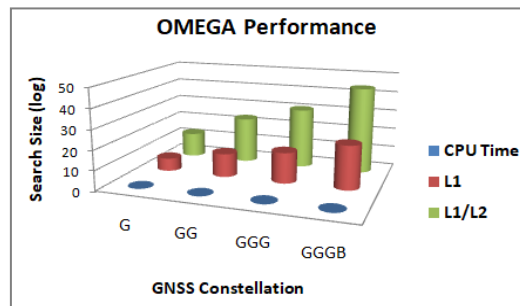
GNSS PPP Engine
(Measurement Filtering PPP)

1. Measurement filtering-based PPP technique
   - Removes any constant error and bias
   - Simplifies conventional PPP approaches
2. Positioning accuracy: ≤1 dm(3drms) within 30min

<PPP Performance>

mmTR Filtering

1. Navsys's proprietary filtering algorithms
   - Measurement domain filter (noise/error reduction)
   - Position domain filter (for trend extraction)
   - Parallel processing for optimal solutions

|	Response time	Accuracy
Horizontal	≤30 min	1mm (1σ)
Vertical	≤30 min	2mm (1σ)

<Navsys Static Monitoring Precision>

Technological Competitiveness

✓ **Performance: Superior convergence speed and response time compared to competitors**

Trimble & Leica	Navsys
≤1mm(σ)	≤1mm(σ)
≤2mm(σ)	≤2mm(σ)
≤1hr	≤5min

✓ **Price: S/W Customizing Service and User-Oriented UI**
✓ **Convenience: Integration with user systems and technical collaboration possible**
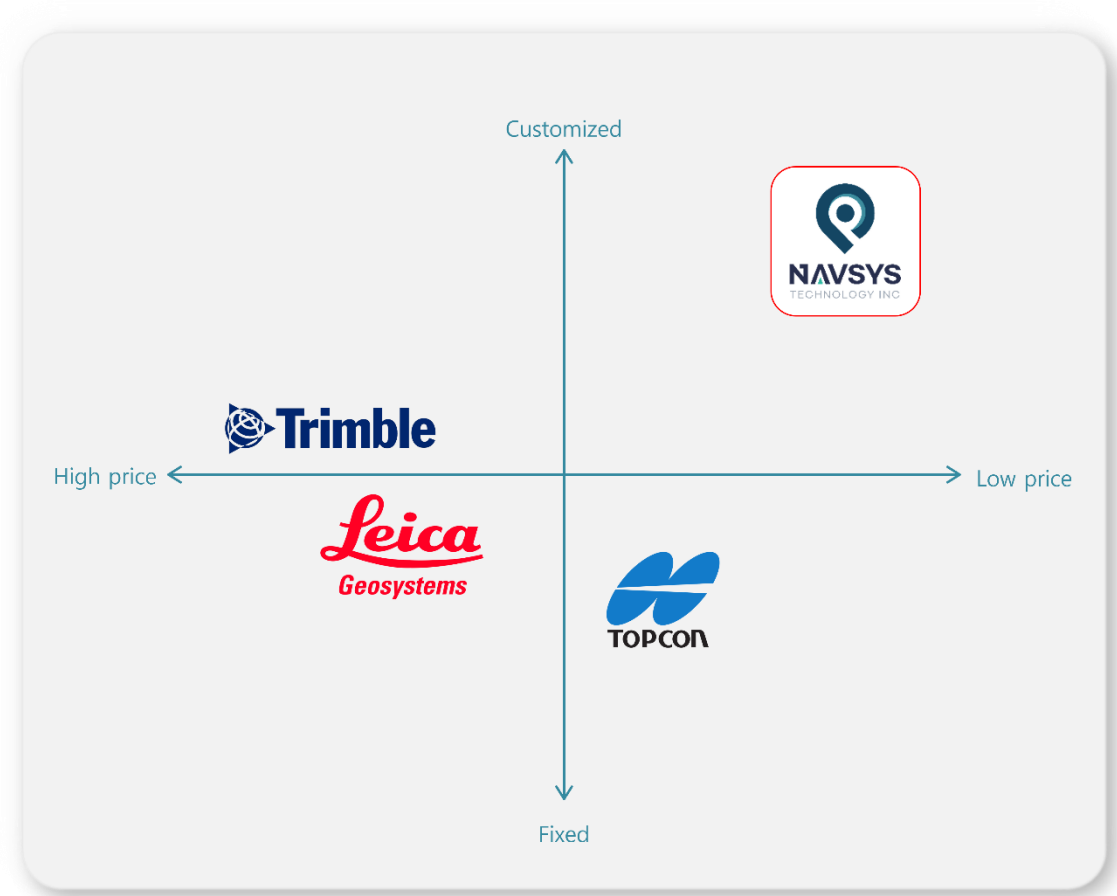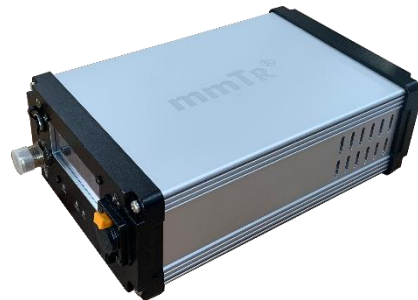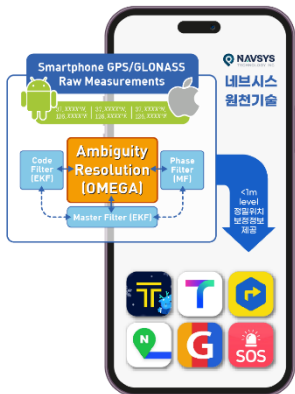
Total Addressable Market

GNSS : 270.51 Billion
Infrastructure : 2.7 Trillion

Total : 2,970.51 Billion

HD Map : 7.4 Billion
Autonomous : 54.6 Billion
Drone : 28.00 Billion
Smart cities : 151.01 Billion

Total : 241.01 Billion

HD Map
4 Autonomous : 4.4 Billion
Autonomous S/W : 1.8 Billion
Drone sensor : 1.4 Billion
5G IoT Module : 17.90 Billion

Total : 25.5 Billion

* Globenewswire, Global Strategic Business Report, 2024
  MarketsandMarkets, Drone Sensor Market Report, 2024
  Globenewswire, Autonomous Driving Software Market Report, 2024
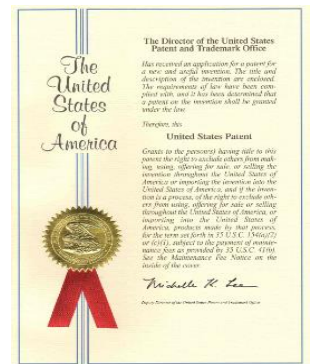
Patents

Patent

✓ 3 patents Registered

Copyright & Register

✓ S/W – GS certification and holds 14 copyrights, including $mmTR^{®}-NetVu$
✓ H/W – $mmTR^{®}-S\ Receiver$ is registered as a suitable equipment
   for broadcasting and communication
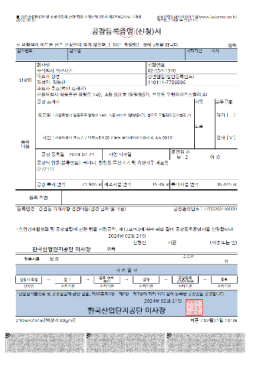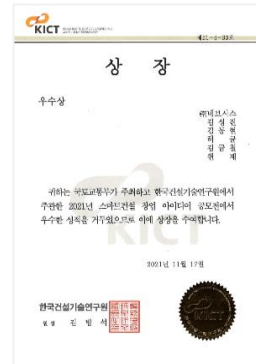
Autonomous

✓ 1 U.S. patent registered

Autonomous driving
of port freight trucks

Team

- 5 years of experience in big data and pattern analysis
- 4 years of R&D on ship noise control
- 3 years in international technical sales and data analysis

Don Kim
Ph.D / CTO

Year	Institution	Position	Key Responsibilities
2017~2020	KRISO	Visiting Researcher	GNSS Advisory
1999~2016	**University of New Brunswick (Canada)**	**Researcher/Professor**	**GNSS Research**
1998~1999	University of Maine (US)	Post-Doc Researcher	**GNSS Research**
1997~1998	Seoul National University Joint Research Institute for Automotive Systems	Special Researcher	Navigation Control Systems Research
1997	Korea Aerospace Research Institute	Senior Researcher	Flight Attitude Control Research

- International journal and conference papers: Over 150 GNSS-related publications

Awards		
2012	CDA Published Paper Award of Excellence	Canada Dam Association, Cnada
2011	ION GNSS Best Presentation Awards	
2008	IEE/ION PLANS Best Track Paper Award	
2007	ION GNSS Best Presentation Awards	The Institute of Navigation, USA
2006	IEEE/ION PLANS Best Track Paper Award	
2004	ION Samuel M.Burka Award	

Sungjin Kim
CEO, CMO

Period	Field
25years	R&D of noise, vibration and earthquake-resistant technologies
	Semiconductor Active Vibration Control R&D
	R&D of nuclear seismic and shock protection devices

Kyun Huh
H/W / Executive Director

Period	Field
26years	CCTV H/W & S/W R&D
3years	GNSS H/W R&D

Geumcheol Kim
Head of Research Institute

Period	Field
16years	DVR R&D
5years	Web software R&D
3years	GNSS software R&D

Jungsik Shin
S/W / Dept. Manager

Period	Field
17years	GNSS S/W R&D
3years	GNSS RTK service software R&D
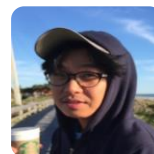
Jae Won
Analyst / Dept. Manager

Period	Field
5years	Big data and pattern analysis
4years	R&D on Ship noise control R&D
3years	Data analysis & Sales