

QZSS Industrial Utilization Work Shop

Activities for Utilization of QZSS

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Electronic Systems Group
Mitsubishi Electric Corporation
(MELCO)

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1. Overview

Mitsubishi Electric Corporation (MELCO)

MELCO, one of the long-established & blue-chip company (founded in 1921), is world's leading manufacturer of electronic products and systems in a broad range of fields, automotive equipment, factory automation systems etc. Over the past four decades, we have been involved in many satellite projects for telecom operators, government agencies, and other large-scale clients.

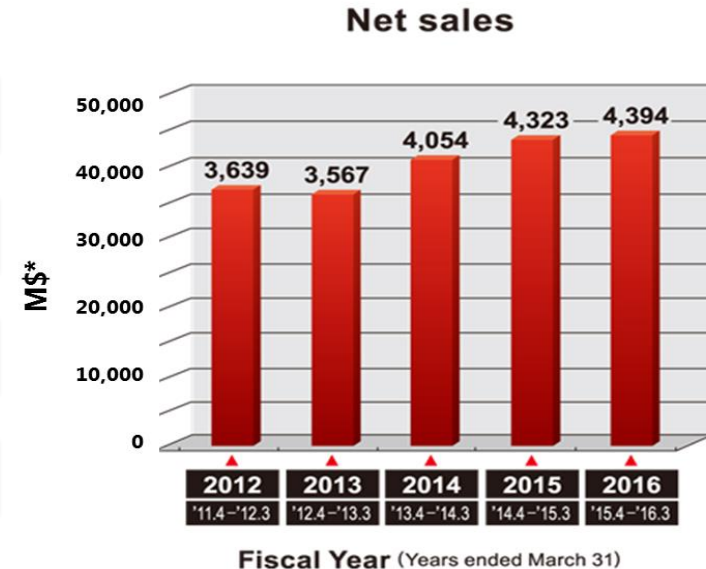
President & CEO : Masaki SAKUYAMA

Head Quarters : Tokyo, JAPAN

Net Sales : ¥4,239 billion

Employee : 138,700*

* Inclusive employees of consolidated subsidiaries



Corporate Organization

As of Apr. 1, 2016



Electronic Systems Group



Communication

- MELCO established strategic standard GEO platform "DS2000"
- Chosen as the prime contractor for
 - E's hail-2(Qatar)
 - Türksat-4A/4B (Turkey)
 - ST-2 (Singapore/Taiwan)
 - Superbird C2 (Japan) ...and others.



Earth Observation

- Earth Observation from LEO using optical or SAR sensors
- Chosen as the prime contractor for
 - GOSAT : greenhouse gases monitoring
 - ALOS-2: disaster surveillance
 - "Himawari 7/8/9": meteorological
 ...and others.



Navigation

- 4QZSs, 24hrs service, will start from 2018, 7QZSs, self-contained navigation service, will start from 2023
- Chosen as the prime contractor for
 - 1st QZS(Michibiki)
 - 2nd-4th QZS



Space Exploration

- Astronomy using space telescope, VLBI etc.



- Ground based telescopes



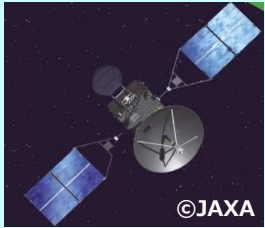
- H-II Transfer Vehicle(HTV)



In Orbit Records and Back-logs

Over 15 spacecraft In Orbit

In Orbit



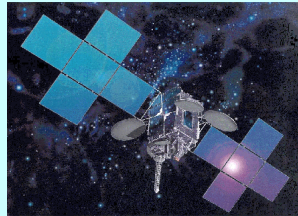
DRTS : GEO
Data Transfer
since 2002



SOLAR-B : LEO
Science
since 2006



HTV #1/#2/#3/#4
Transfer Vehicle
(2009, 2011, 2012, 2013)



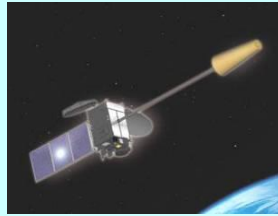
OPTUS C1 : GEO
Communication
since 2003



GOSAT : LEO
CO₂ Monitoring
Since 2009



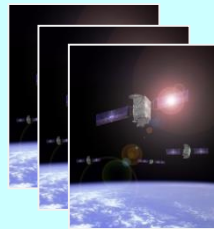
ALOS-2 : LEO
SAR Observation
since 2014



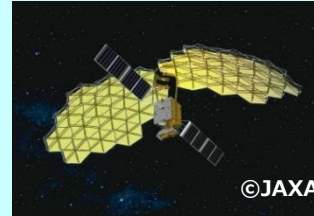
MTSAT-2 : GEO
Meteorology
since 2006



ST-2 : GEO
Hi- power
Communications
since 2011



QZS #2/#3/#4
HEO & GEO, GPS
Since 2017



ETS-VIII : GEO
Communication
since 2006



TURKSAT-4A/B : GEO
Hi- Power
Communications
since 2014/2015



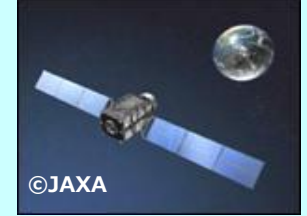
Es'hail 2: GEO
Hi- Power
Communications



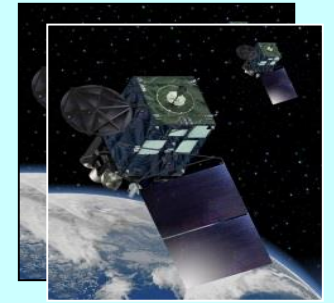
SB-C2 : GEO
Communication
since 2008



HTV#5/#6/#7
Transfer
Vehicle



QZS#1 : HEO
Navigation
since 2010



Himawari-8/9: GEO
Meteorology
Since 2014/2016



GOSAT-2 : LEO
CO₂ monitoring

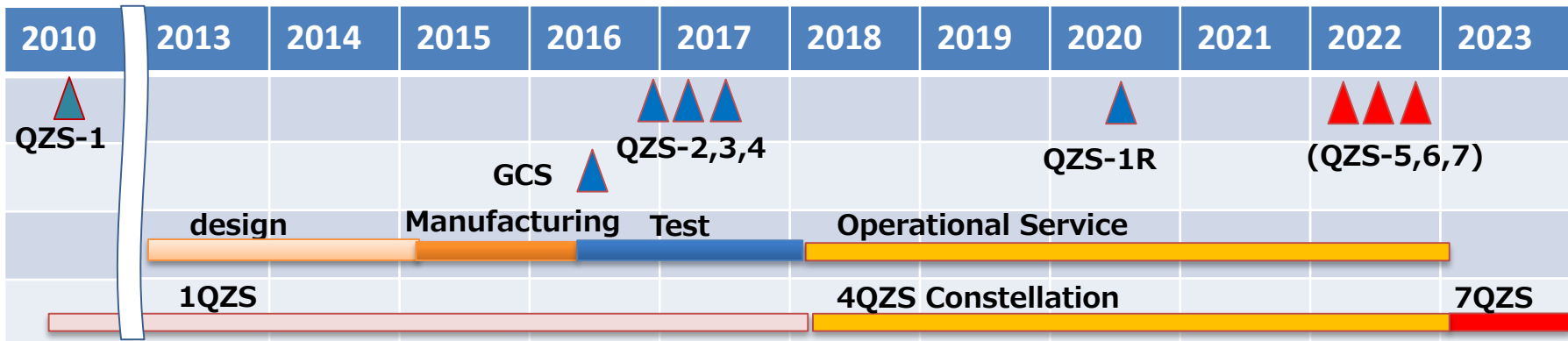
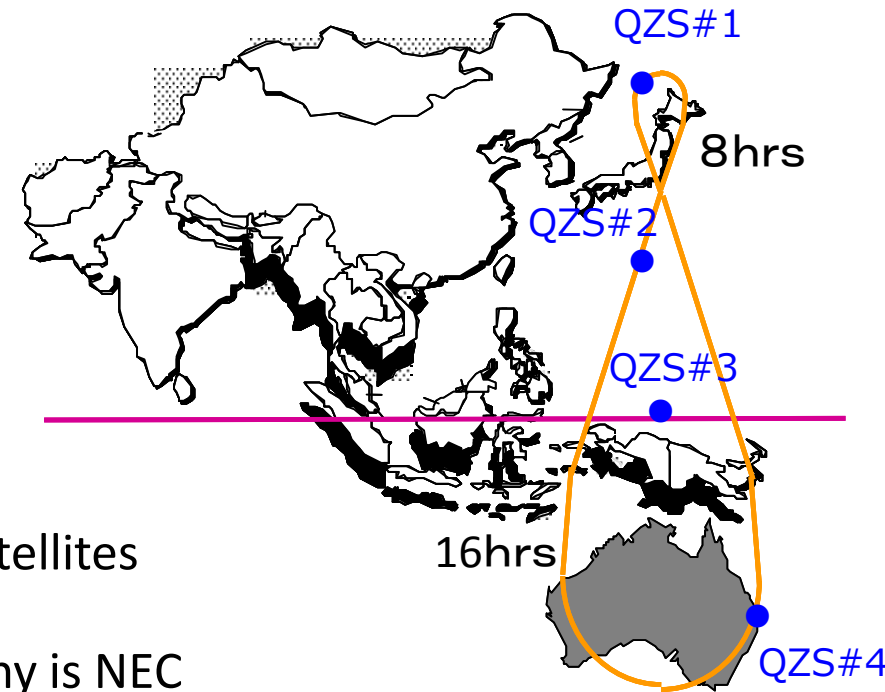
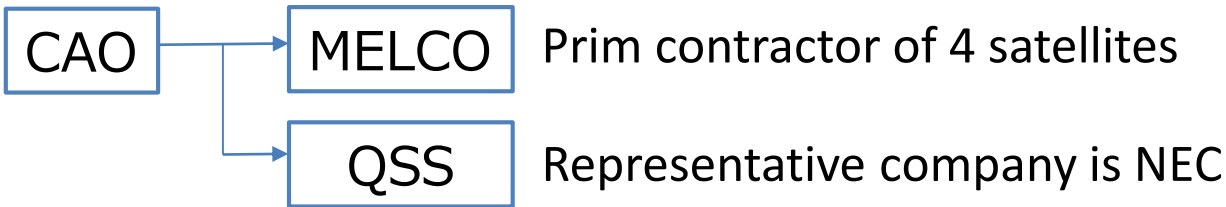
Back-log

2. QZSS and CLAS

Roles of MELCO in QZSS Program

- Four-satellite constellation for 24hr service will be established in FY2018
- Roles of MELCO in QZSS program
 - Prim contractor of 4-satellites
 - Member of PFI company, QSS *, for development of QZSS ground control system and QZS operation

*QSS : QZS System Services Inc.



Roles of MELCO in QZSS Program

■ QZS#2、#3、#4

- MELCO has developed QZS#2/#3/#4 and IOT has completed
- Under final tuning of Navigation Signal



QZS#2
Launch 1st, June



QZS#3
Launch 19th, August



QZS#4
Launch 10th, October

■ QZSS Ground Control Systems

- MELCO developed following Operation Centers

➤ 2 Main Control Station(MCS)

- Hitachiohota
- Kobe

➤ 7 Tracking Stations

- Okinawa, Ishigaki, Miyako,



Ishigaki



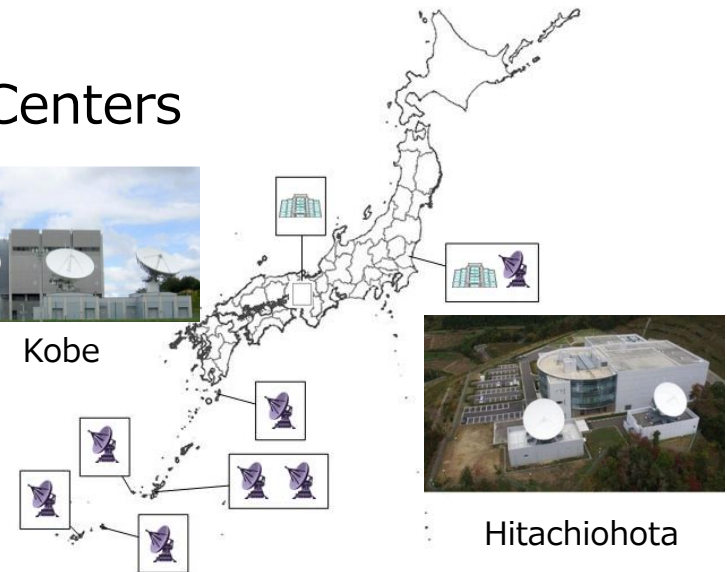
Miyako



Kume



Kobe

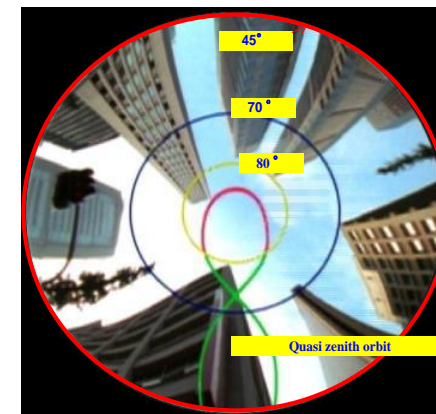
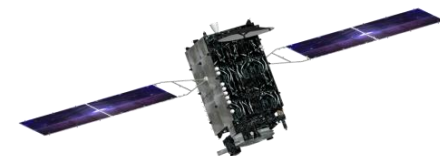
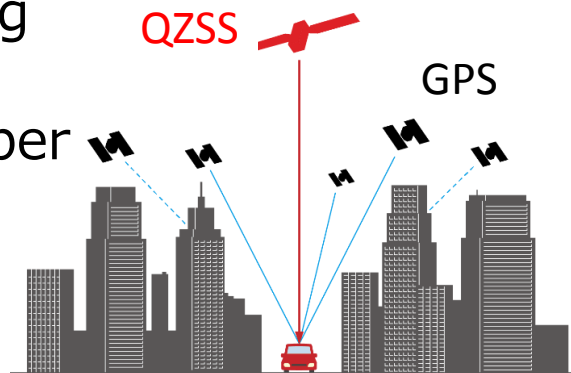


Hitachiohota

Major Services of QZSS

■ GPS Complementary

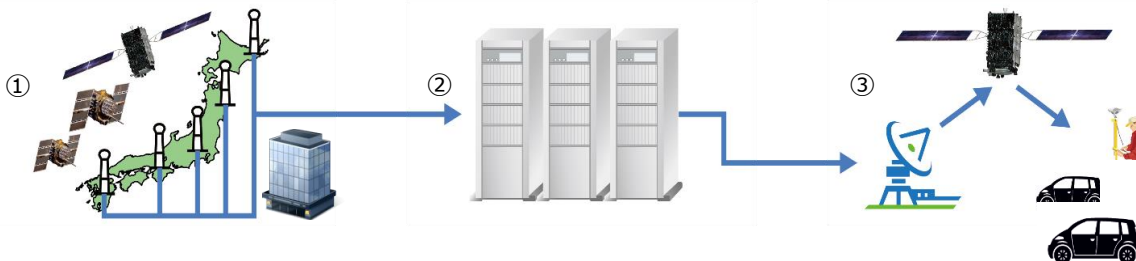
- Enhance positioning signal availability
- Transmission of positioning signal compatible of GPS
- Improvement of the number of visible GPS satellites



High Elevation

■ Positioning Augmentation

- Provide cm level high precision 3D positioning

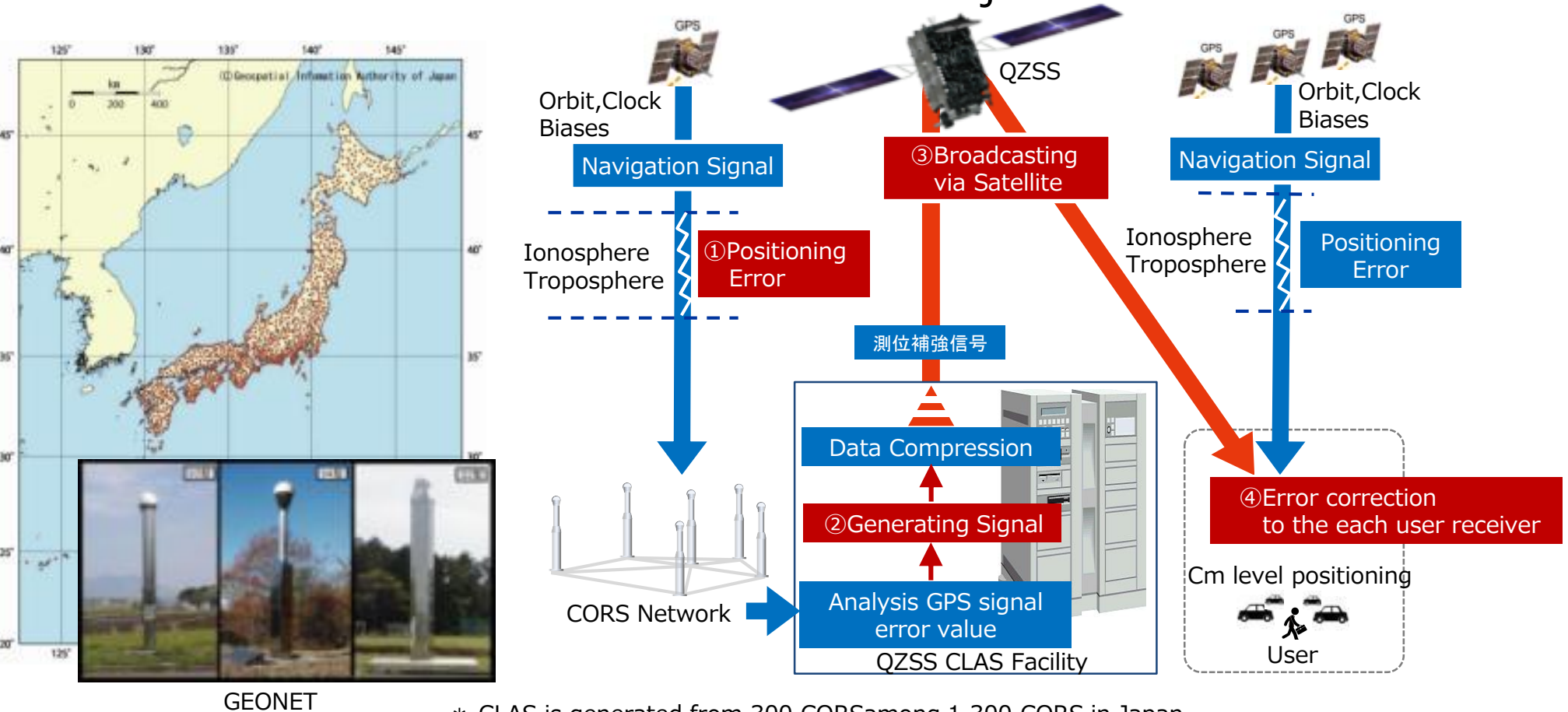


- MELCO has responsibility to generate and provide signal for CLAS *
- Transmission of augmentation signal from QZSS to all over Japan
- Improvement of GPS/GNSS positioning accuracy

* CLAS: Cm(Centi-meter) Level Augmentation Service

How CLAS signal is generated

- In Japan, there are more than 1,300* Continuously Operating Reference Stations (CORS). On each station, Multi-GNSS receiver is continuously tracking the signals from GPS, QZSS and Galileo satellites
- The signals monitored in CORS are processed in QZSS CLAS Facility to determine the correction data for each major error sources in real-time



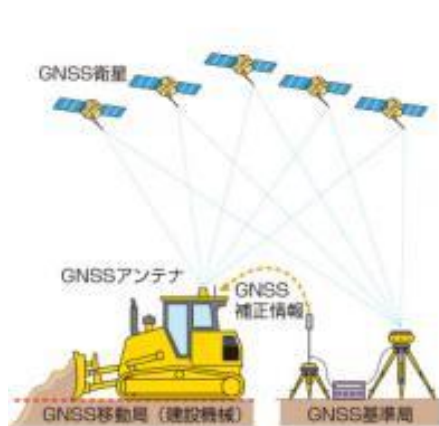
Features of CLAS broadcasted from QZSS

- Augmentation Service realizing Centimeter-level positioning in Japan
- Broadcasted 24 hours from QZSS free of charge (in Japan)
- Equivalent in accuracy as RTK-GNSS and can be used broadly

In general : Data transmission on ground

RTK - GNSS

- Local CORS and data transmission equipment
- Radio-wave license



Network RTK(VRS)

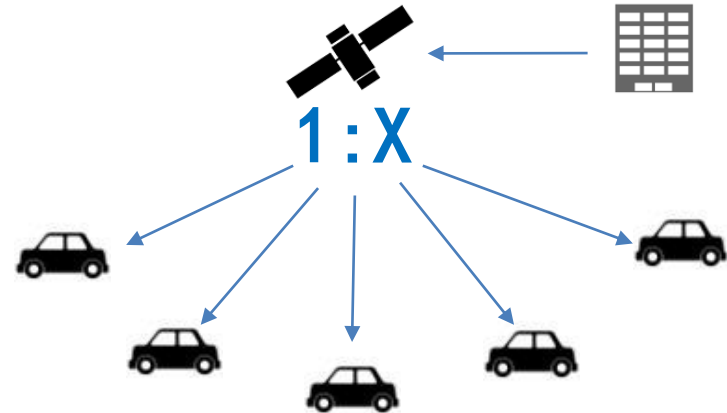
- On ground data transmission via network
- Contract with providers



1:1

CLAS : Broadcasted from satellite

- Broadcasted from high elevation
- Can be used by large amount of users



RTK : Real Time Kinematic
GNSS : Global Navigation Satellite System
VRS : Virtual Reference Station

Various Applications using CLAS

- Utilization of cm level high precision 3D positioning has potential to create new innovative services and new industries that contribute creation of “Smart Society”

Construction



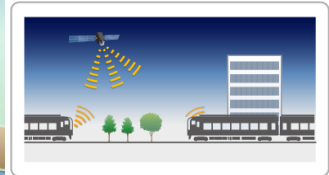
Agriculture



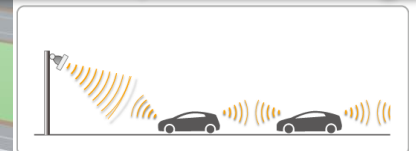
Marine Observation



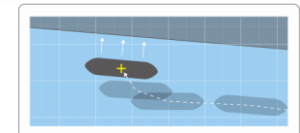
Train Control



Automated/Safe Driving



Ship Control



3. Realization of Society using High Precision Positioning

3 Core Elements to Realize Society using High-Precision Positioning

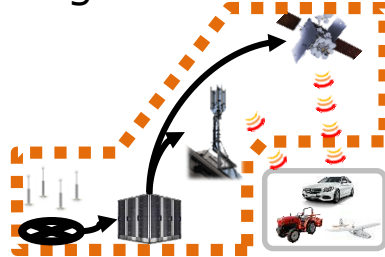
cm-level High-Precision Positioning Infrastructure

Generation and distribution of CM-level high-precision positioning correction data

Quasi-Zenith Satellite System (QZSS)



Japan:
Governmental project (CLAS) from 2018



Global:
-Sapcorda Services GmbH
-Interoperable with CLAS

High-Precision 3D Map

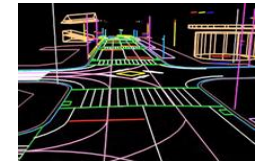
- Dynamic map data platform for automated driving
- Automated mapping, Extraction of transition



DMP commercialization
June 2017



Detachable MMS



Automated Mapping

Realization of highly precise positioning by correction data from CM-level High-Precision Positioning Infrastructure



Industrial use



High precision locator for vehicles

High-Precision Positioning GNSS Receivers

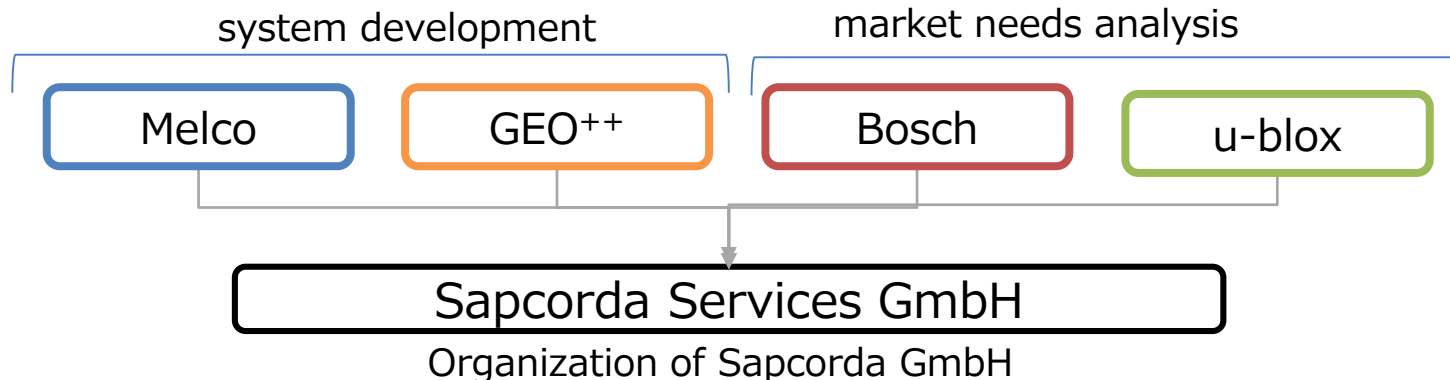
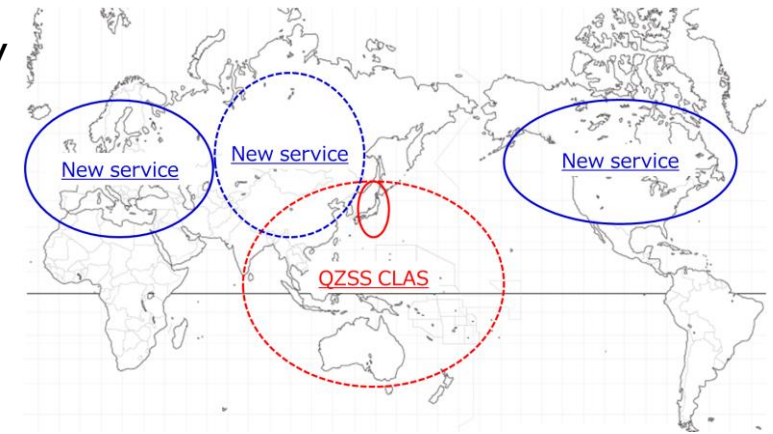
World Wide Use of Cm Level Augmentation Signal

- Establishment of JV Company “Sapcorda”
 Sapcorda Services GmbH has been established to provide Cm Level Augmentation Signal mainly for Europe and US Regions.

Sapcorda : **S**afe **A**nd **P**recise **COR**rection **D**ata

- Features of Sapcorda Business

1. Globally available service
2. Correction data at centimeter level
3. Adoption of open format
4. Safety information for autonomous driving
5. Distribution via satellite and ground network
6. Interoperability with Japanese CLAS



High-Precision 3D Map

Why maps are needed for automated driving and other uses;

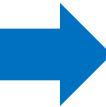
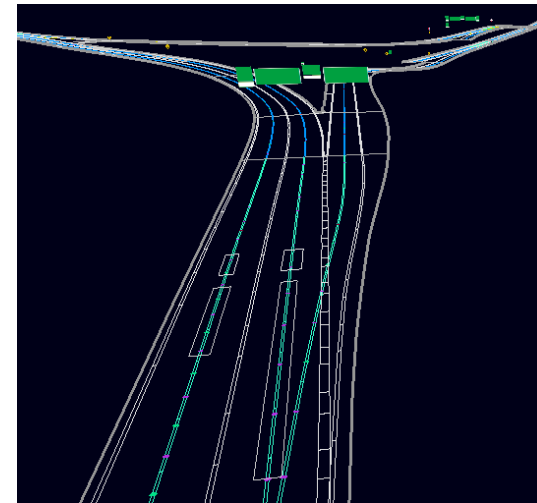
Current digital maps
(navigation etc)



Read by human beings

- Search and navigate to location

High-Precision 3D maps
for automated driving



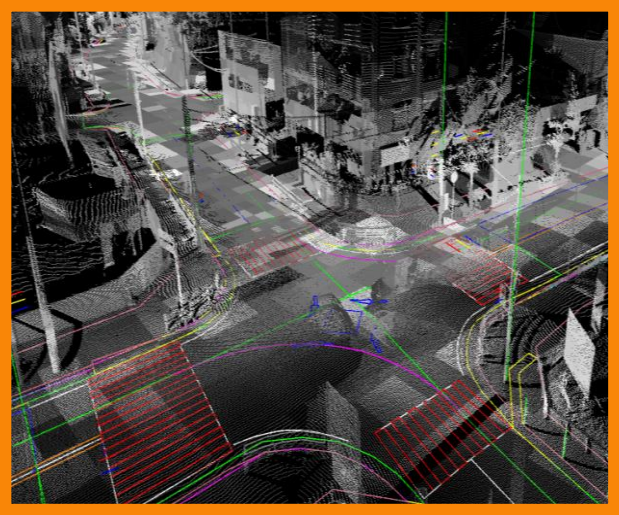
Maps installed and perceived by vehicles

- Contributes to improving self positioning accuracy and decreasing total work load of autonomous driving systems

How to use High-Precision 3D Map

1st STEP

Surveying, data gathering



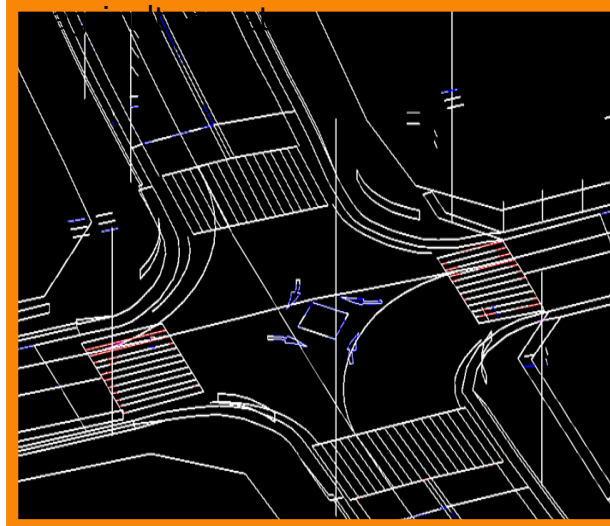
Map



2nd STEP

Extract Vectorized Data
(Create 3D Map)

Point clouds created by MMS becomes identifiable data for the use of automated driving,



Map



3rd STEP

Identify High Precision Positioning Results using QZSS / CLAS on the 3D Map

Receivers

CLAS



“Dynamic Map Platform Co., Ltd.”

- Start from 30th June 2017.
- Distribution of practical maps for automated driving to OEM.
- All domestic highway data will be delivered by March 2019.
- MELOC MMS used to gather data.

ZENRIN

PASCO
World's Leading Geospatial Group

アイサテクノロジー株式会社

Increment P
FEEL THE SPACE

map master

DYNAMIC MAP PLATFORM

INCJ

MITSUBISHI ELECTRIC

TOYOTA

NISSAN

HONDA

MITSUBISHI MOTORS

SUBARU

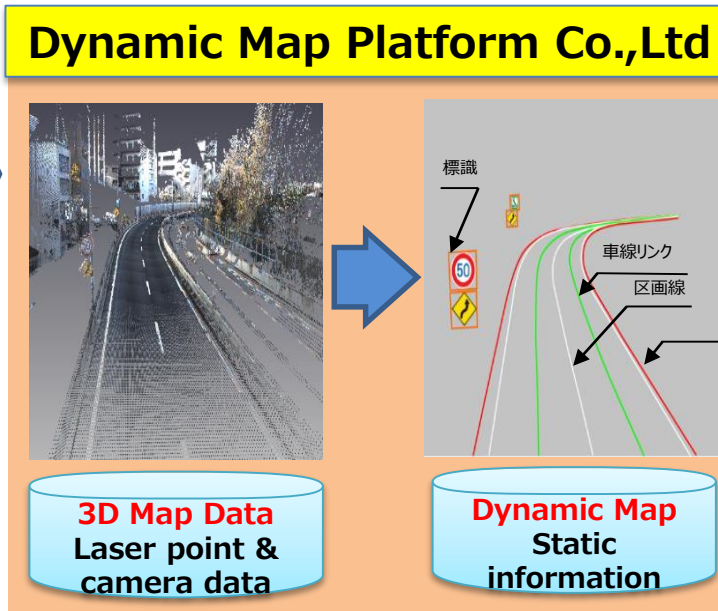
MAZDA

SUZUKI

HINO ISUZU
〈Investors for DMP〉







MMS



High Precision CLAS Receivers

Line up of CLAS Receivers(MELCO Products)

items	Purpose	Configuration and size	Availability
Monitor Terminal	For development and demonstration	<p>Antenna Receiver</p>  <p>φ200 178×142×90mm</p>	Already available
Terminal for Business Users	For various business users	<p>Antenna Receiver</p> 	FY2018
Terminal for Car navigation system	For high precious car navigation system		FY2018
Terminal for ADAS & Automobile	For ADAS or automobile equipment for high precision locator		TBD

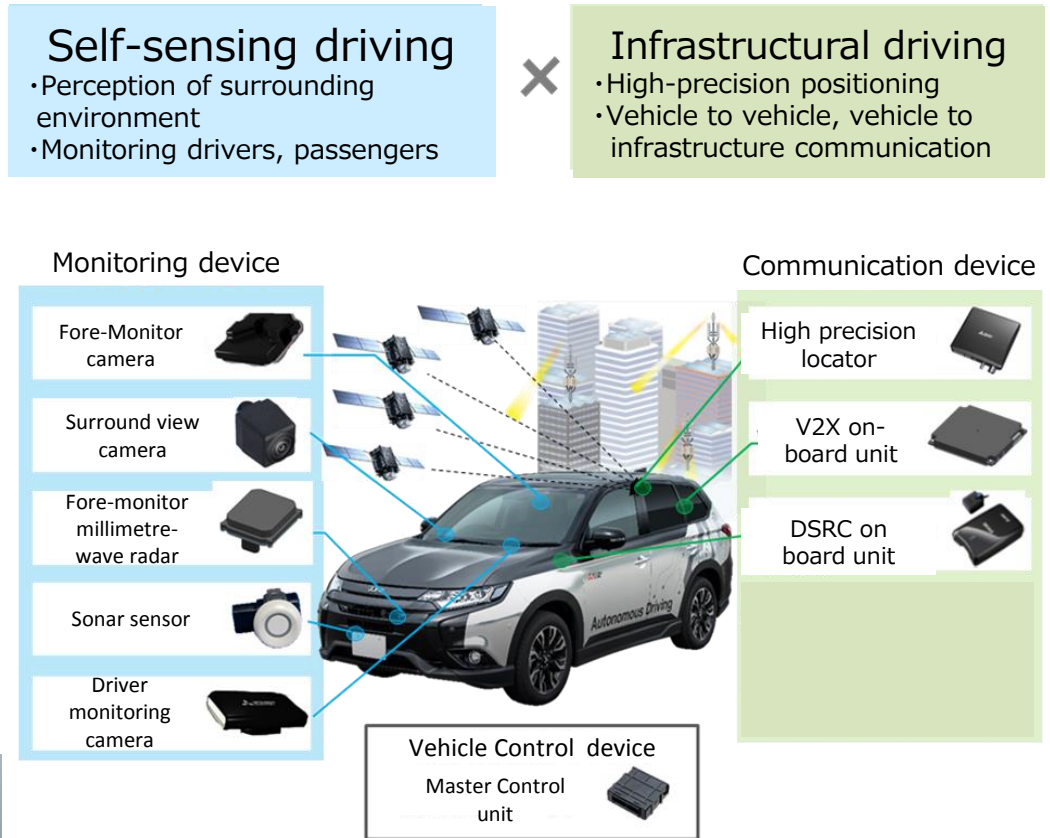
Utilization of CLAS for Automobile

Autonomous Driving and Safety Driving Support

- **Self-sensing driving**
Combines on board sensors (cameras, radars) to perceive other vehicles, objects and surrounding environment
- **Infrastructural driving**
High-precision 3D maps and centimeter-level augmentation service (CLAS) broadcasted from satellites together with vehicle to infrastructure communication is used to identify self position to realize safe driving even in bad vision



Infrastructural Driving is effective in bad vision such as under snow, fog or at night



Undertook demonstration of autonomous driving using positioning augmentation signals broadcasted from QZSS for the first time ever (19th Sept 2017)

Utilization of CLAS for Automobile

High-end audio system & car navigation system "NR-MZ300PREMI"

The navigation system which aims for "improved comfort" and "safe and secure driving support"

Features

● "Smart voice control"

Voice recognition and vocabulary is improved by using the cloud server, making searching for a location or operating the navigation system more like a natural conversation.

● "NewsReader"

Thanks to our cloud server's unique sentence recognition AI technology, the latest news will be read out loud to you while driving.

● "Compatible with the Quasi-Zenith Satellite System"

Lane-level guidance is provided through the professional terminal's (name TBD) link to the Quasi-Zenith Satellite System. The terminal is also able to detect when you are driving in the wrong direction, further enhancing driver safety.

Note: scheduled for release as an optional upgrade in Spring 2018.

Detail

Smart voice control



NewsReader



associate zenith satellite-adaptive

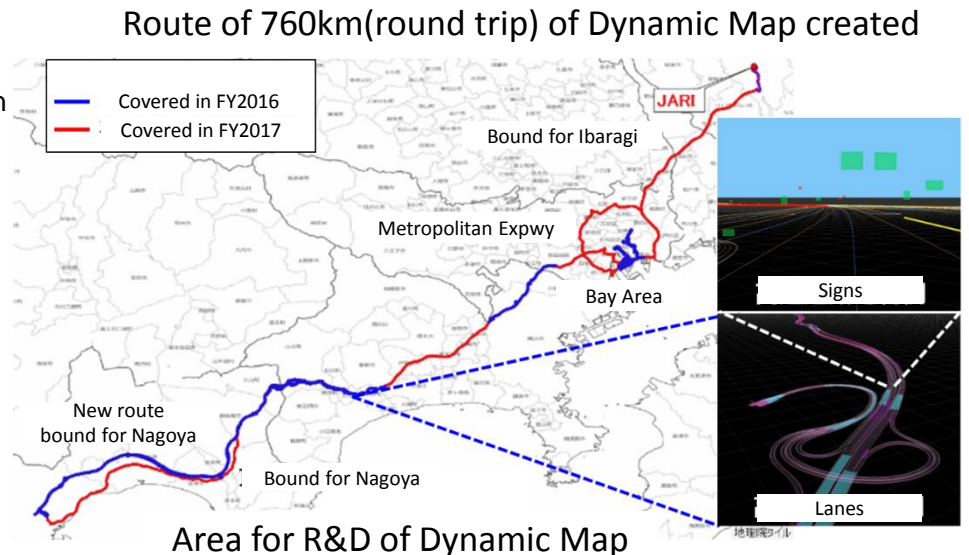
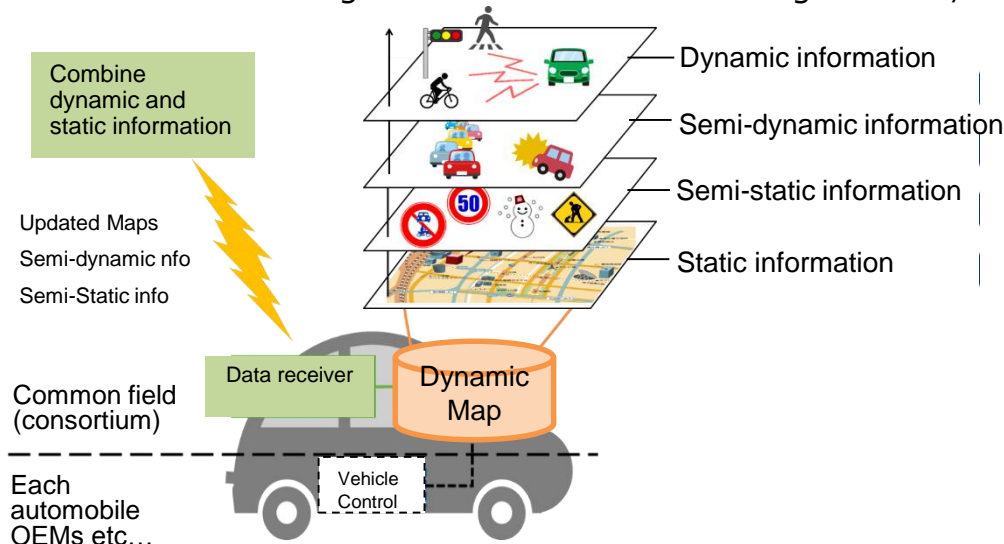


Utilization of CLAS for Automobile

Dynamic Map data has been distributed to automobile OEMs and Tier1 manufacturers under an demonstration for “Automated Driving for Universal Services” undertaken by SIP* and is being used for test driving.

- FY2017 R&D of Dynamic Map and 760km of its creation
- FY2018 2 years of test driving (each automobile OEM)
- FY2019 Wrap up for application to practical use
- FY2020 Practical use at Tokyo Olympics

*SIP = Strategic Innovation Promotion Program led by the Japanese government



Summary

- We focus on “Autonomous Driving” and “Safety Driving Support” in order to help achieve an innovative society.
- MELCO would like to make various cooperative activities in the application fields presented using the QZSS CLAS and Dynamic Map.

We are waiting for requests!

Please contact us at:

Our corporate site

<http://www.mitsubishielectric.com/>

Positioning Satellites (QZSS)

<http://www.mitsubishielectric.com/bu/space/satellite/positioning/index.html>

Thank you for your attention



for a greener tomorrow