Status on GNSS R&D Activities in KARI

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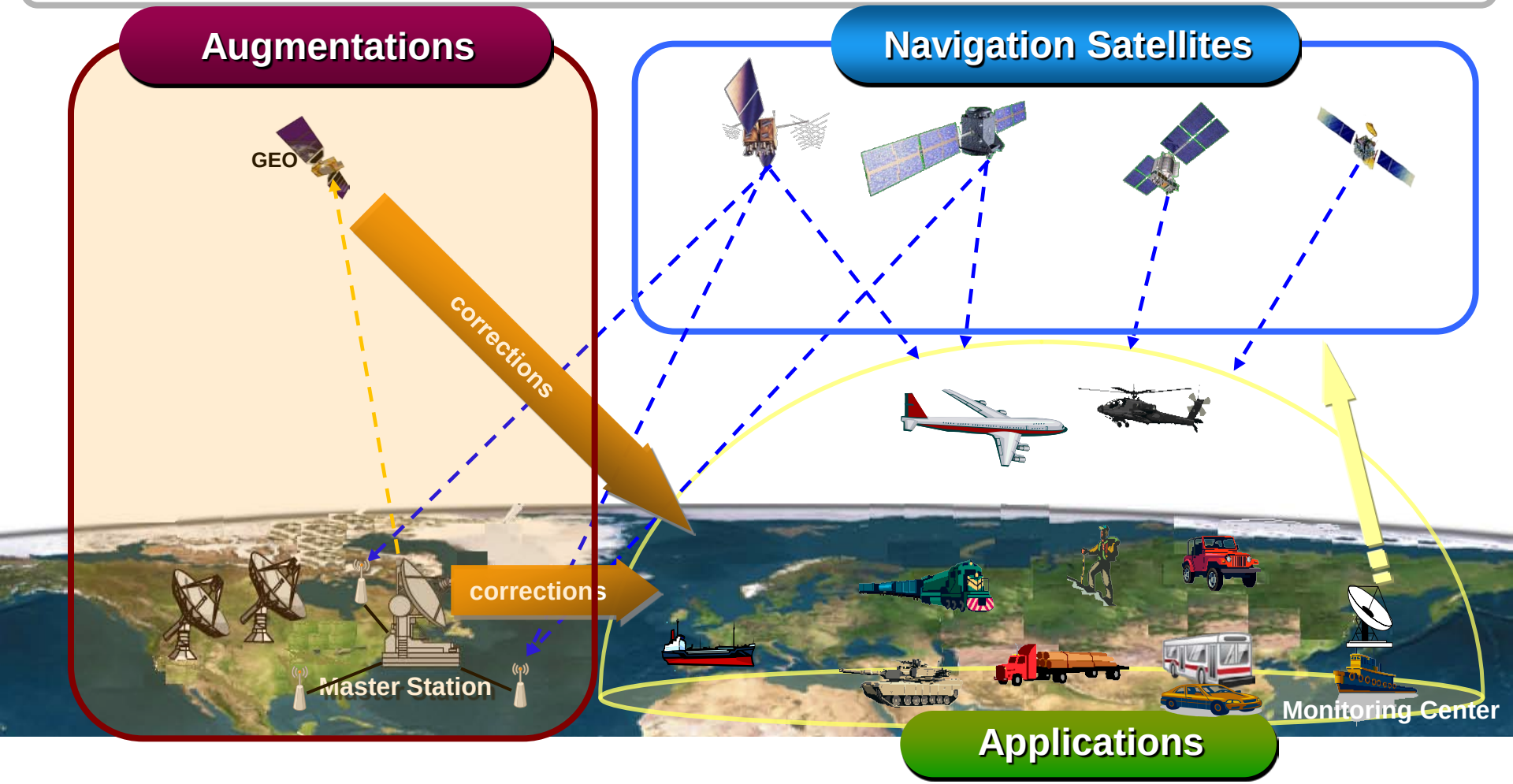
What is GNSS?

GNSS : Global Navigation Satellite System

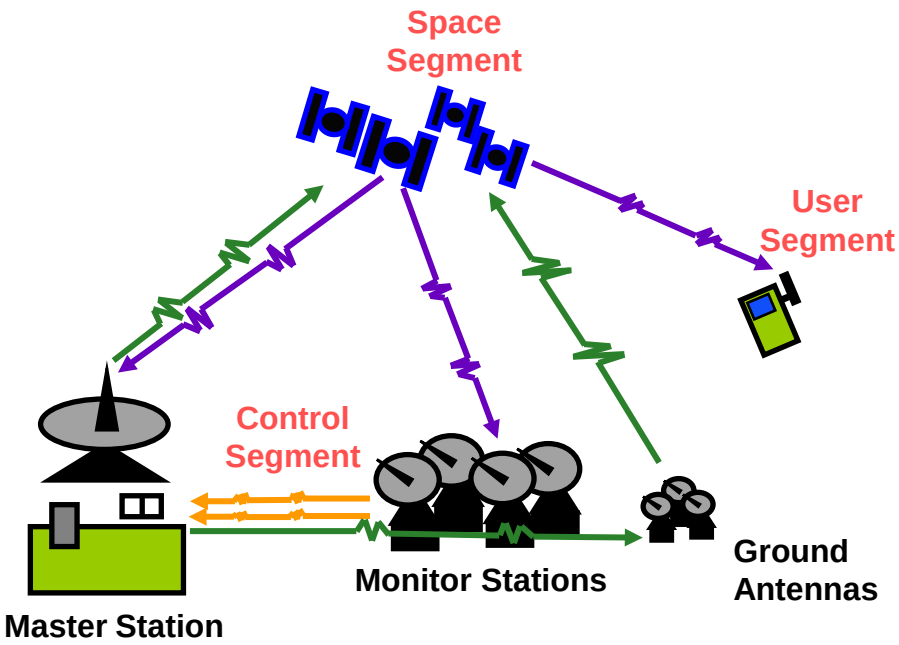
Satellite navigation systems that provide autonomous geo-spatial positioning with global coverage



Components of GNSS

- Navigation satellites
- Navigation message broadcast

- Applications based on navigation message



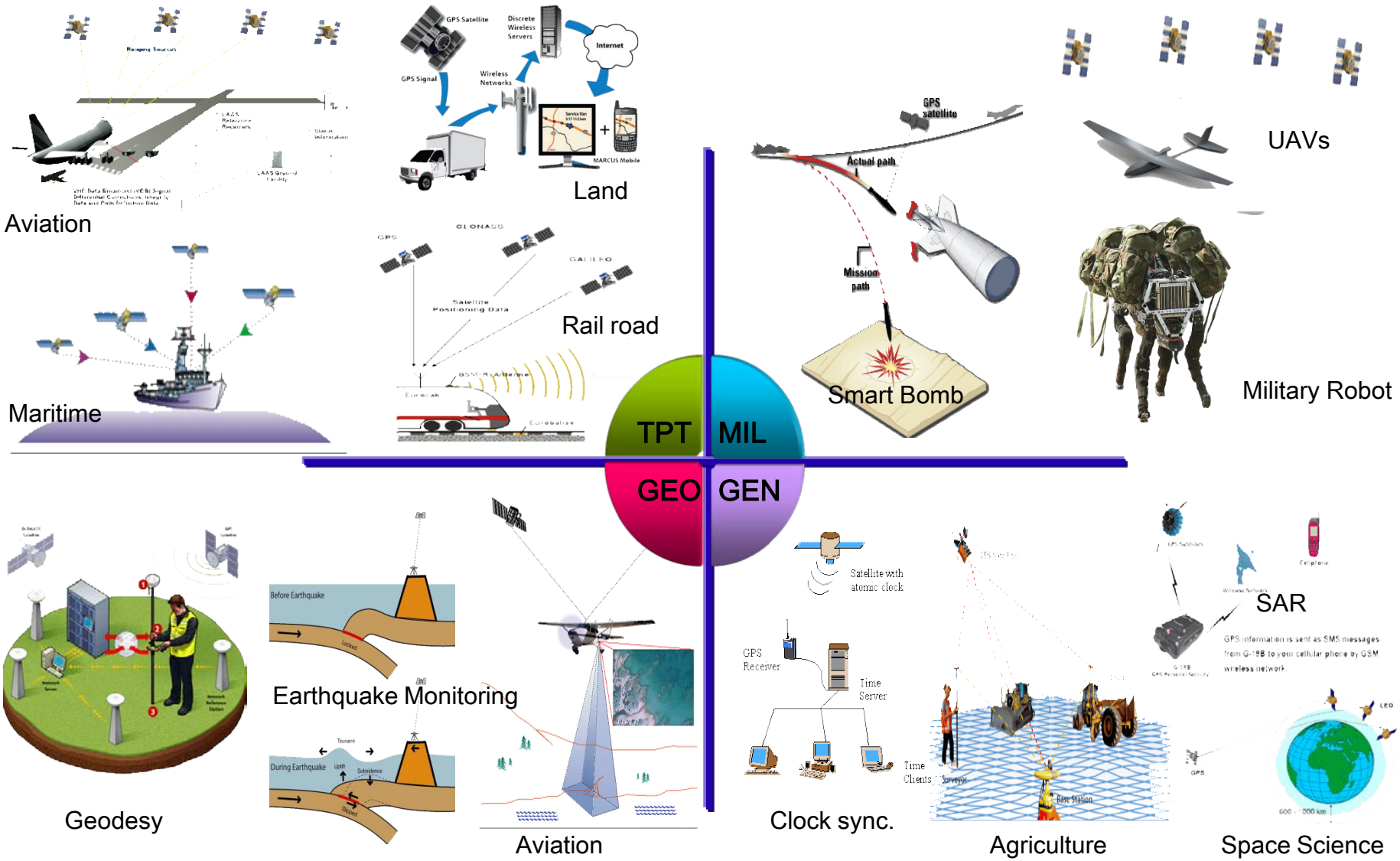
- Satellites monitoring and orbit corrections
- Satellites clock corrections

GNSS - the system of the future?

A navigation system should be:
– available everywhere (availability)
– available all the time (continuity)
– extremely accurate (accuracy)
– trusted (integrity)
– easy to use - “switch it on, know where you are”

GNSS has this potential . . .
. . . but, it requires augmentation.

Application areas



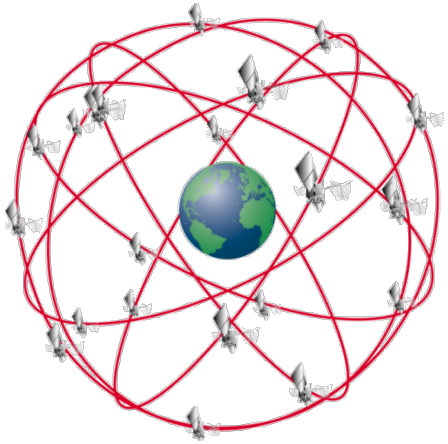
Status of GNSS - I

- **GNSS-Global Navigation Satellite System**

  Navigation system for global service composed by 20-30 navigation satellites, e.g., GPS (USA), GLONASS (Russia), Galileo (EU), COMPASS (China)

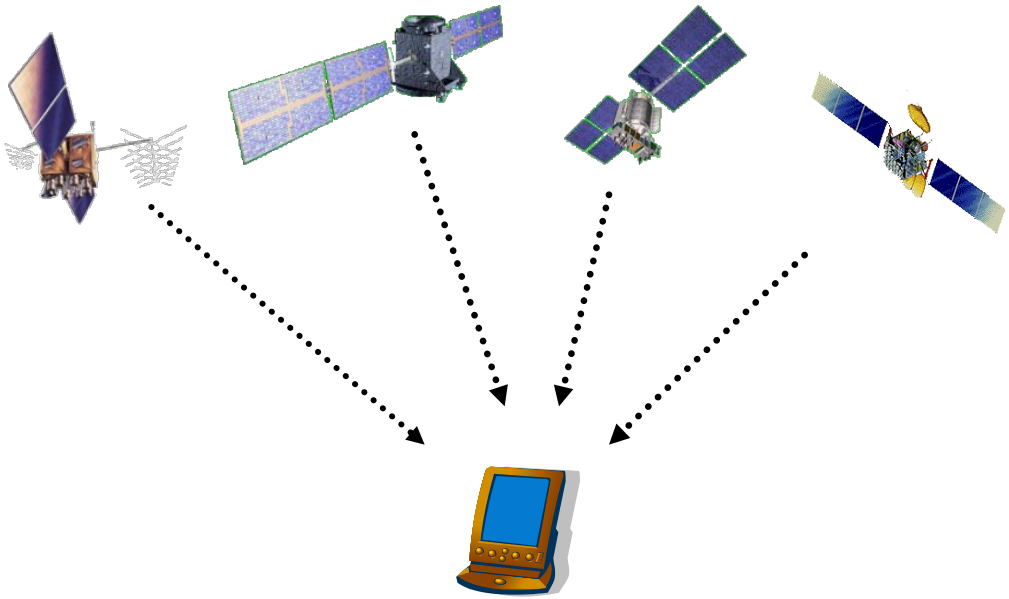
- **RNSS-Regional Navigation Satellite System**

  Navigation system for regional service using GEOs, e.g., JRANS (Japan), Beidou (China), IRNSS (India)

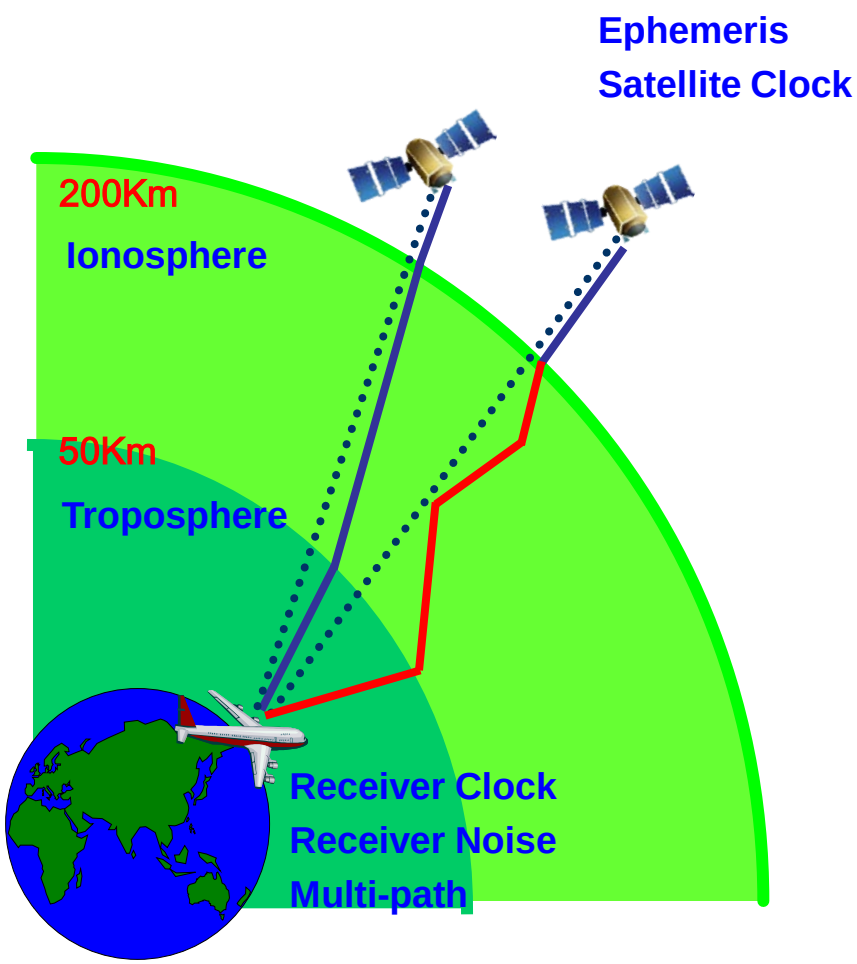


Status of GNSS - II

- **Possibly increasing availability (# of SV) and accuracy (DOP)**
- Needs to solve the compatibility and interoperability issue
- The International Committee on GNSS (ICG) Working Group is discussing about it
- Mr. James Miller (NASA) is the right person to ask about it



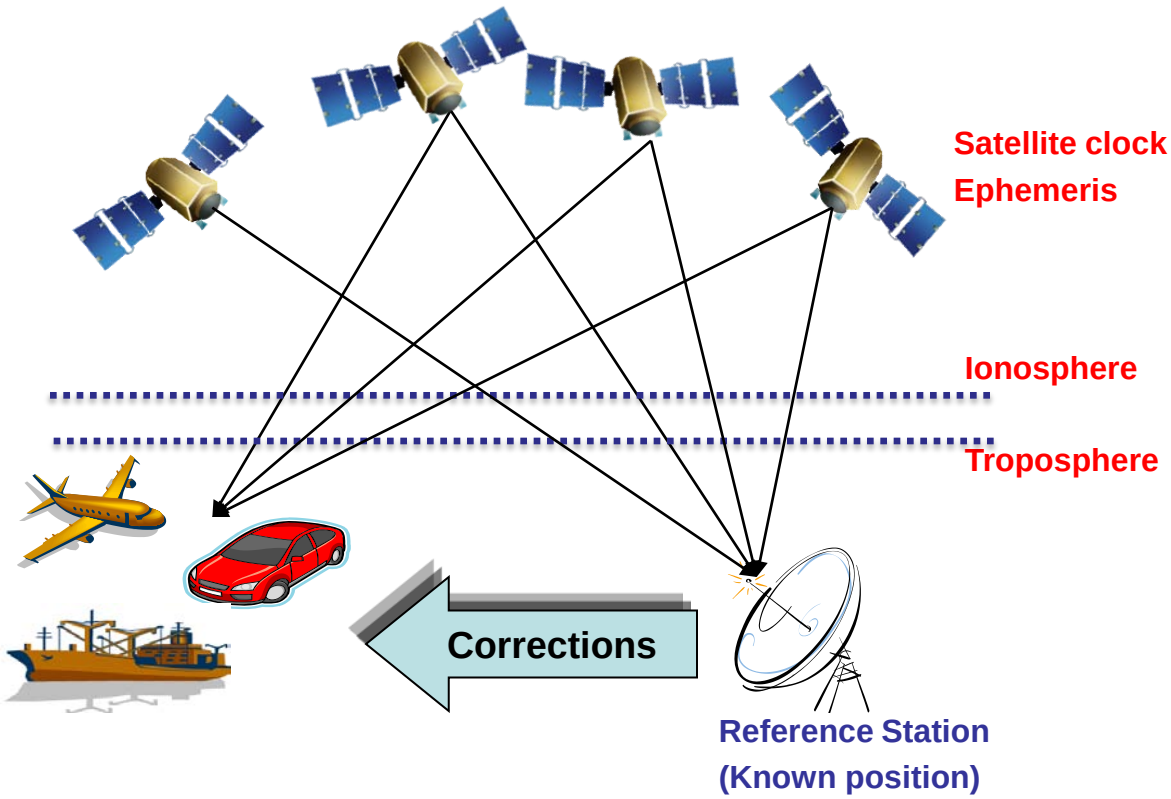
Satellite navigation system error



Error source	Error Budget
Ephemeris	1.5m
Satellite clock	1.5m
Ionosphere	4m
Troposphere	0.7m
Receiver clock/noise	0.7m
Multipath	1m

Differential GPS (DGPS)

- DGPS – a reference station at known position calculates common navigation errors such as ionosphere, troposphere, etc., and broadcast corrections to users to improve its position accuracy



Corrections = (Clock + Ephemeris + Ionosphere + Troposphere) error

Augmentation systems

Wide Area Augmentation Systems

Aviation

Satellite Based Augmentation Systems (SBAS)

- USA : WAAS (Wide Area Augmentation System)
- EU : EGNOS (European Geostationary Navigation Overlay Service)
- Japan : MSAS (Multi-functional Satellite based Augmentation System)
- India : GAGAN (GPS and Geo Augmented Navigation System)

Local Area Augmentation Systems

Aviation

Ground Based Augmentation System (GBAS)

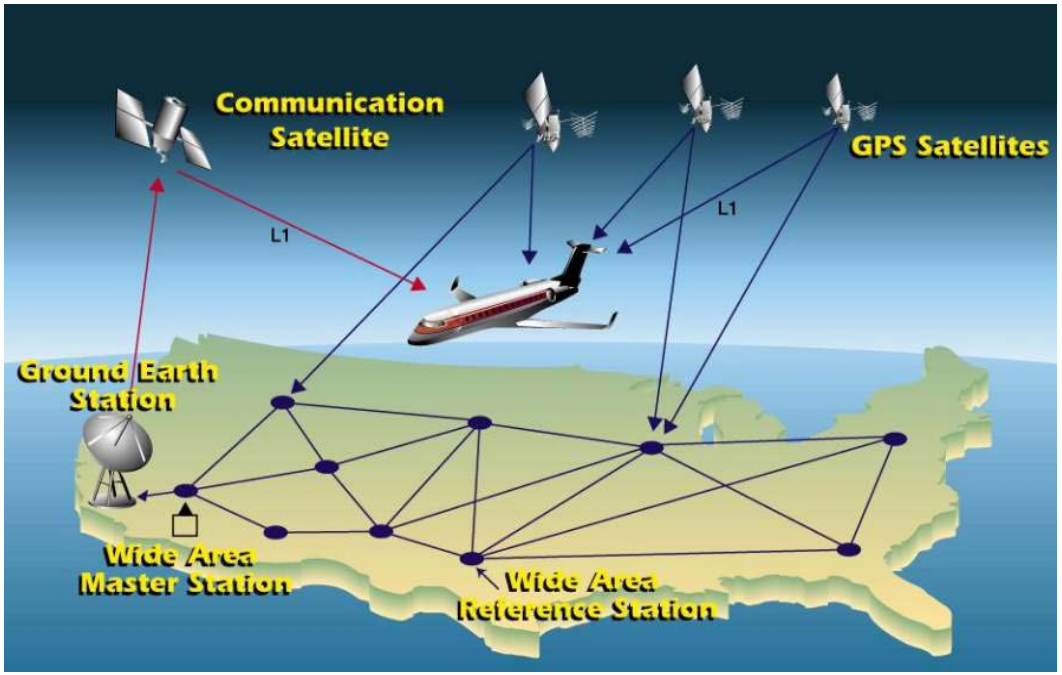
- USA : LAAS (Local Area Augmentation System)

Maritime

- USA : MDGPS (Maritime Differential GPS)

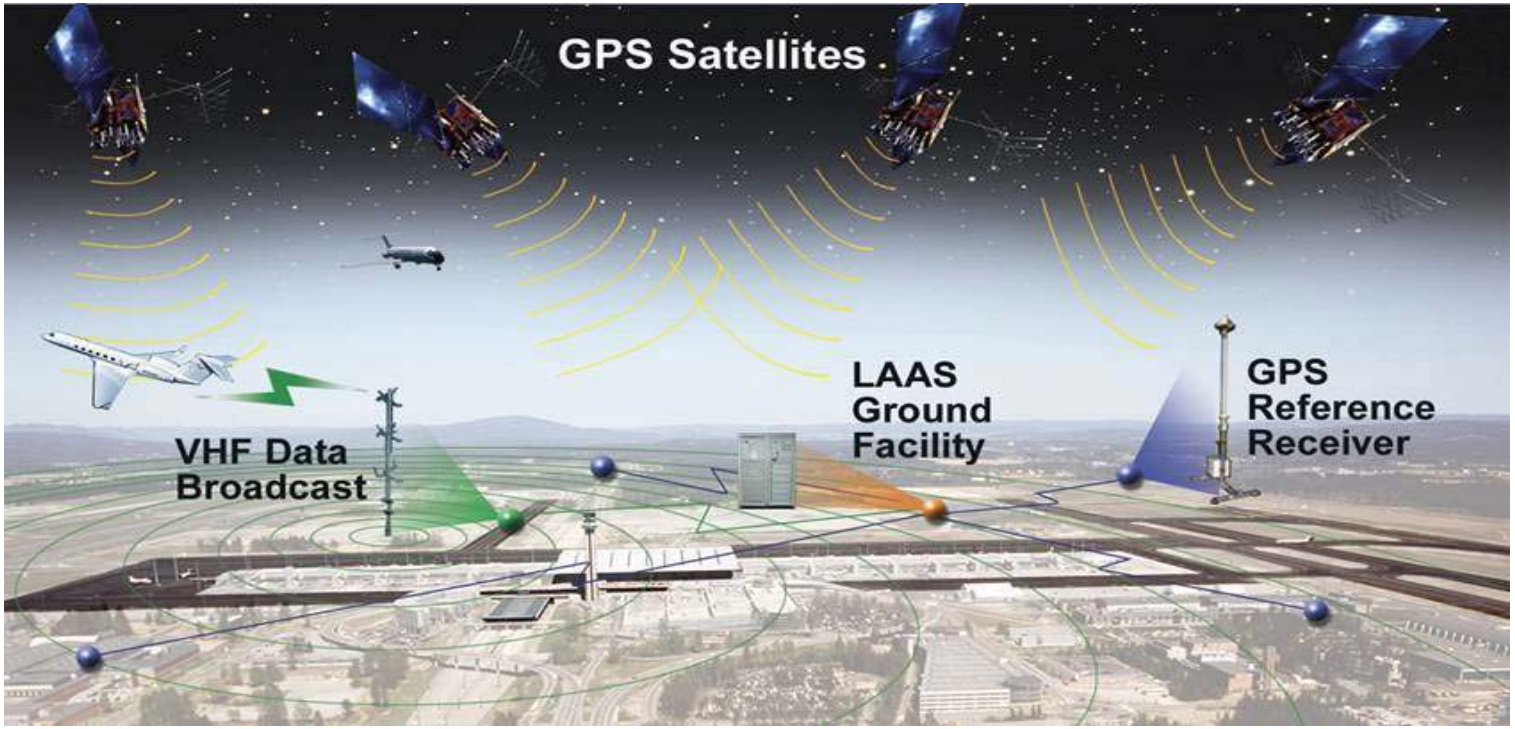
SBAS

- SBAS consists in reference stations / master station / ground earth station
- A master station computes corrections based on the data collected from reference stations distributed in wide area and send them to users via a communication satellite
- SBAS uses L1 band for down-link

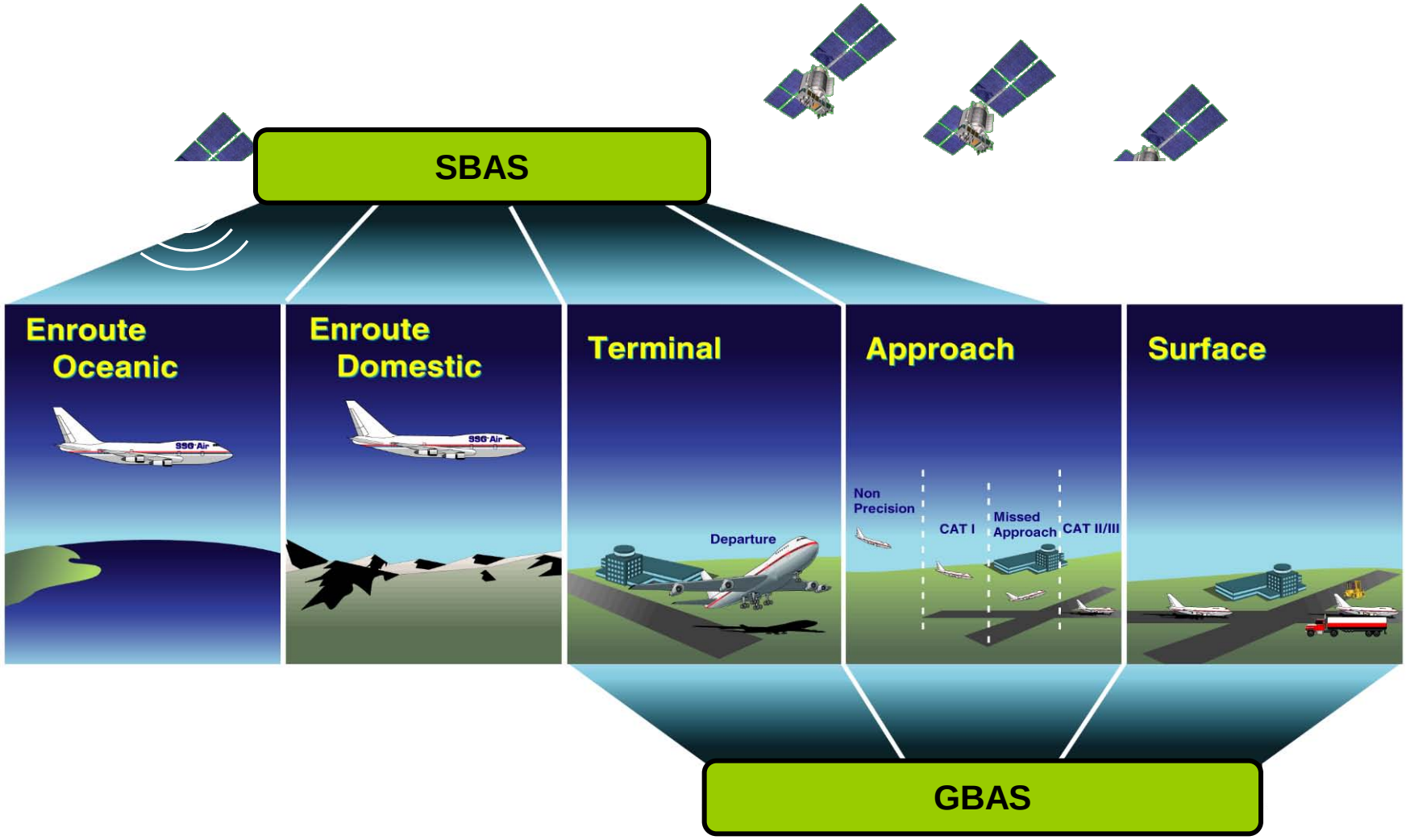


GBAS

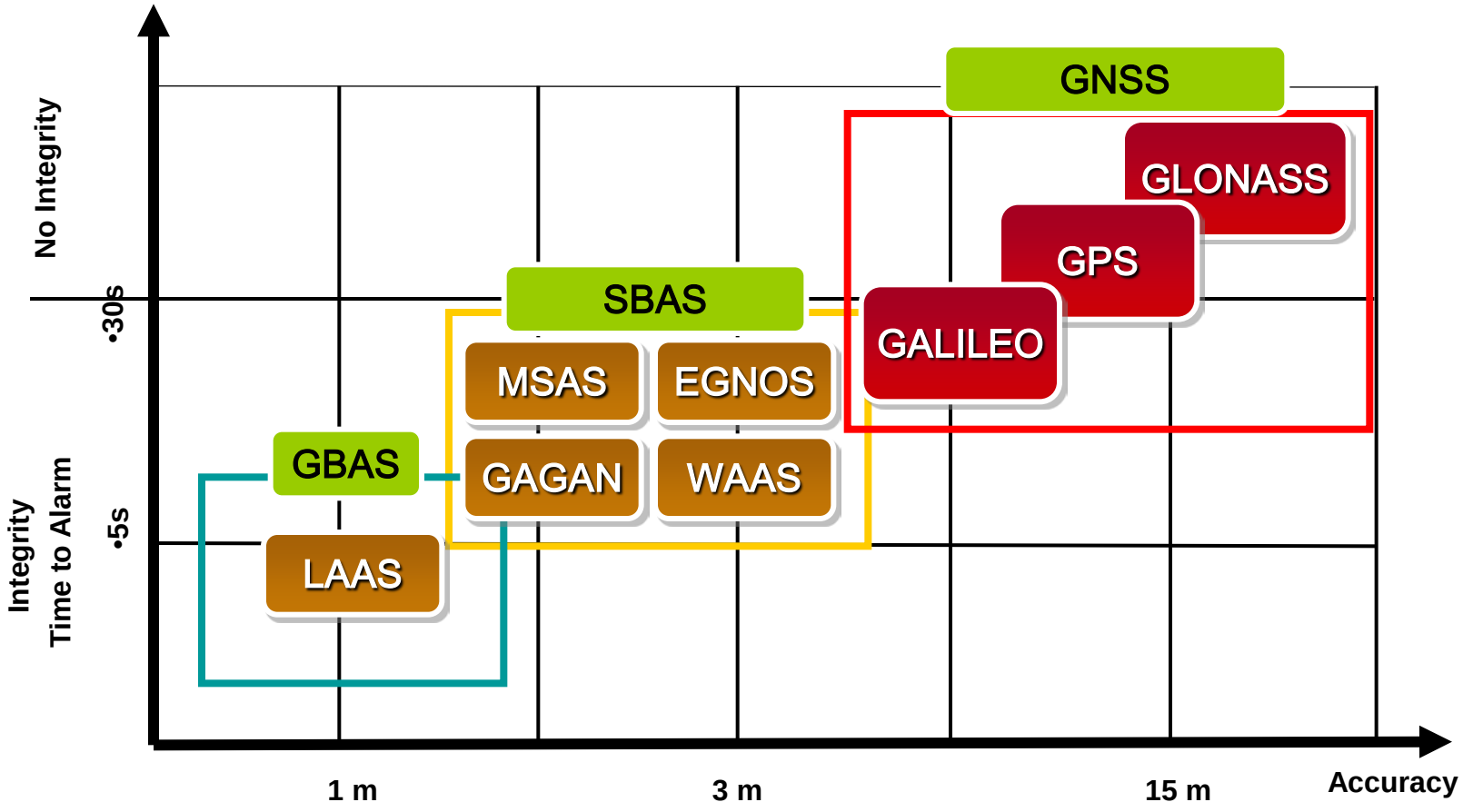
- GBAS consists in 4 reference stations very closely located and VDB
- A master station computes corrections based on the data collected from 4 reference stations in the airport and send them to planes via VDB
- GBAS provides CAT-I capability



Augmentation systems - aviation



Performance of Augmentation systems



KARI R&D activities

- **Integrity Monitoring Test-bed**
- **Development of GNSS based Transportation Infrastructure Technology**
- **National Agenda Program**

GBAS test-bed

1990's : Feasibility Study on GNSS Based Air Navigation

- Follow up the decision of 10th Air Navigation Committee in 1991
- Prepare GNSS implementation for air navigation in the future
- Promote the universities and industries to work on GNSS R&D

2000's : IMT for GBAS Development

- Investigate ionospheric behavior over Korean peninsular
- Develop algorithms for accuracy enhancement, integrity monitoring, etc
- Build GBAS test-bed and install at Jeju airport
- Monitor GNSS signal to detect anomaly for R&D purposes

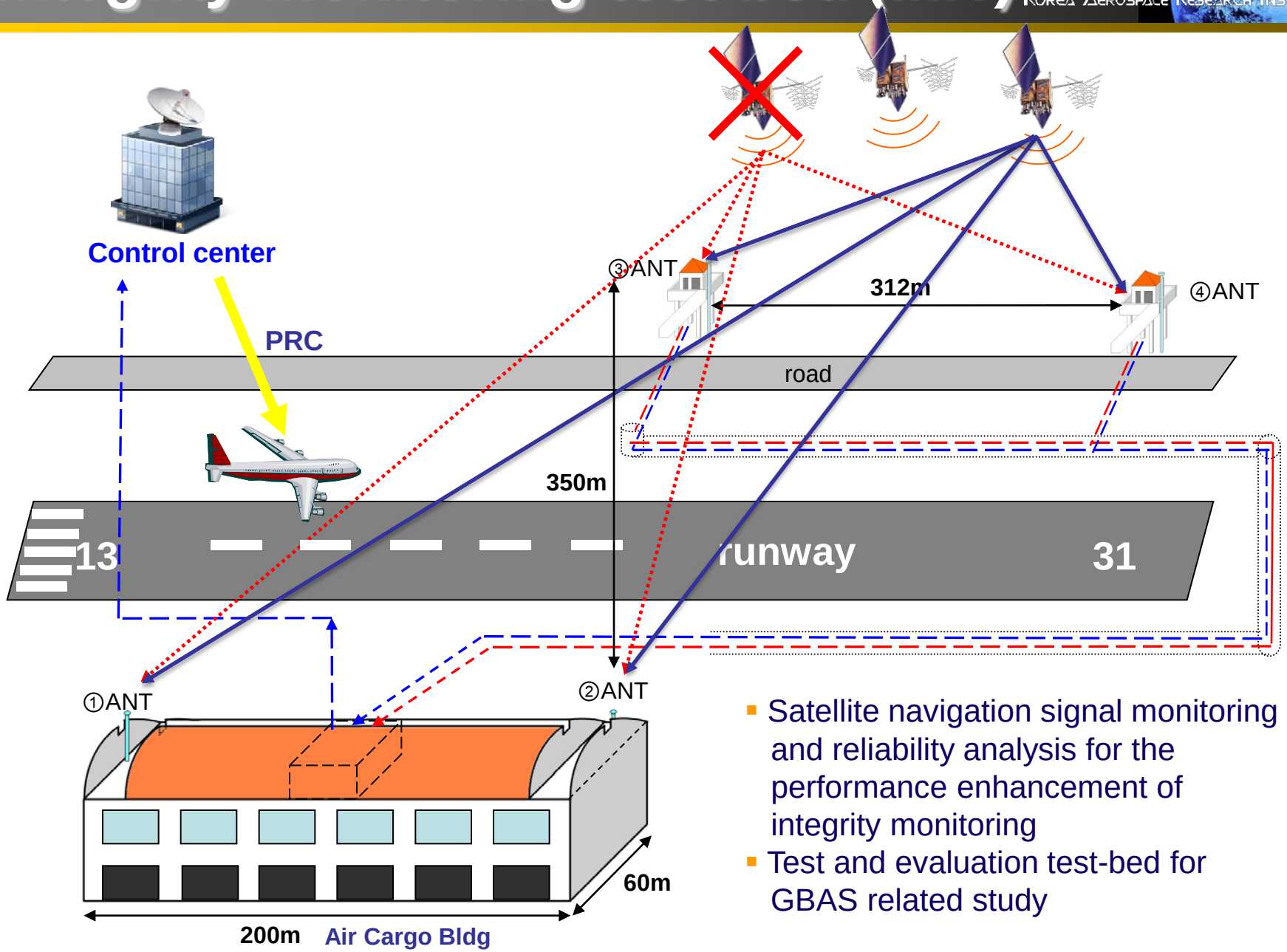
2010's : GBAS Implementation

- GBAS Installation and Approval by 2014
- GBAS CAT-I Service from 2015

IMT for GBAS

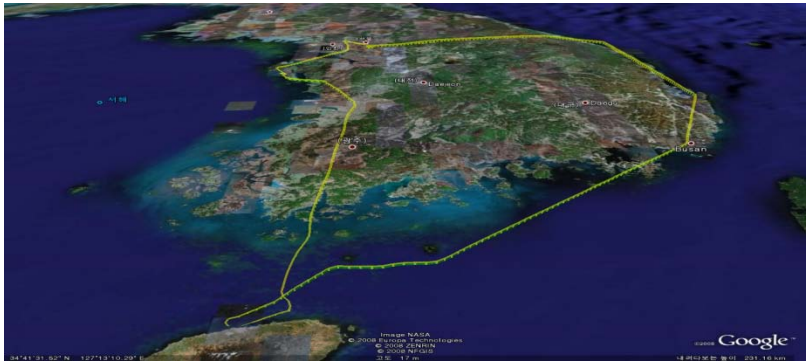
IMT
starting from 2000

Integrity monitoring test-bed (IMT)



- Satellite navigation signal monitoring and reliability analysis for the performance enhancement of integrity monitoring
- Test and evaluation test-bed for GBAS related study

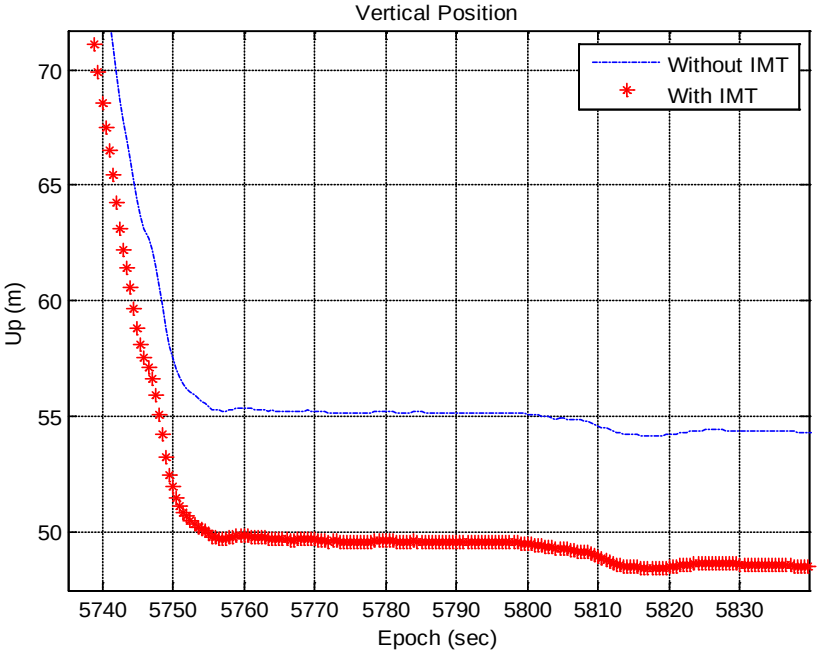
Flight test with IMT



Test flight trajectory

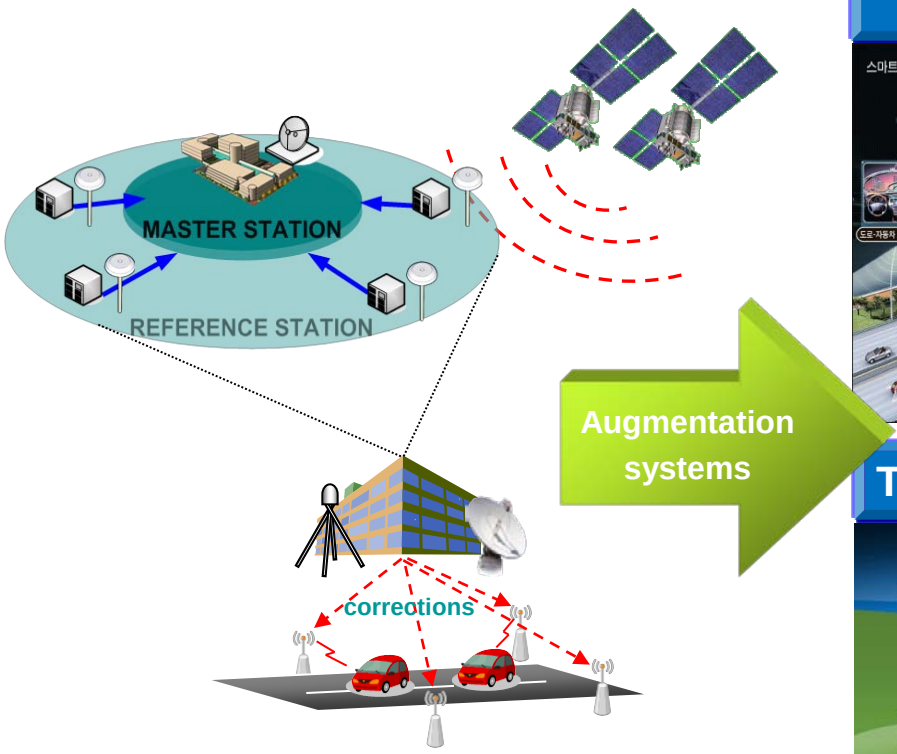
Aircraft used in the test

Landing and take-off



Vertical errors

GNSS Based Transportation Infrastructure



Smart hiway

u-T

Transport safety and efficiency enhancement

- Increased average personal mobility level
- Cost savings due to more efficient transport systems
- Safe, reliable and environmentally friendly transport systems

*** This research is supported by the ministry of land, transportation and maritime**

Current status of ITS in Korea

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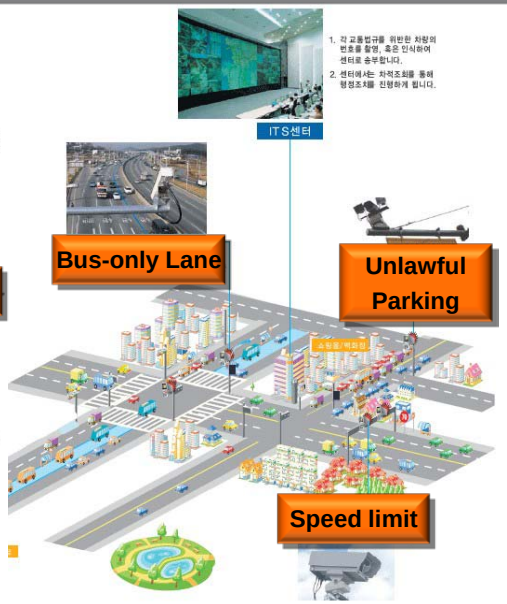
Traffic Signal Control

- Based on road conditions using loop detectors, CCTV, etc, the traffic signal or highway on-ramp is controlled and warning signs posted when necessary.

Traffic Regulations Violation



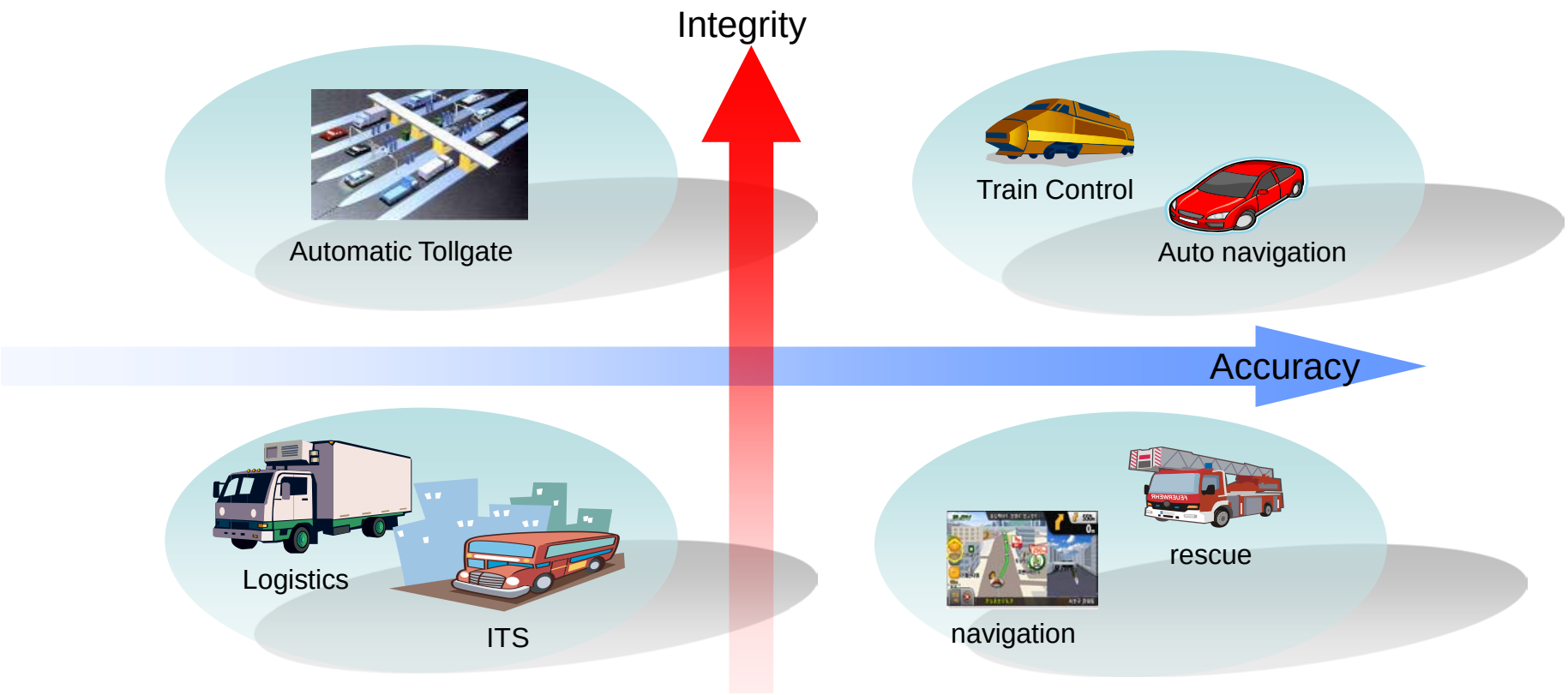
- Prevent traffic accidents by monitoring bus-only lanes, unlawful parking and speeding using cameras.

Traffic Accident Transaction

- Routes are detoured to scatter traffic volume by traffic accident, and also call the police, ambulance, tow truck, etc.

Restrictions on ITS

- ITS applications – ranging from electronic toll collection to automatic road enforcement and expanding rapidly across all modes of transport
- Positioning Systems currently being utilized demonstrate low accuracy and no integrity
- For the extension of the ITS/u-T, GNSS needs to be a component



Weakness of land applications

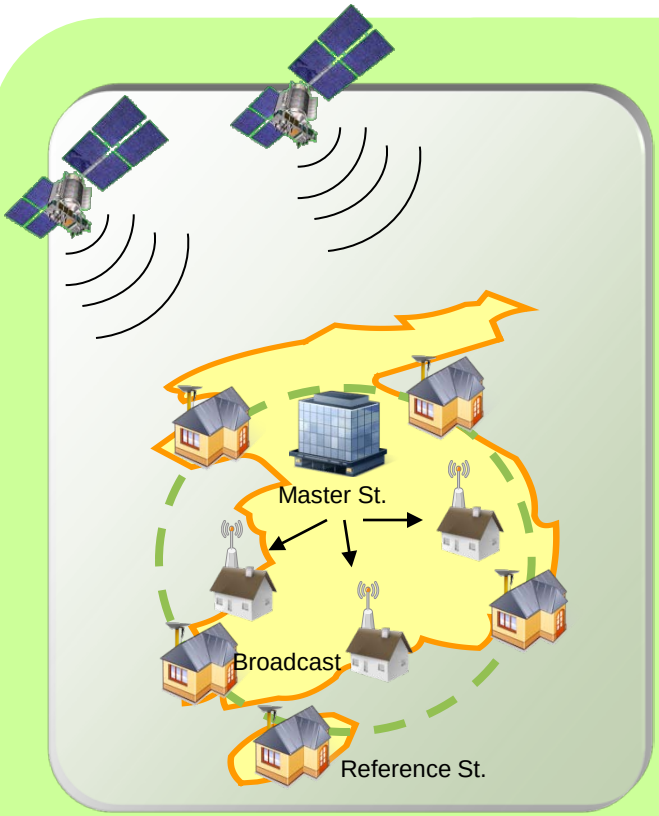
Difficulties

Good Visibility
on air and sea applications

Bad Visibility
on Land applications

We need to solve the urban valley problems - multipath, weak signals etc

GNSS based TPT infrastructure



Accuracy Improvement

Integrity Improvement

Signal acquisition Improvement

GNSS Shading Removal

Correction and reliability Information

Infra information

Integration of infra information and other sensors

*** Land Application must be low cost for general user**

National Agenda Program

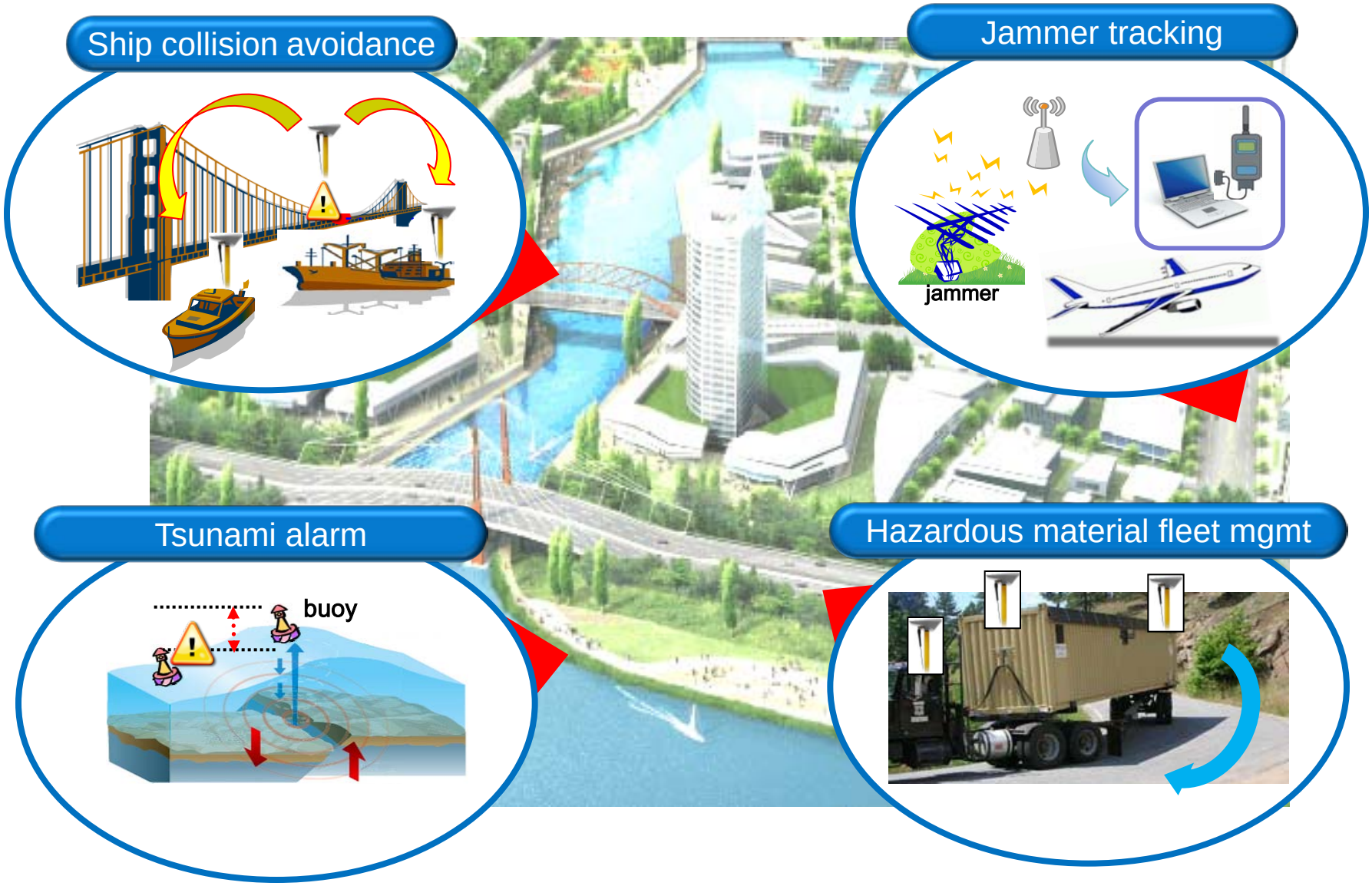
- **GNSS based positioning accuracy enhancement technology is under development in order to improve national risk management and disaster prevention**

  - Disaster detection and prevention in Land/Aviation/Maritime
    - monitoring of the radio navigation interference by a jammer
    - Tracking hazardous material transport location and preventing from its accident
    - ship bridge collision avoidance and Tsunami monitor

  - Fast disaster relief
    - Rescue personnel location tracking
    - react quickly (including obtaining disaster site images information via small UAV)

This research is supported by Korea Research of Fundamental Science and Technology

Settlement on national agenda



Improved disaster mgmt system

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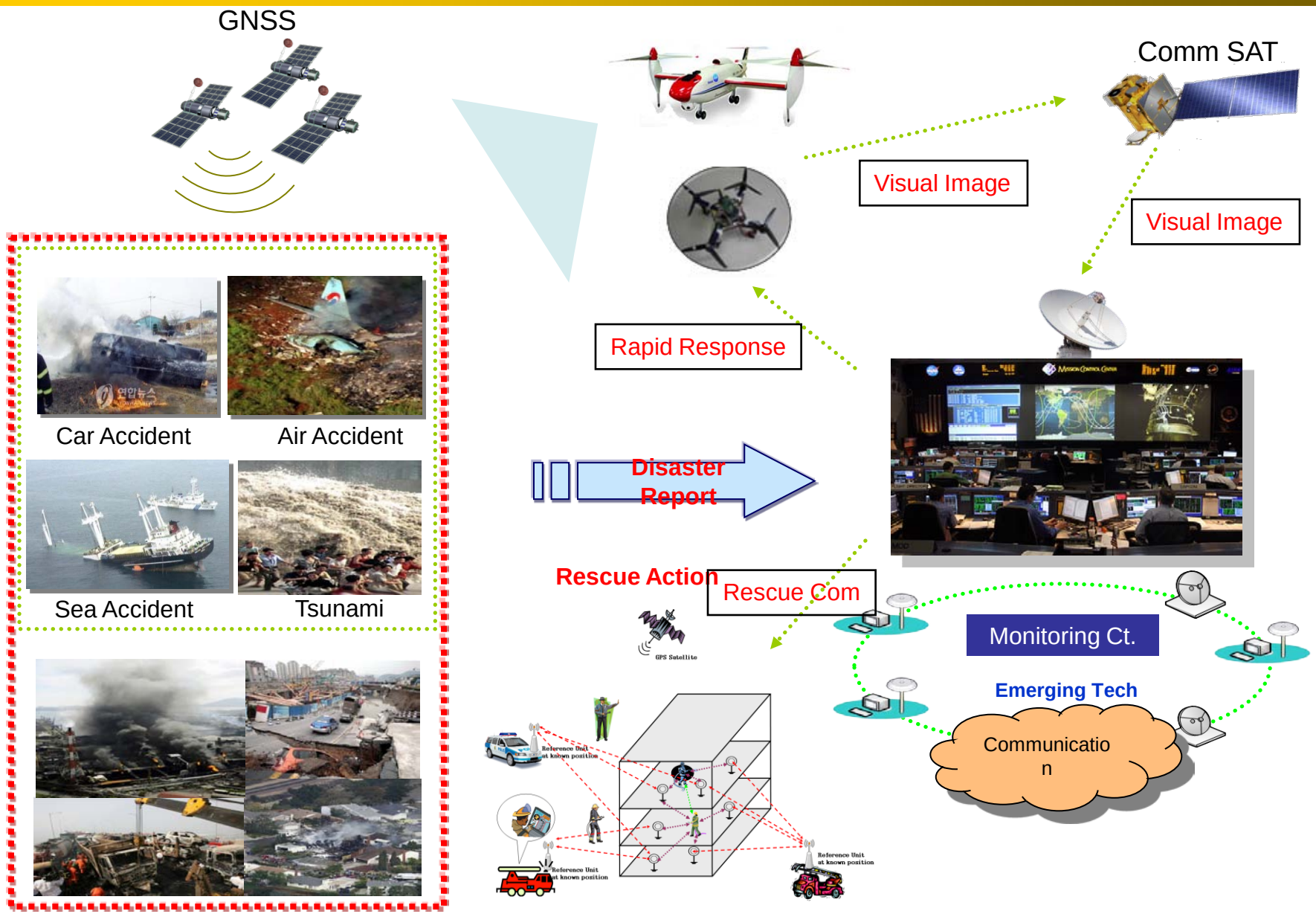

Thank You