Country Report from Japan

Current GNSS Activities in Japan

The 51th CGSIC, 19 Sept, 2011

at Portland, Oregon

Hiroshi Nishiguchi

Japan GPS Council

Operation “TOMODACHI” and more…..

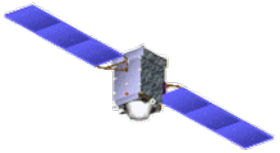
Thank you for your all of support !

Tsunami flooding around the Sendai Airport, from Wikipedia

http://www.imart.co.jp/tohoku-hisachii-jyouhou.html

QZS-1 was launched on 11 September successfully.

3.11 disasters push the QZSS implementation.



QZSS Constellation Plan 1

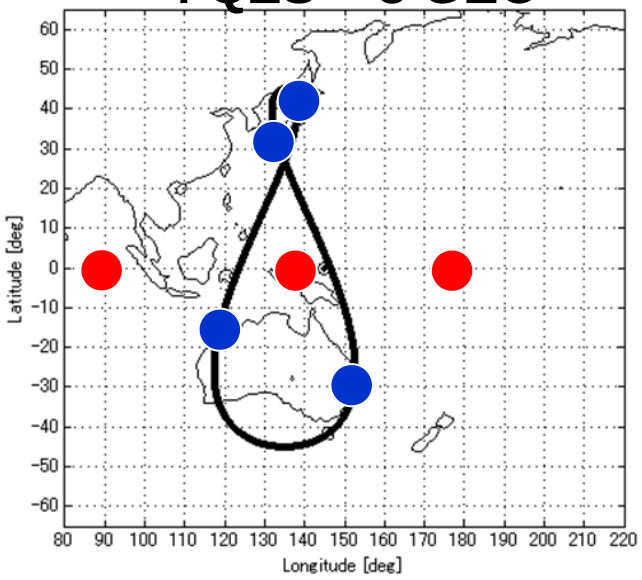
Planned Satellite Constellation

There are several QZSS satellite constellation plans.

The total number of satellites is 4 to 7 including Quasi-zenith orbit and Geostationary orbit satellites.

Case of 7 Satellites

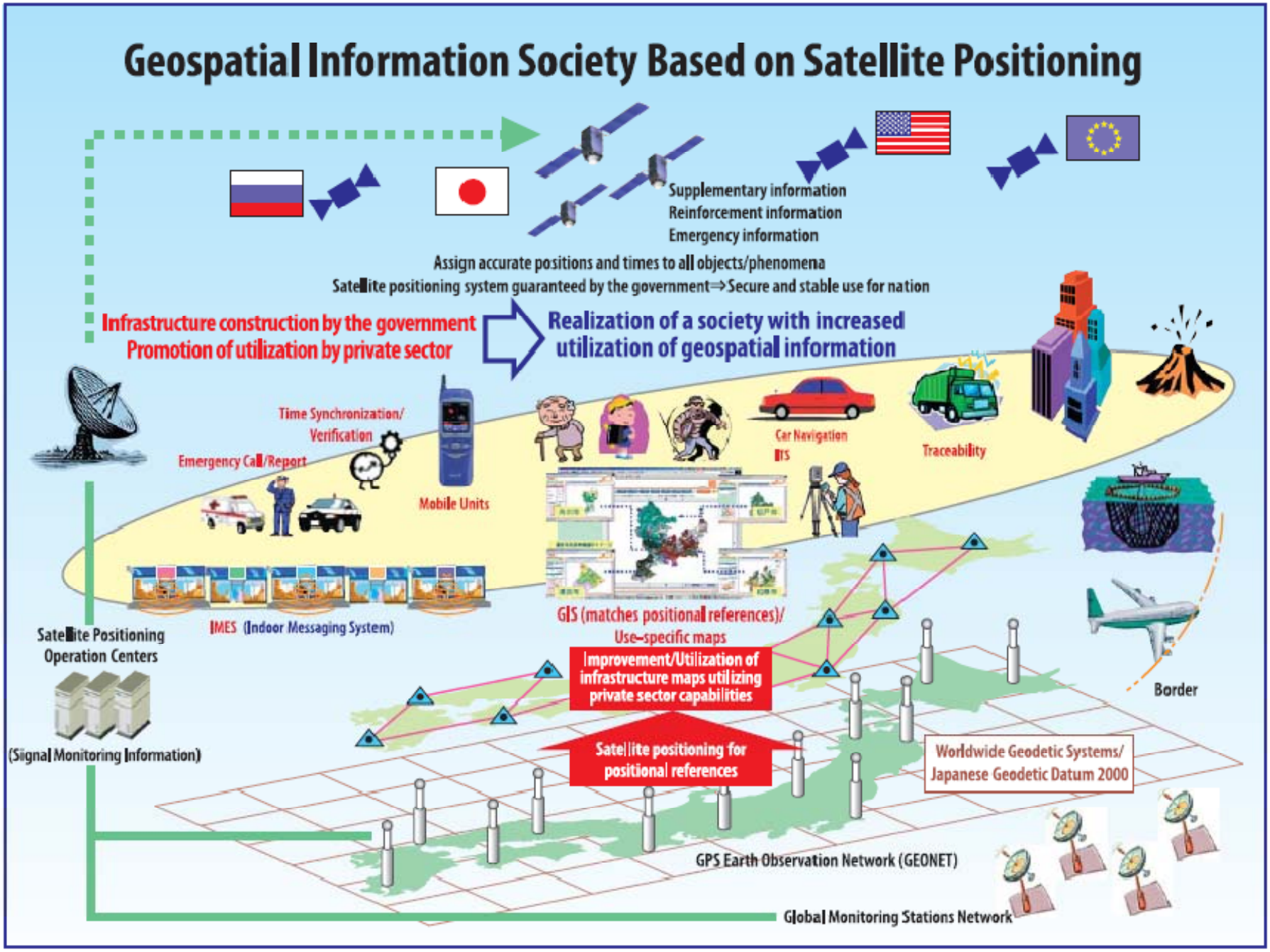
4 QZS + 3 GEO



- **Quasi-Zenith satellite (QZS)**
- **Geostationary satellite (GEO)**

@Watanabe, 6th ICG

Society with Increased Utilization of Geospatial Information

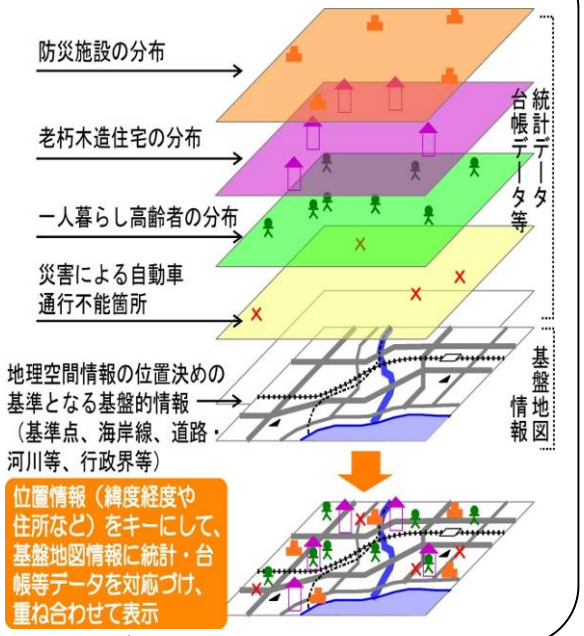


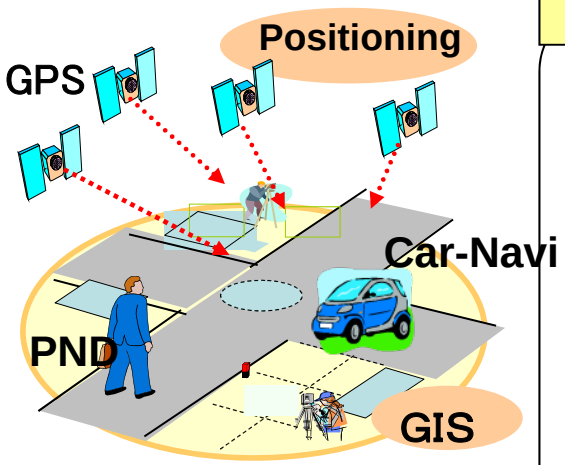
Significance of National Spatial Data Infra（NSDI）

GIS
Geographical Information System

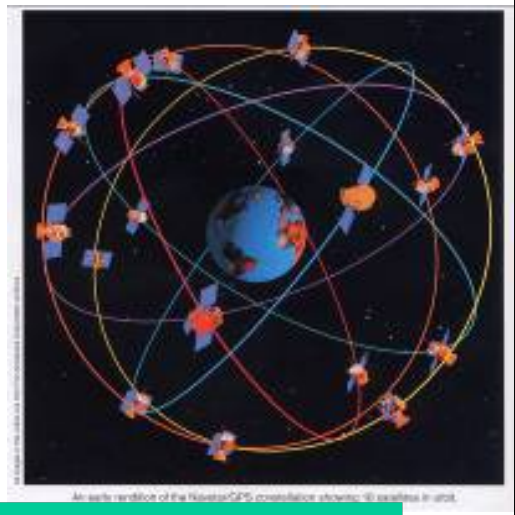
Digitalized

NSDI





Space-based PNT
Positioning, Navigation and Timing



Vast amount of Information

Necessity to manage them by PNT

GIS and Space-based PNT

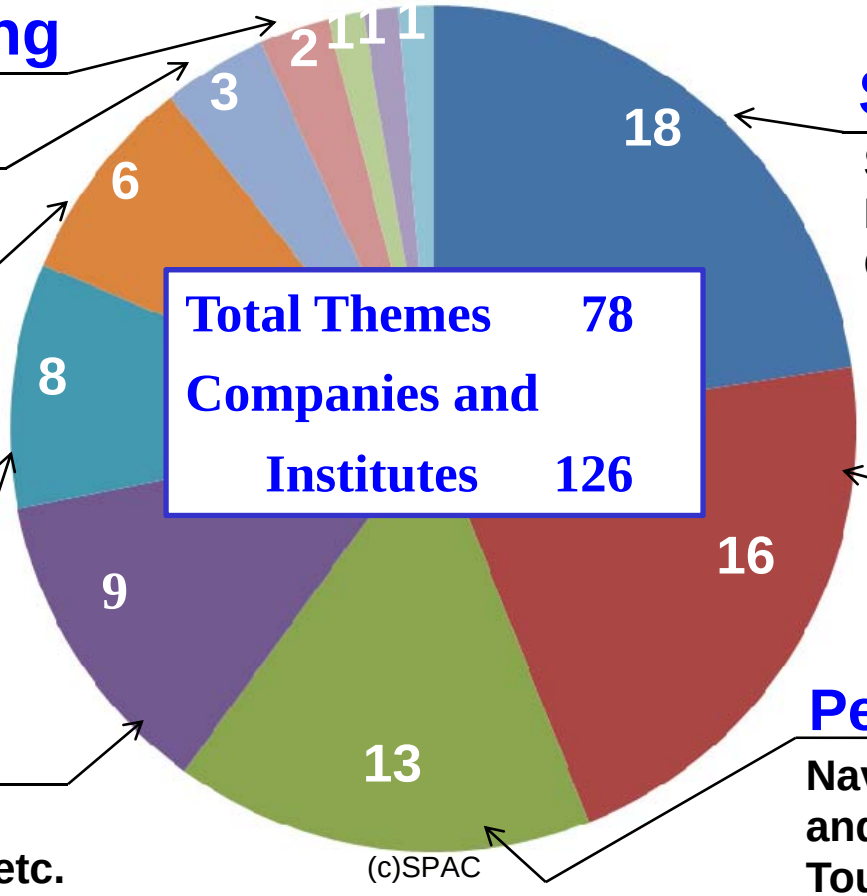
- All nature exists in terms of Position and time
- Fusion of PNT with communications, to manage, analyze and present the information
- Provide precise information as the basis of choosing action

Realization of the high grade society using Geo-Spatial information and Space-based PNT

QZSS Application Verification by Private Companies

QZSS Application Verification Themes

Using reinforcement signals L1-SAIF and LEX from QZSS, over 120 private companies have been verifying their applications under the coordination of SPAC.



Mapping

Railway and Bus

IT Automatic Driving
Automatic Driving for Construction, Agriculture etc.

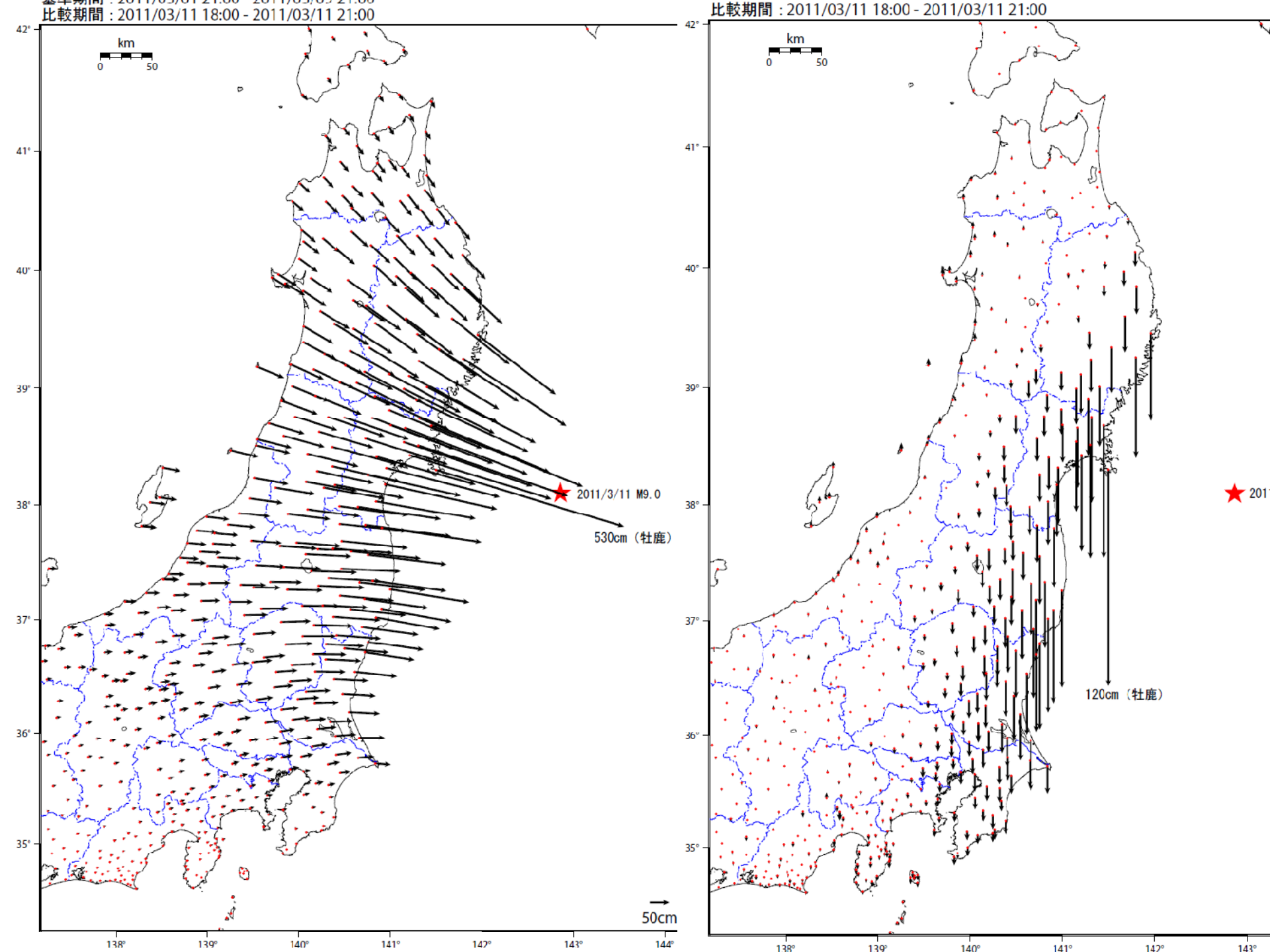
Disaster Management
Ground Displacement, Search and Rescue etc.

Car Navigation
Driver Assistance
Route Optimization etc.

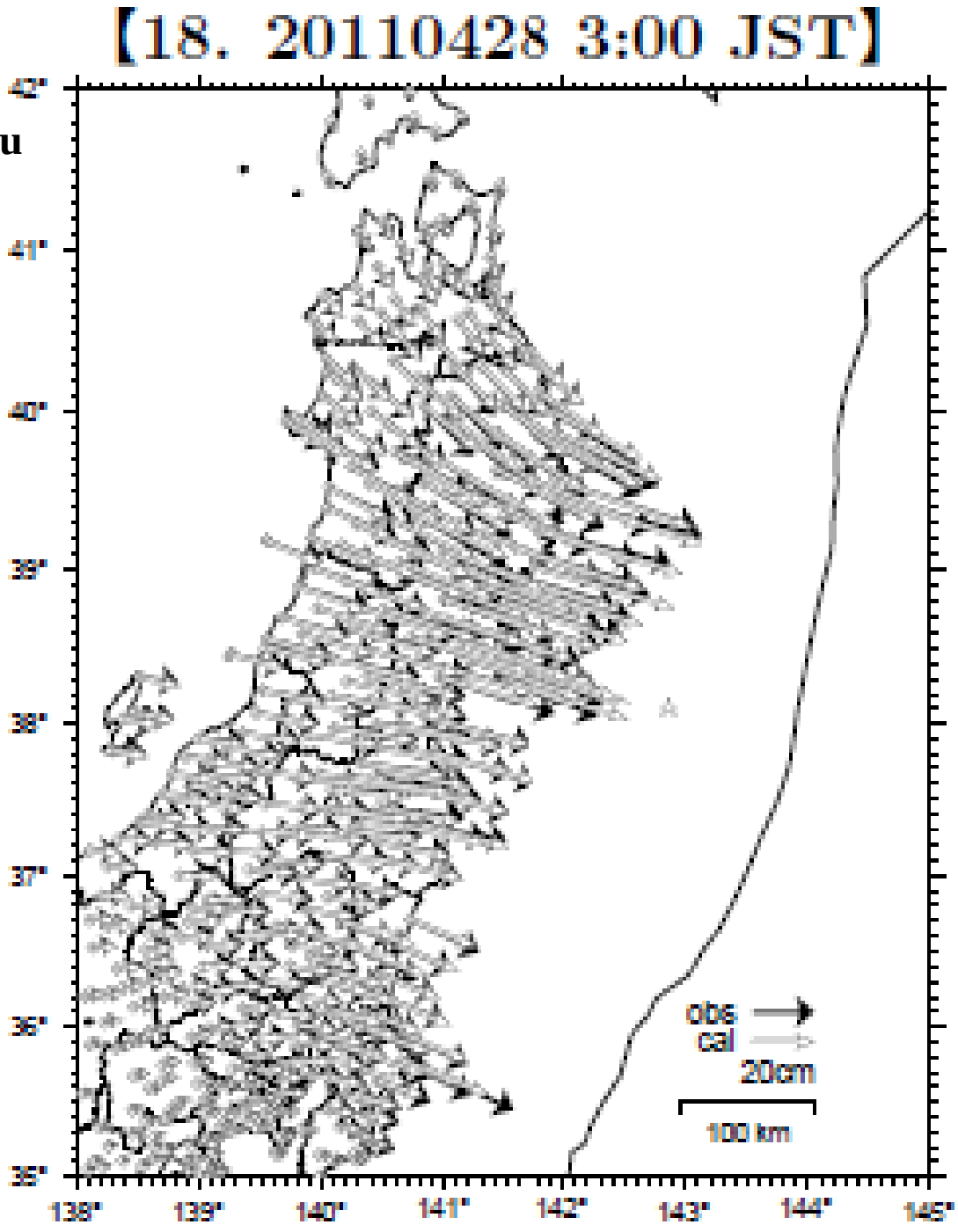
Survey
Static and Moving Survey, Forest Survey, Cadastral Survey etc.

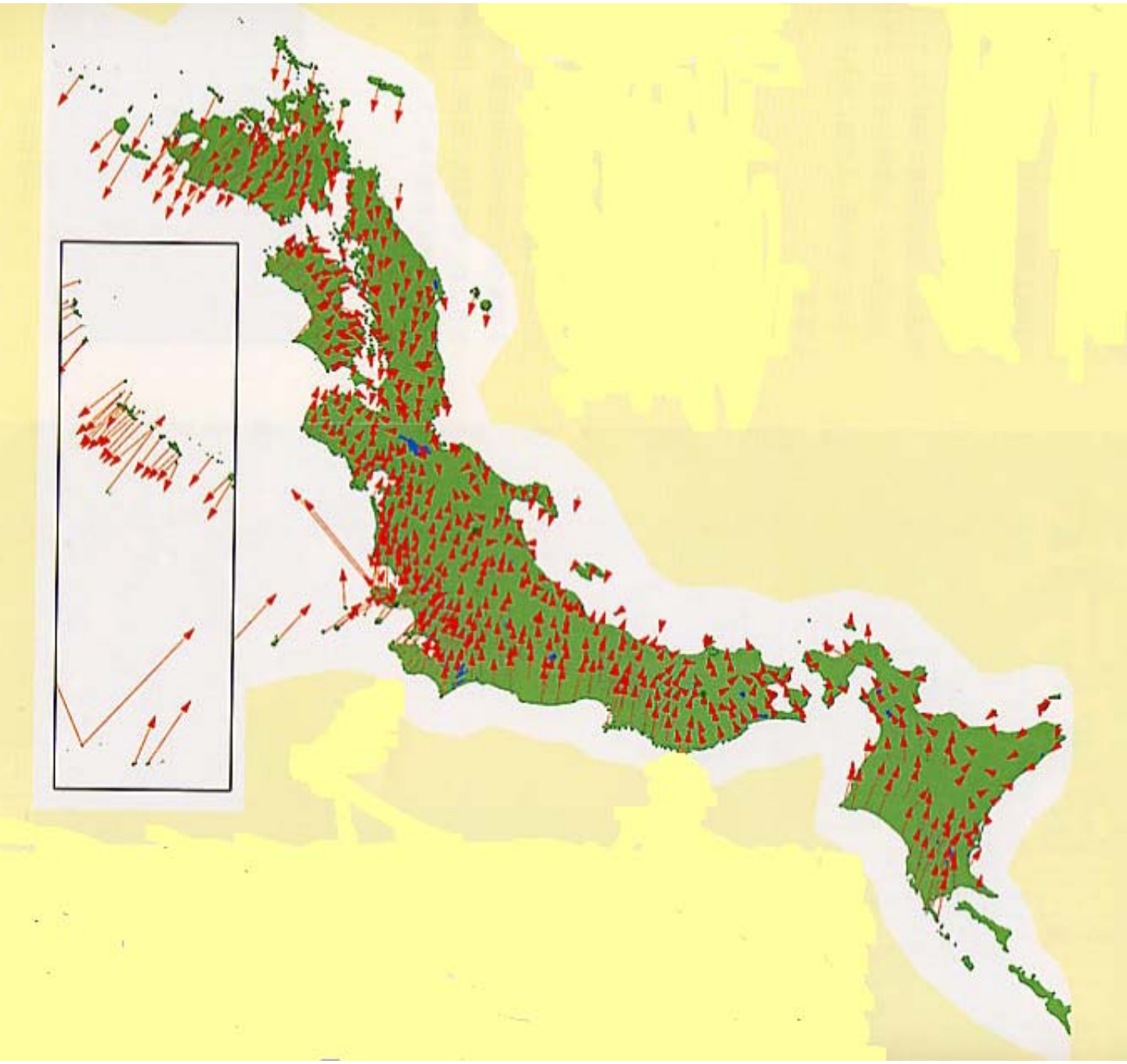
Basic Research
Verification of Basic Performance of the Augmentation

Personal Navigation
Navigation for Disabled and Aged persons, Tourist Navigation etc.


比較期間：2011/03/11 18:00 - 2011/03/11 21:00
km
0
50
2011/3/11 M9.0
530cm（牡鹿）
50cm
比較期間：2011/03/11 18:00 - 2011/03/11 21:00
km
0
50
120cm（牡鹿）
42°
41°
40°
39°
38°
37°
36°
35°
138°
139°
140°
141°
142°
143°
144°

The 2011 off the Pacific coast of Tohoku Earthquake observed and calculated horizontal replacements after the mainshock 2





Acceleration of R&D for GNSS Utilization and Technology

○ Architecture Plans for realization of QZSS by National Budget

"3 QZSS + 4 GEO" or "4 QZSS + 3 GEO" or "5 QZSS + 2 GEO" or ・・・

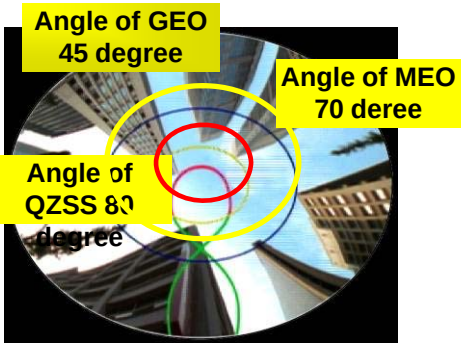
Including SAR Services, PRS and Short Messaging Services

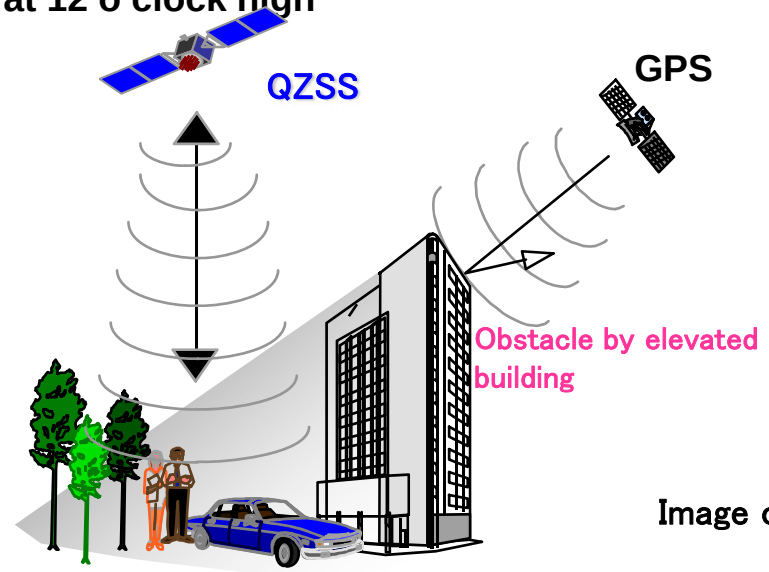
Signals for GPS Complement and Augmentation data by GEONET

○ Governmental Body for QZSS Operation and Service Management

Concept of QZSS

Realization of high-precision positioning services free of multi-pass effects at urban cannons etc to cover entire national land with the constellation visibility close at 12 o'clock high





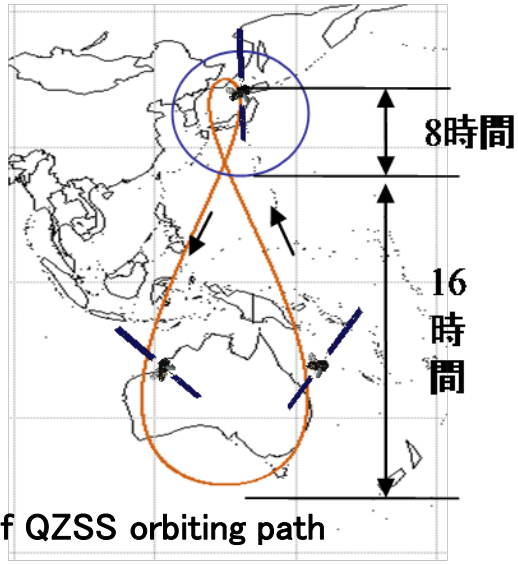


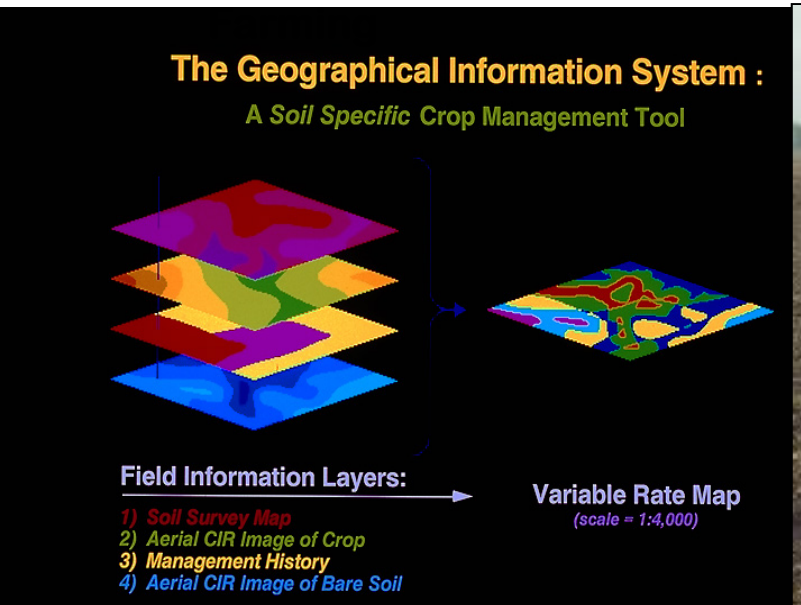
Image of QZSS orbiting path

Major feature is the provision of high precision PNT in entire Japan

Precision Agriculture

- Precision Agriculture addresses -
  - Production of high-quality foods and feeds at a site-specific (individual) optimized use of resources for production
  - Economical and ecological improvements in agricultural production
- Precise Positioning with Satellites are effective

Site Specific



Economical and Ecological Improvements

Mission of IT Automated Driving WG

- **Prove QZSS-LEX corrections effect for Autonomous Vehicle Control**
  - **Evaluate LEX Corrections for Vehicle Control Applications such as Farming and Construction Machines** (Slow Dynamic Vehicles)

- **Evaluation of using QZSS-LEX for vehicle positioning and its precise control**
  - **Geo Spatial Data Maintenance (Field Maintenance)**
  - Un-manned Operation
  - Realize Precision Agriculture using QZSS LEX correction

Planting rise Robot
(Courtesy National Agricultural Research Center)

QZSS Application Verification by Private Companies

Tourist Navigation

A memory card type receiver is used to receive L1 C/A and L1-SAIF signals.

A mobile smartphone shows pin-point location on the application and provides detailed map and contents.

Sub-meter class Augmentation Data L1-SAIF (250 bps)

QZS

GPS

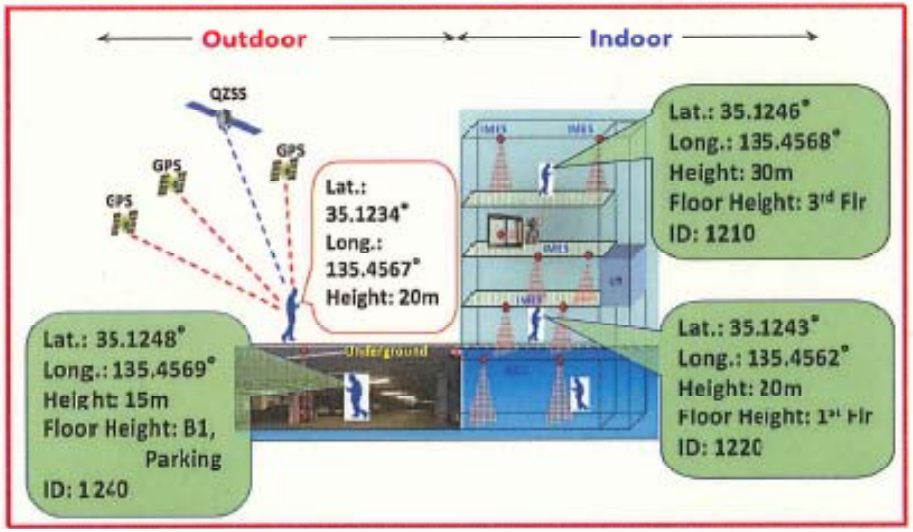
Memory card type L1 C/A, L1-SAIF receiver

What is the IMES ?

- IMES is indoor positioning system applying the same signals from GPS satellites, and is aimed so as to obtain correct position even indoor environment where radio wave from GPS satellites is hardly penetrated.

- A basic idea of IMES is originated from the framework of the Japanese original positioning satellite system, Quasi Zenith Satellite System (QZSS) named "*Michibiki*". IMES transmitters send the positioning information of its location as the message.

Item	IMES	Pseudolite
Pseudo range measurement	No Ranging	Ranging
Synchronization	Not required	Required
Multi-path effect	Nothing	Strong/Unstable
Flexibility of installation	Perfect	Complex
2D positioning	by 1 unit	by 3 units
3D positioning	by 1 unit	by 4 units
Implementation to GNSS receiver	PRN code only	PRN code only



Source : IMES Consortium

IMES CONSORTIUM established on June 23, 2011

- Major activities of IMES Consortium for the time being are as follows:
  - Public relations for broader range deployment and growth of IMES
  - Suggestion and advice on standardization of IMES specifications
  - Guidelines for utilization and installation of IMES
  - Internationalization activities of IMES

Head	Kaoruko Kohtake
Director	Makoto Ishii
	Minoru Saito
	Akihisa Toyooka
	Hiroshi Nishiguchi
	Masaaki Hayashi
	Kenjiro Fujii
	Hiroaki Maeda
Inspector	Hitoshi Kondo
	Satoshi Sugawara
Secretary General	Susumu Yoshitomi
Supervisor	Prof. Jun Murai
	Prof. Ryosuke Shibasaki
	Prof. Saburo Saito
	Prof. Takaaki Hasegawa

Are you looking for a solution for the seamless positioning?

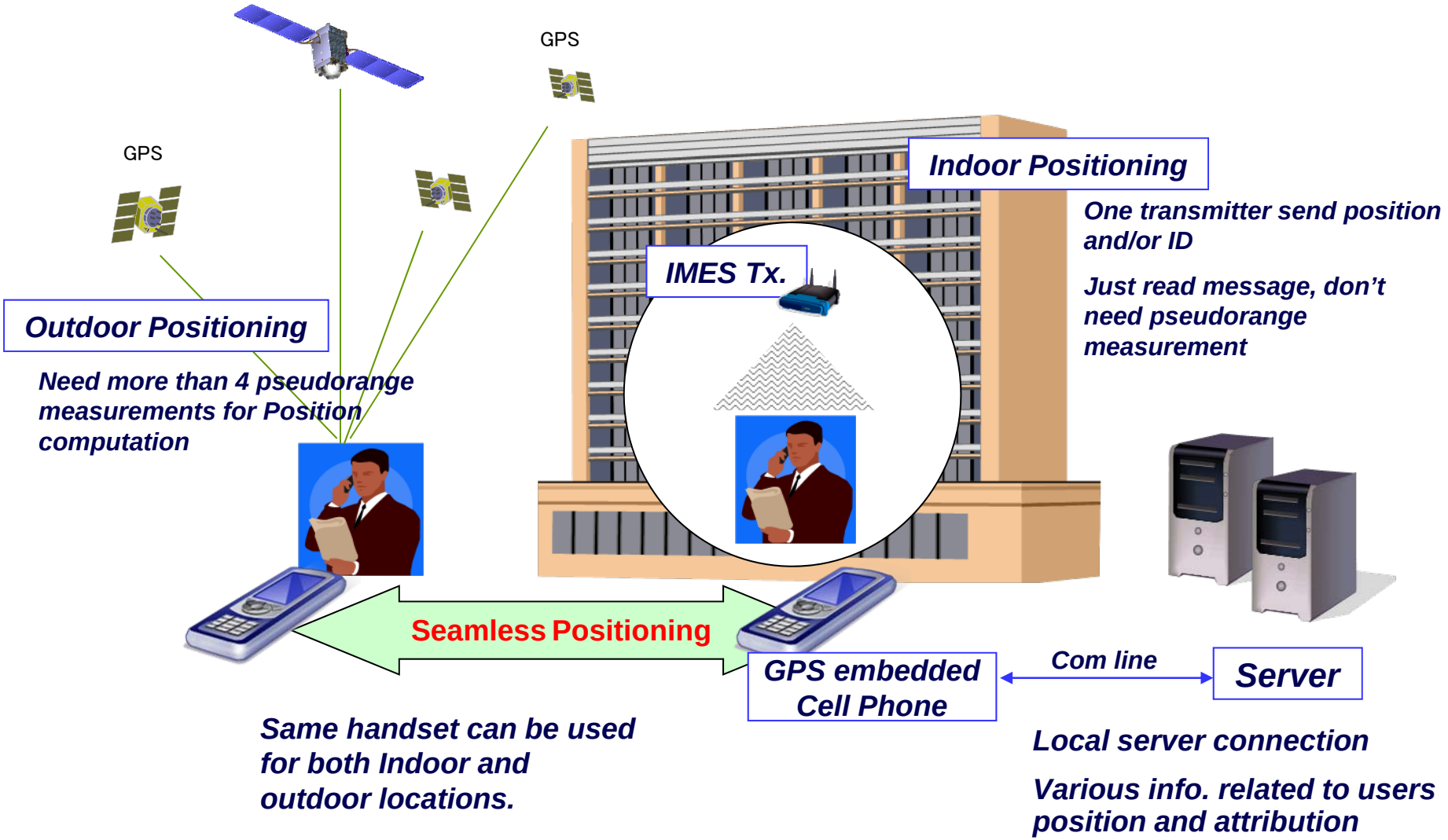
- How many hours do you spend indoor during your daily life?
  - Most people spend their life much longer time indoor than outdoor
- Growing smart phone and LBS market require seamless positioning
  - at any condition
  - at any location
  - at any time

Indoor MEssaging System (IMES) is a powerful solution for realization of seamless positioning.

Concept of IMES

- IMES can transmit its position in three dimensions and/or ID directly
  - No pseudorange measurement and time synchronization.
- Moderate accuracy (10-20m), but stable even in deep indoor.
  - Signal reception area equals to position accuracy.
- Signal is still compatible and interoperable with GPS/QZSS signal for seamless positioning
  - The same GNSS chipset can acquire signals from satellites as well as IMES Tx without serious modifications on existing chipset software. (No change on H/W design)
- Target users are cell-phone, smart-phone and handheld receiver with low dynamics.

Seamless positioning between Indoor and outdoor with common GPS chipset



IMES signal characteristics

Signal Properties of GPS & IMES

	GPS	IMES
Center Frequency	1575.42MHz	1575.42MHz +/- 8.2kHz
PRN ID	1-32	173-182
PRN Code Chip Rate	1.023MHz	1.023MHz
PRN Code Length	1ms	1ms
Data Rate	50bps	50bps
Modulation	BPSK	BPSK
Polarization	RHCP	RHCP

- The power of transmitter is
  - less than defined figure as Japanese radio regulation (-94.35dBW) .
  - set value NOT over specified MAX receiving power strength at the user anntena input.

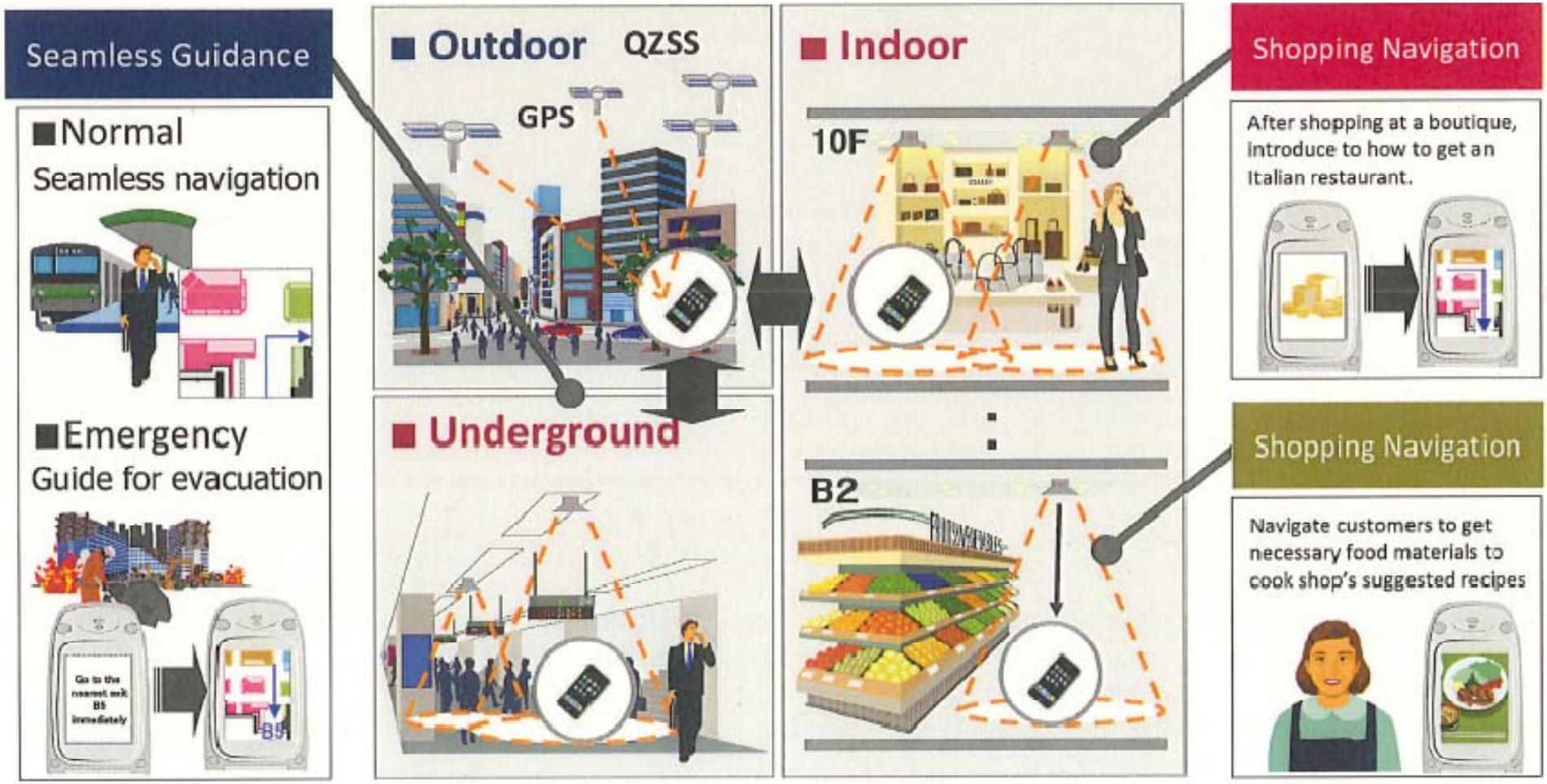
PRN Code for IMES

- 10 PRN Codes in 210 C/A codes which the US GPS maintained its allocation table were assigned for IMES in November 2007
  - http://www.losangeles.af.mil/shared/media/document/AFD-101124-042.pdf

PRN Signal Number	G2 Delay (Chips)	Initial G2 Setting (Octal)	First 10 Chips (Octal)	PRN Allocations	Orbital Slot
173	150	1362	415	QZSS – IMES3	Ground
174	395	1654	123	QZSS – IMES3	Ground
175	345	510	1267	QZSS – IMES3	Ground
176	846	242	1535	QZSS – IMES3	Ground
177	798	1142	635	QZSS – IMES3	Ground
178	992	1017	760	QZSS – IMES3	Ground
179	357	1070	707	QZSS – IMES3	Ground
180	995	501	1276	QZSS – IMES3	Ground
181	877	455	1322	QZSS – IMES3	Ground
182	112	1566	211	QZSS – IMES3	Ground
183	144	215	1562	QZS1	A1
184	476	1003	774	Reserved (QZS	TBD

NOTE: PRN codes are currently allowed to use only in JAPAN.

One solution for a seamless positioning, IMES concept and compatibility with GNSS signals



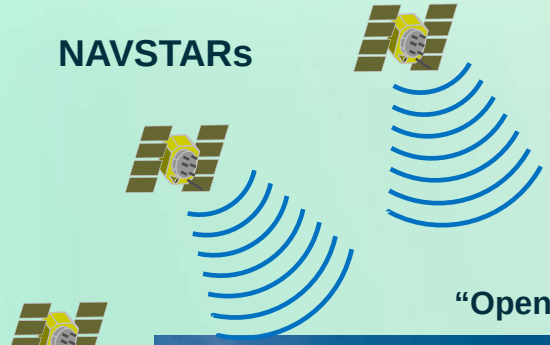
Applications

- Location Based Service
  - Check in service
  - Location based Advertisement.
- Disaster Management, rescue support
  - Evacuation support, and effective rescue underground mall, huge shopping mall complex, department store and so on.
- Provide DR reference point to reset INS sensor.
  - Spot IMES transmitters are installed at revolving doors, elevator halls, entrance doors into room.
- Tracking service for children, asset, entrance control into security area, and more

Avoiding Interference to GPS

- **Compatibility with GPS is Vital for IMES**
  - IMES gets real power when it goes together with GPS, broadcasting signals of the same properties as the pioneer of the global navigation satellite system.
  - IMES has not spared any effort to make sure **not** to give a harmful interference to GPS.

NAVSTARs



Where GPS and IMES meet

IMES will be operated “indoors” including by the window and building entrances. They are where the two positioning systems are expected to work seamlessly.

IMES Transmitters

“Open Sky”

Received Signal Strength:
-158.5dBW
(minimum, as specified in IS-GPS)

“by the Window”

Received Signal Strength:
say, **-165dBW**

“Deep Indoor”

Received Signal Strength:
almost none

Outline of the 6th Meeting of the ICG at Tokyo

Participants is widely increasing;

GNSS Providers : USA, Russia, European Union, China, India, Japan

Associate members :

CGSIC, COSPAR, ESA, EUPOS, FIG, IAG, EUREF, BIPM, IERS, IGS, ITU, IOAG, FAI

Other members :

Indonesia, Italy, Malaysia, Nigeria, South Korea, Thailand, UAE, Vietnam

Next Meeting : 7th ICG : Nov 4-9, 2012 at Beijin, China

8th ICG : Dec, 2013 at Dubai, UAE