

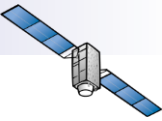


Status Update on the Quasi-Zenith Satellite System

ICG-10

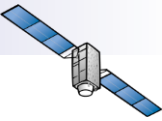
2 November 2015

Office of National Space Policy,
Cabinet Office, Government of Japan



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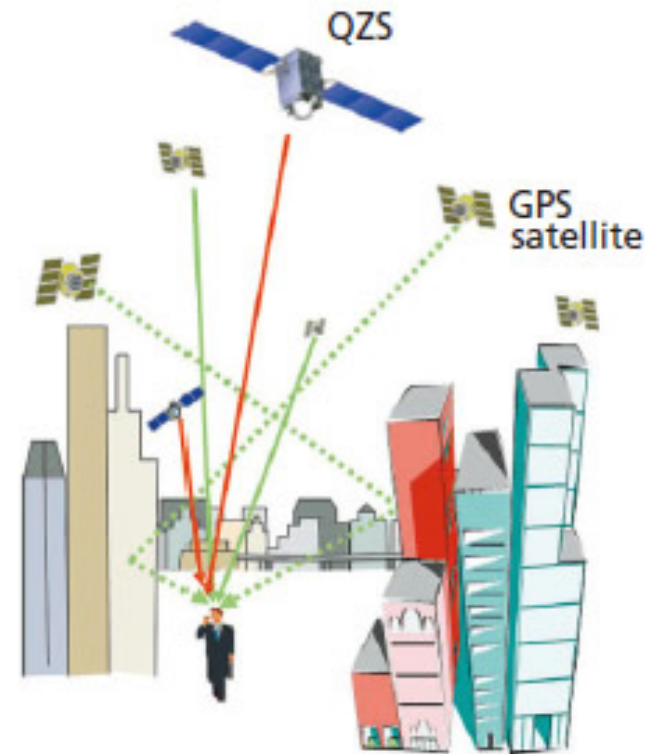
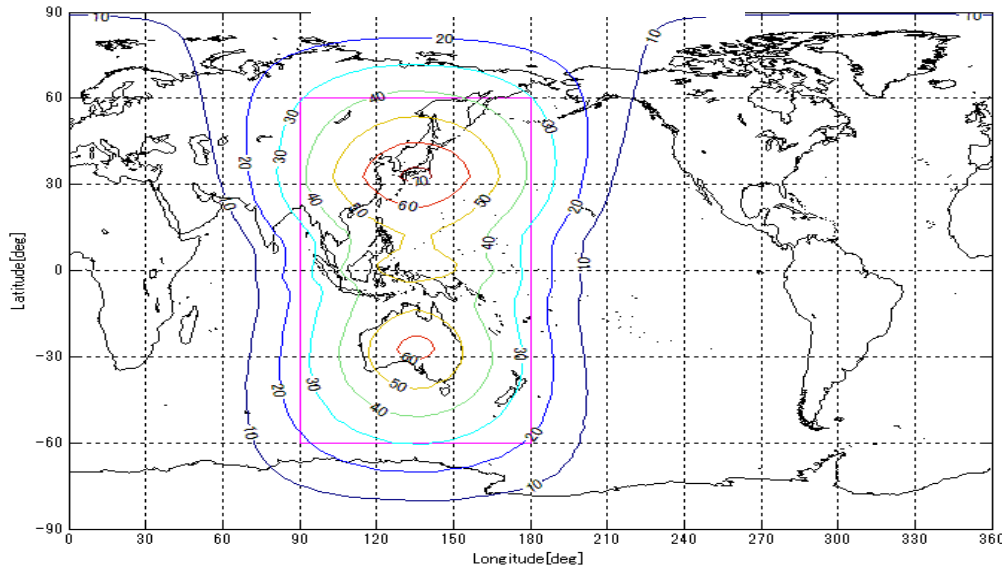


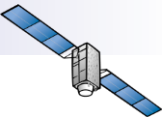
System Overview

■ **Functional Capability:**

- GPS Complementary
- GNSS Augmentation
- Messaging Service

■ **Coverage:** Asia and Pacific region





System Overview

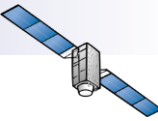
■ Signals:

Signal	1 st Satellite	2 nd -4 th Satellite		Services		Frequency (MHz)
	QZO	QZO	GEO			
L1C/A	○	○	○	Positioning	Complement GPS	1575.42
L1C	○	○	○	Positioning	Complement GPS	
L1S	○	○	○	Augmentation (Sub-meter)		
				Message Service*		
L1Sb	—	—	○	SBAS**	ICAO Standard	
L2C	○	○	○	Positioning	Complement GPS	1227.6
L5	○	○	○	Positioning	Complement GPS	1176.45
L5S	—	○	○	Augmentation Experimental Use		
L6	○	○	○	Augmentation (Centimeter)		1278.75
S-band	—	—	○	Message Service (Safety Confirmation)		2GHz band

* Message service (Satellite Report for Disaster and Crisis Management) is also provided in L1S signal

** SBAS service will operated by MLIT(Ministry of Land, Infrastructure, Transport and Tourism)

System Overview

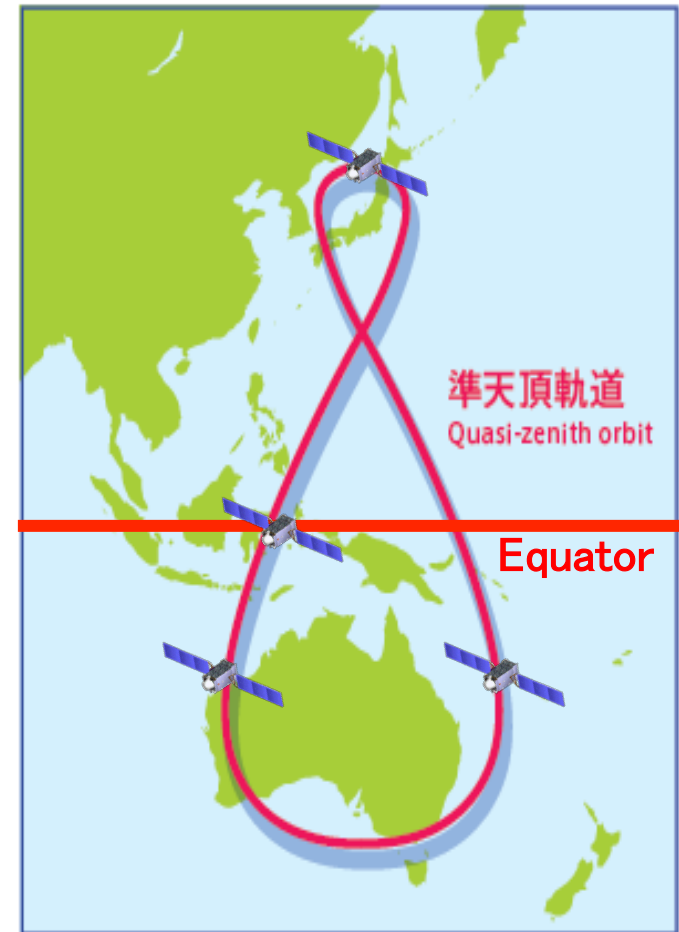


■ Constellation:

- 1 GEO Satellite
- 3 QZO Satellite
 - *First QZSS satellite “MICHIBIKI” launched in 2010.*

■ Ground System

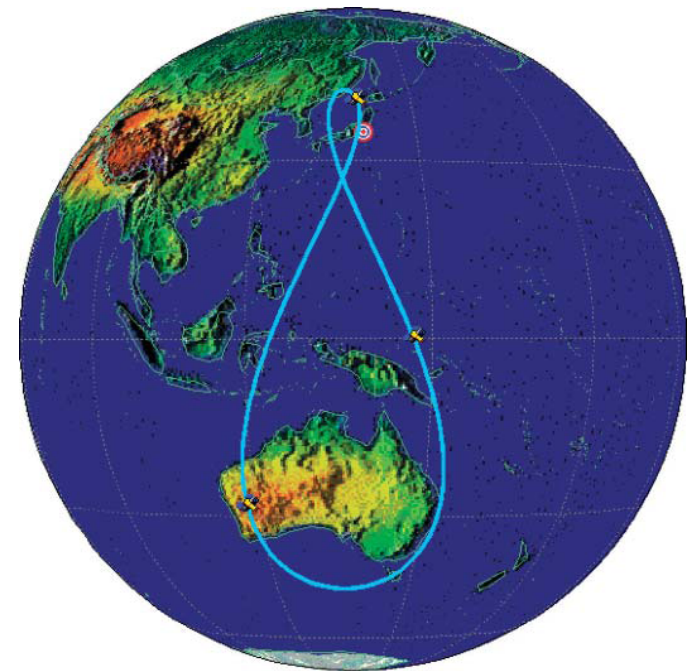
- 2 Master Control Stations
- 7 Satellite Control Stations
- Over 30 Monitor Stations around the world
 - (Including exclusive GPS monitoring use stations)



Basic policy on the implementation of the operational QZSS project (1)

The QZSS will contribute to

- Welfare of the Asia and Pacific region
- Broad range of security including the improvement of the capacity to respond to natural disasters



QZSS Satellite Ground Track

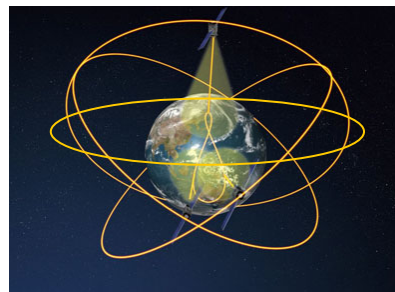
Basic policy on the implementation of the operational QZSS project (2)

- GOJ has decided to accelerate the deployment of the operational QZSS as expeditiously as possible.
- Four satellites constellation shall be established in 2018.
- Seven satellites constellation shall be completed to enable sustainable positioning around 2023 (New Basic Plan on Space Policy).
- Ministry of Land, Infrastructure, Transport and Tourism (MLIT) has decided to continue SBAS* service using QZSS after the MTSAT* retirement.

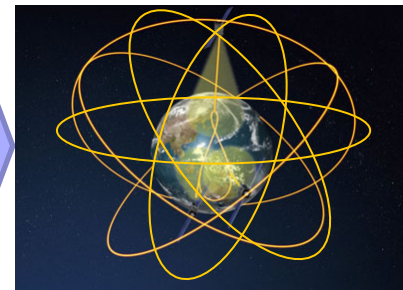
*SBAS: Satellite-based augmentation systems *MTSAT: Multi-functional Transport Satellite



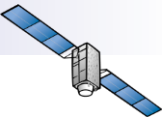
2010
1 QZO



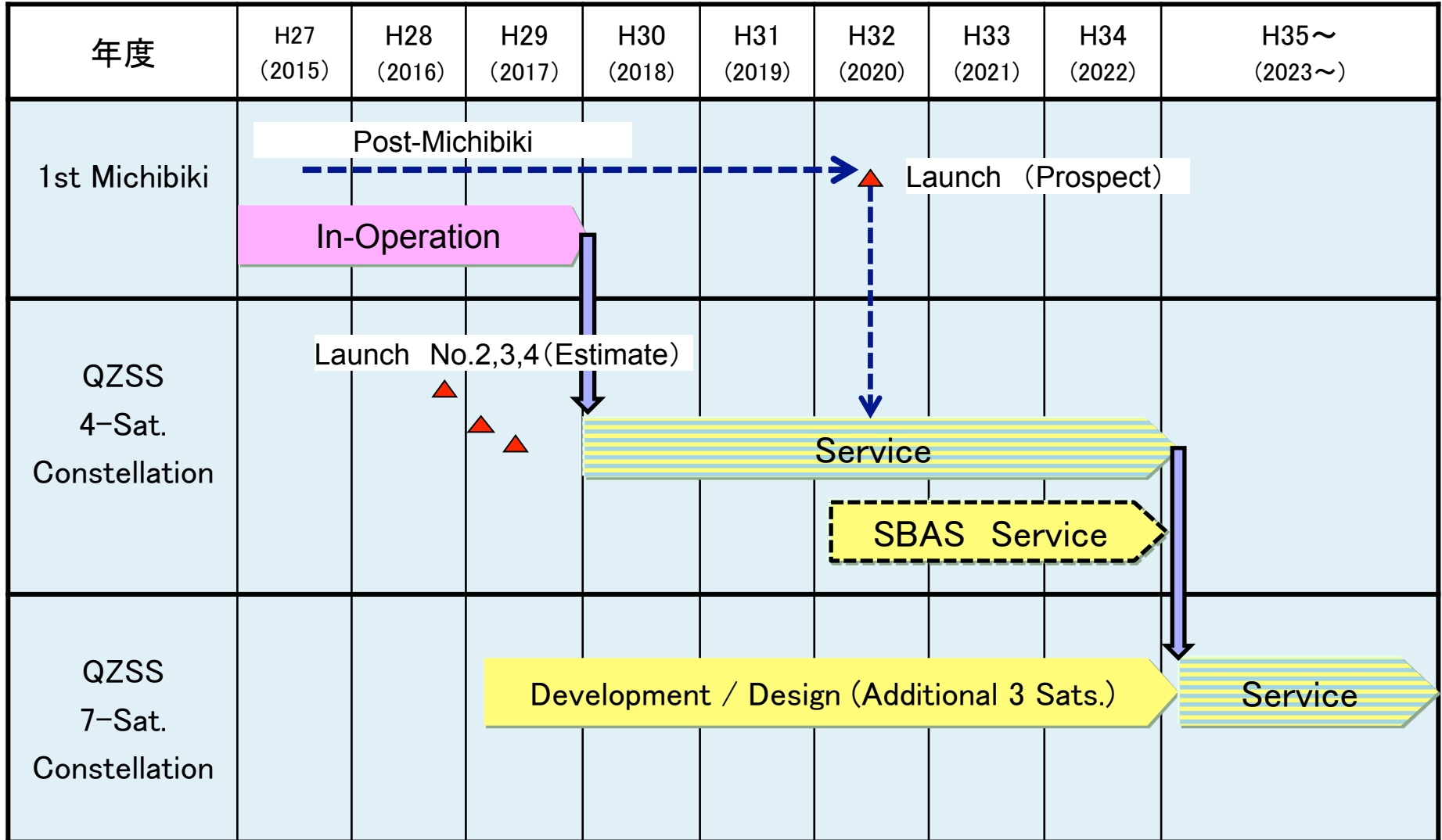
2018
1 GEO, 3 QZOs



in the future
7 satellites constellation



QZSS Program Schedule (latest)



○ In light for changes of environment surrounding space policy, the GOJ establishes a new Basic Plan on Space Policy, which sufficiently reflects the new national security policy shown in the National Security Strategy (NSS) and is a long-term and concrete public investment plan for next 10 years foreseeing coming 20 years, thereby maintaining and strengthening Japan's space industrial basis through improvement of foreseeability of industrial investment.

1. Environmental Awareness surrounding space policy

● Change in balance of power on space policy

- Transformation from the US-Soviet bipolar structure to multi-polarized structure
- Greater number of countries involved in space activities, and a corresponding growth in commercial space market.

● Growing importance of outer space for national security policy

- Necessity to utilize space for the security area proactively based on the National Security Strategy
- Advent of a new era for Japan-US space cooperation

● Growing risks against stable use of outer space

- increased number of space debris and growing threats of ASAT attacks
- necessity to cope with such risks sustainably and ensure stable use of outer space

● Growing importance of the role of outer space to solve global challenges

- Global challenges such as energy, environment, food and natural disasters have come to the forefront and posing severe threats to the international community
- Necessity to contribute to solve global challenges using space systems

● Space industrial basis is at stake

- Industrial basis is essential for conducting space activities autonomously
- Lack of foreseeability of investments led to continuous business withdrawals and stagnated new entries into space industry

● Absence of organic cycles among science & technology, national security and industrial promotion

- Insufficient efforts of R&D in use of space for security purpose and of making the most of outcomes of R&D in civil space areas for industrial promotion.

2. Goals for Space Policy

● Ensuring space security

- ① Ensuring stable use of outer space
- ② Strengthening security capabilities utilizing space
- ③ Strengthening Japan-US alliance through space cooperation

● Promoting use of space in civil area

- ① Utilization of space for tackling with global challenges and realization of safe and affluent society (national resilience)
- ② Creation of new Industries related to space (utilization of geospatial information)

● Maintaining and strengthening industrial and Science & Tech basis

- ① Maintaining and strengthening space industrial basis
- ② Maintaining and strengthening science and technology basis which contributes to realizing outcomes

3. Basic stance for fostering space policy

Giving consideration to shifts in policy environment, the GOJ proceeds space policies based on three guidelines below, putting more emphasis on "ensuring space security" among three-space policy goals.

● Prioritize realization of outcomes from use of space (exit strategy)

- Substantiate and clarify needs for space use for purposes such as security and industrial promotion.
- Sufficiently considering the contribution of space system to the needs specified.

● Prioritize realization of policy outcomes that match with budget allocations

- Set clear goals for outcomes for next ten years for each policy
- Fully enforcing the prior consideration and post implementation assessment. Pursuing maximal policy effects through cycles of demonstration, assessment and improvement.

● Rather than fixing rigid targets for each individual initiative, ensure targets are meaningful and in accordance with shifts in the environment

- Adjust policy targets flexibly in response to changes in the environment and results of examinations of progress status, and introduce new policy measures accordingly.
- Basic Plan on Space Policy consists of 2 parts ("Main Text" & "Implementation Schedule"), with the Schedule revised every year by the Strategic Headquarter for Space Policy.

4. Concrete approach (1) policy framework for realization of goals

Ensuring space security

- Quasi-Zenith Satellite System (QZSS)/ Japan-US cooperation in GNSS
- Space Situational Awareness (SSA)/ Japan-US cooperation in SSA
- Space Debris clean-up technology
- X-band Satellite-Based Communication Network
- Information Gathering Satellite (IGS)
- Small-sized Operationally Responsive Satellites (ORS), early warning, Japan-US cooperation in Maritime Domain Awareness (MDA)
- Advanced optical & radar satellites, data-relay communication satellite

Promoting use of space in civil area

- Geostationary meteorological satellites HIMAWARI
- GOSAT, environmental observation satellites, natural resource exploration satellite
- QZSS, IGS
- Advanced optical & radar satellites, data-relay communication satellite
- Automation, unmanned and labor saving operations through GNSS and geospatial information
- Creation of new industries using satellite remote sensing data as big data

Maintaining and strengthening industrial and Science & Technology basis

- New-type core rocket and Epsilon rocket
- Engineering Test Satellite
- The GOJ steadily takes steps according to the schedule
- Foster public-private efforts to achieve the cumulative market size of 5 trillion yen during 2015-2024 FY.
- Build organic cycles among science & technology, security and industrial promotion through R&D activities by JAXA, public and private institutions based on utilization needs on outer space.

4. Concrete approach (2) concrete initiatives

Implementation guideline for space projects to achieve individual goals

Satellite Positioning

- Establish 7-satellite constellation of QZSS
⇒ begin project of additional 3 satellites around 2017FY, start operation of 7-satellite constellation around 2023FY.

Space Transportation System

- New-type core rocket
⇒ Aim to launch 1st rocket in 2020FY
- Epsilon rocket
⇒ Complete upgrade and begin survey for next steps in 2015FY.
- Launch sites and facilities

Satellite communication and broadcasting

- Next Engineering Test Satellite
⇒ aim to launch it around 2021 FY
- Data-relay communication satellite
⇒ begin project 2015FY, launch it around 2019FY
- Establish 3-unit constellation of X-band Satellite-based communication satellite
⇒ begin project around 2016FY

Space situational awareness (SSA)

- Establish SSA-related facilities and a whole-of-government framework for implementation
⇒ establish it by 2022FY

Space Science and exploration, manned space activities

- Launch 3 mid- & 5 small-sized space crafts in next 10 years in line with roadmap on space science & exploration.
- ISS: Until 2020, cope with 2 HTVs and highly promising technologies for future.
Extension to 2024, consider cost-effectiveness etc. comprehensively, taking trends in other countries etc. into account sufficiently.
- International manned exploration; consider comprehensively from diplomatic, industrial, and cost-effectiveness perspectives, taking trends in other countries etc. into account sufficiently.

Satellite Remote Sensing

- Augmentation in functions and increase in numbers of IGS
- Survey related to small-sized ORS
- Advanced optical satellites
⇒ begin project around 2015FY, start operation around 2019FY
- Advanced optical satellites (successor model)
⇒ begin project around 2022FY, start operation around 2026FY
- Advanced Radar satellites
⇒ begin project around 2016FY, start operation around 2020FY
- Advanced Radar satellites (successor model)
⇒ begin project around 2023FY, start operation around 2027FY
- HIMAWARI 8 ⇒ start operation 2015FY's summer
- HIMAWARI 9 ⇒ start operation around 2022FY
- HIMAWARI Successor models
⇒ begin project around 2023FY, start operation around 2029FY
- GOSAT2 ⇒ Launch it around 2017FY
- GOSAT3 ⇒ begin project around 2017FY, aim to launch in 2022FY

Maritime domain awareness

Early warning functions

Improvement of resiliency of Japan's whole space systems

Enhancement of industrial and S&T bases to individual projects

Comprehensive initiatives aimed at encouraging new entries and expanding use of space

- Law on space activities and law on satellite remote sensing
⇒ aim to propose the bills to the Diet in early 2016

Consolidation of Environment for steady supplies of essential parts and components for space systems

- Formulate a strategy on parts & components and reflect it to relevant plans
- In-orbit demonstration experiments

Efforts for looking ahead the future of increasing use of space

- Implementation of leading social demonstrations on cutting-edge space utilization taking the occasion of the 2020 Tokyo Olympics and Paralympics.
- Demonstration experiments of LNG propulsion system, research and development of reusable space transportation system, space-based solar power system, etc.

Enhancement of policy framework and institutions for space development and utilization in general

Comprehensive enhancement of policy implementation frameworks

Strengthening of survey, analysis and strategy formulation functions

Enhancement of domestic human resources and promotion of public understanding

Establishment of legal institutions (law on space activities and remote sensing)

Advancement of space-diplomacy and strengthening overseas development strategies

Realization and strengthening of rule of law in outer space

Strengthening international cooperation

- US, Europe, Australia, ASEAN etc

Establish "Taskforce on Space-system overseas development" (provisional name)

- Establish a framework for joint public-private efforts to expand presence in international commercial space market

New economic growth utilizing space infrastructure

- Fusion of space infrastructure, big data and IoT -

Automatic Operation of Farm Equipments

Automated Operation of Farm Equipment and Sophisticated Production Management, utilizing remote-sensing satellites, will be introduced to inefficient large-scale farm, in order to address problems such as low self-sufficiency in food and the shortage of farm operators.



Intelligent Transport System (ITS)

Vehicle stability control, like lane keeping and changing, will be possible thanks to QZS high-accuracy positioning information.



Source: denso

Precision Forestry

Precision Forestry will be expanded widely throughout Japan and overseas, combining cloud services with automatic forest assessments and production management skills utilizing remote-sensing satellites.



Electronic Toll Collection (ETC)

A road pricing system, based on the accurate positioning information from QZSS, will be established in order to achieve a free-flow gateless system.



Logistics

A reciprocal unmanned freight transport system will be implemented between the main islands and remote ones.



Source: YAMAHA

Delivery

The delivery service will be capable of making deliveries to non-fixed address, such as locations inside of a park.

Disaster Prevention

Disaster information will be provided by a built-in electronic message board for vending machines, utilizing Satellite Reports for Disaster and Crisis Management. In addition, beverages will be offered free of charge through vending machines in the case of a disaster.



Sightseeing

Pilgrimages to tourist hotspots peculiar to Japanese Animation is recently on the rise. That is why, a system will be expanded, in which animation fans will be able to take pictures with a certain character using augmented reality when they go to the particular locations, and obtain limited goods.



Source: khara, Inc.

Watching service for elderly person and kids

An environment, which relatives watch their elderly parents or children at any time of night or day, will be provided by the fusion of QZS high-accuracy positioning technology and geospatial information.



Source: MHLW

Society's infrastructure

The operation and maintenance services for society's infrastructure including bridges and expressways will be provided by utilizing QZS high-accuracy positioning technology.



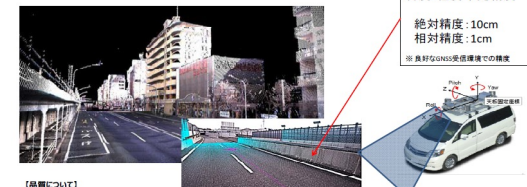
Railway

QZSS will be applied to operation support systems security systems, such as car-body tilting and radio-based train controls, through high-accuracy positioning technology in the railway sector.



Sophistication of MAP

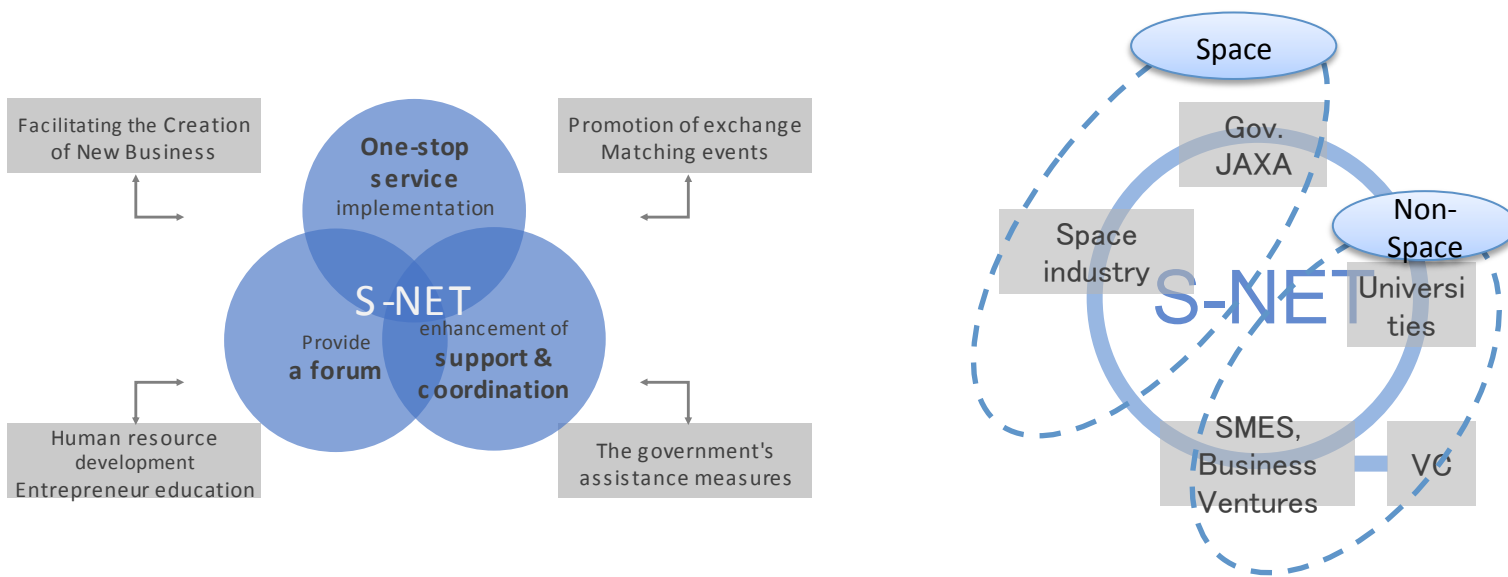
- From Conventional 2D map to 3D spatial map -

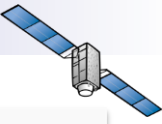


Source: Mitsubishi Electric Corporation

Space New Economy Network (S-NET)

- Creating network which enables any entities that have interests in utilizing and developing the space to interact with each other. Some finance institutions will be involved.
- The network involves the value-chain, such as start-ups, business ventures and SMEs that wish to utilize the space as potential business tools.
- Executive office shall be established at Office of National Space Policy, Cabinet Office. It will be functioned as coordinators and facilitators in collaboration with related Ministries and participants.
- S-NET welcomes International partners regarding space business.



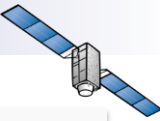


Functional Capability 1 *GPS Complementary*

QZSS improves positioning availability time

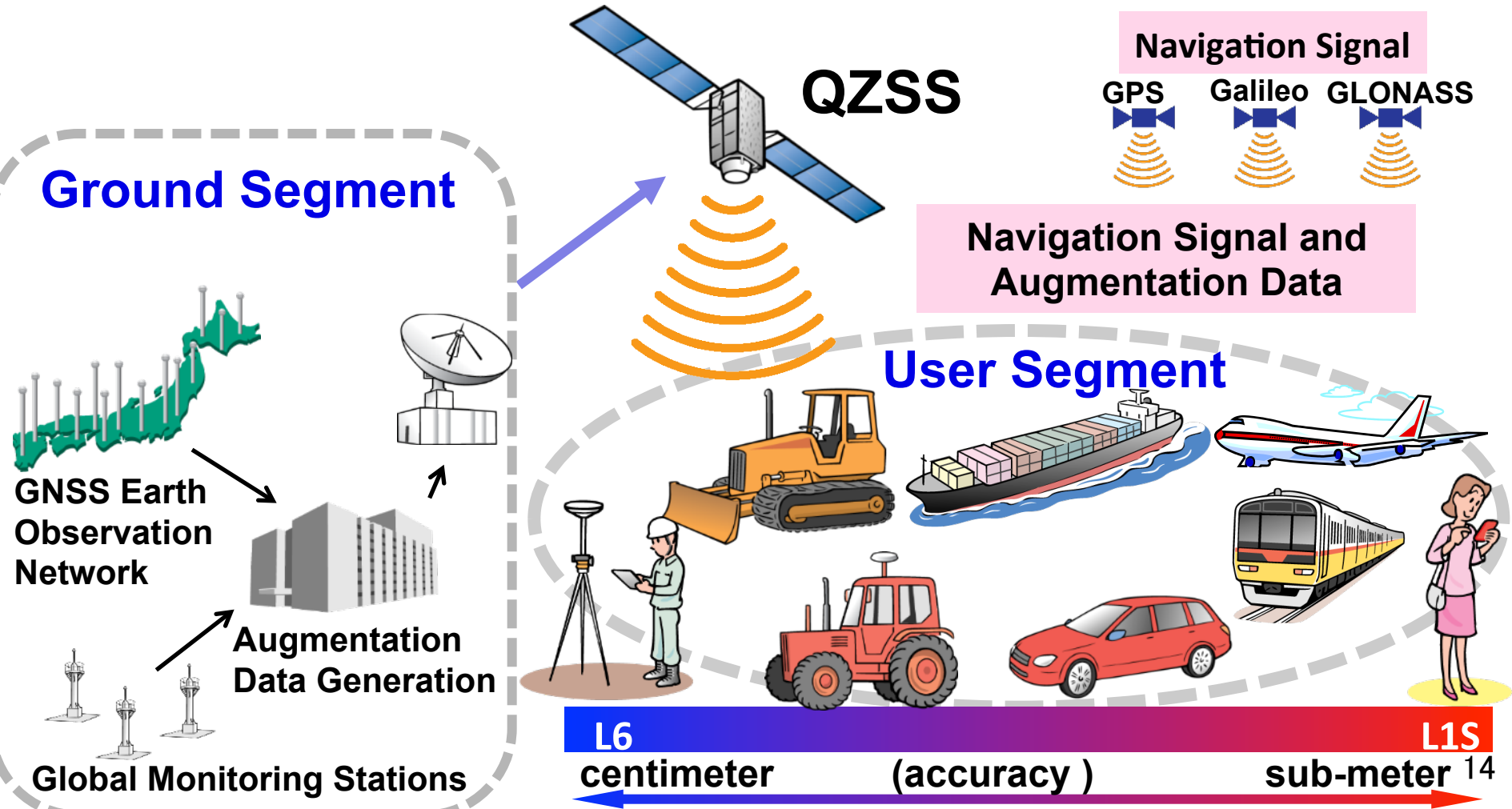
Navigation signals L1-C/A, L1C, L2C, and L5 sent from high elevation will improve the time percentage of positioning availability.

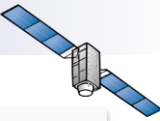




Functional Capability 2 GNSS Augmentation

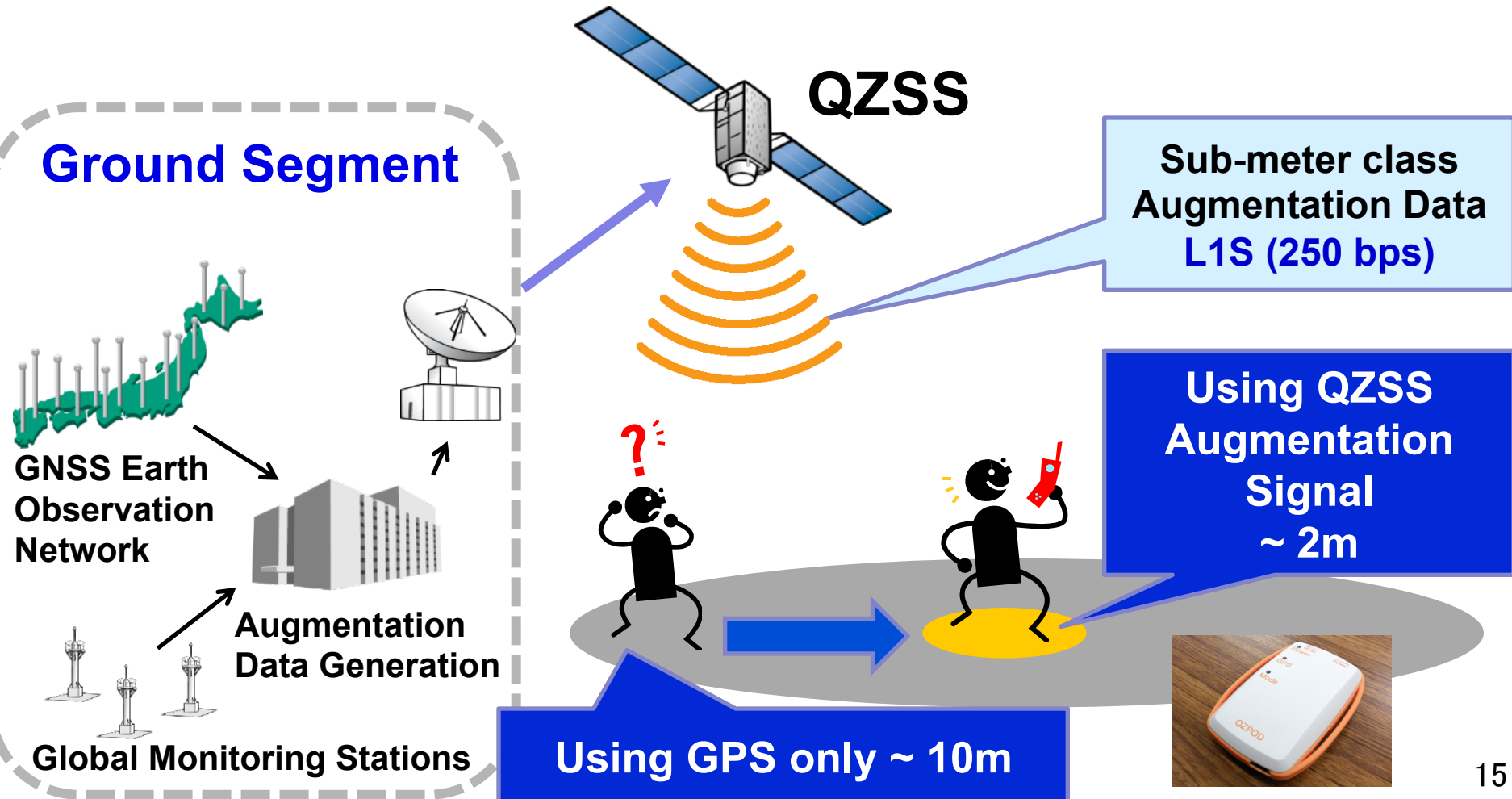
QZSS improves positioning accuracy and reliability

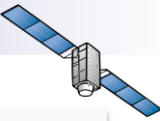




Functional Capability 2 GNSS Augmentation

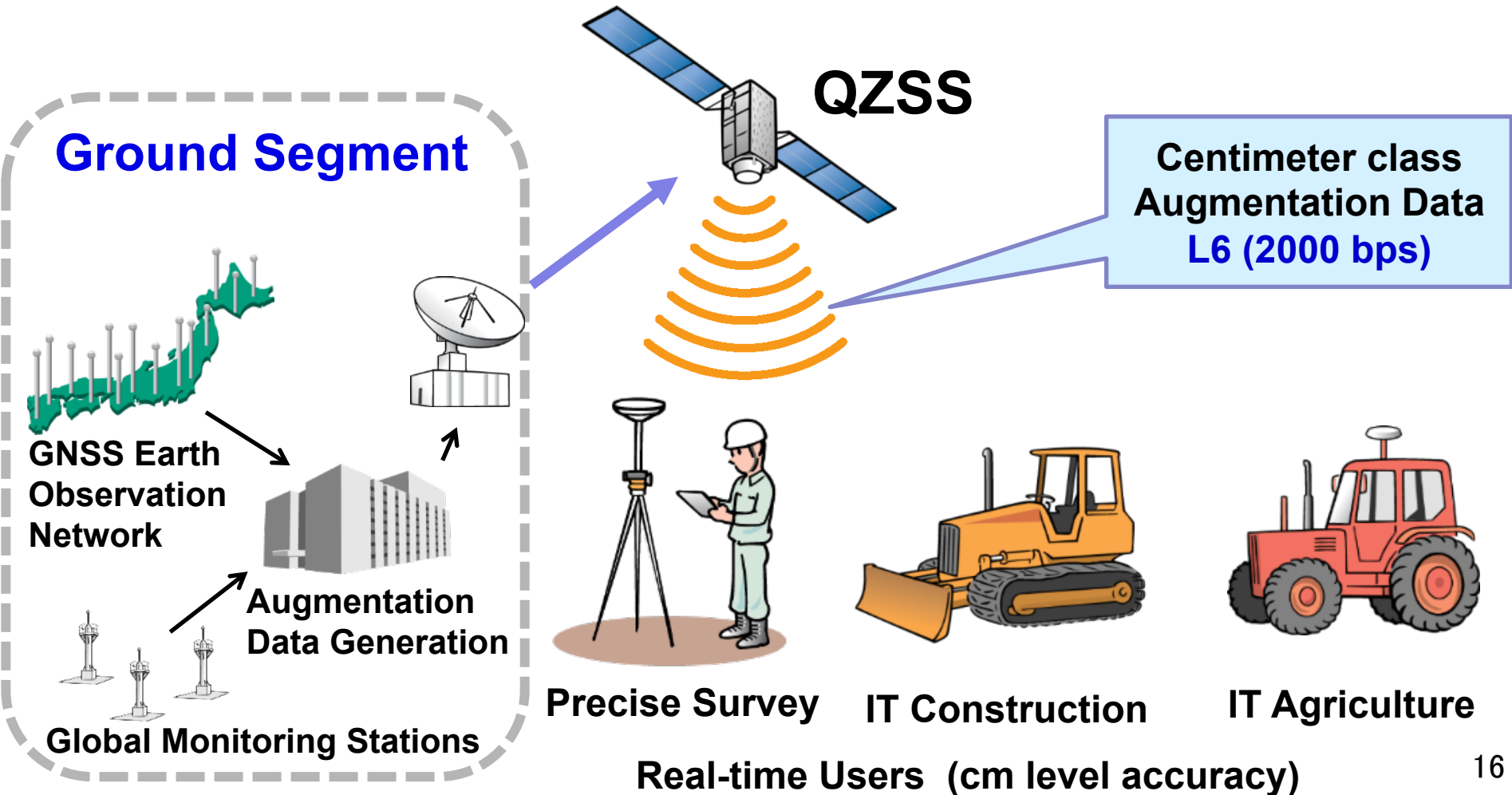
Sub-meter Class Augmentation

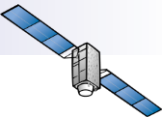




Functional Capability 2 GNSS Augmentation

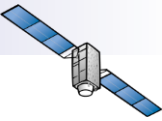
Centimeter Class Augmentation





Summary

- **System development is on schedule.**
 - **Four satellite constellation and corresponding ground system shall be established and the service will start in April, 2018.**
 - **In addition, seven satellites constellation services will start around 2023. (New Basic Plan on Space Policy)**
- **Feasibility Study and Experimental project which promote the future applications by the potential users are in progress under the New Basic Plan on Space policy.**



Thank you for your kind attention!

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