Development of SIP V2P communication technology
Introduction of results of 2016

November 15, 2017

Connected Solutions Company
Panasonic Corporation

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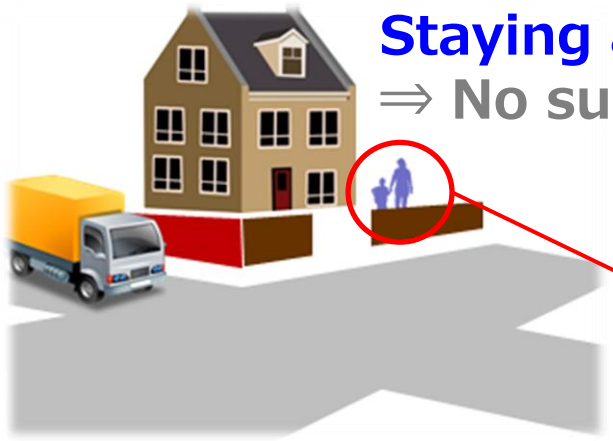
SIP Cabinet Office

V2P(Vehicle-to-Pedestrian) Communication

1. Approach to V2P
2. Experiment video
3. Current results

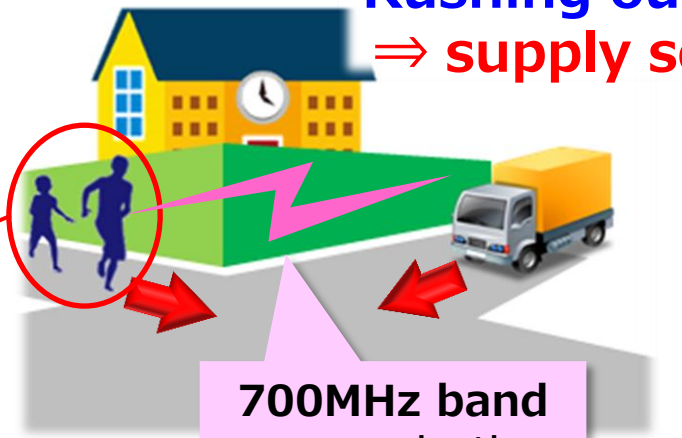
Purpose of the Research

Preventing pedestrian accidents using V2P communication systems, which support both pedestrians and drivers under various situations



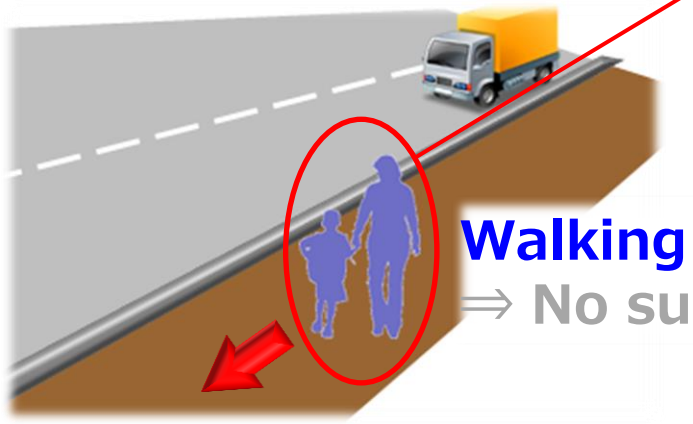
Staying at a safe place
⇒ No support required

- Implement **high accuracy positioning** for pedestrians
- **Supply supports** only for necessary places and actions

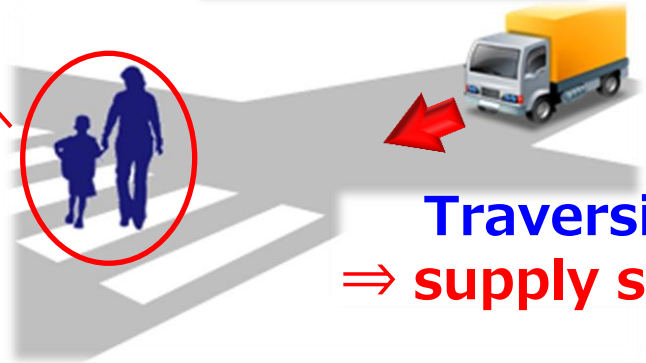


Rushing out a crossroad
⇒ **supply some support**

700MHz band communication



Walking on a sidewalk
⇒ No support required

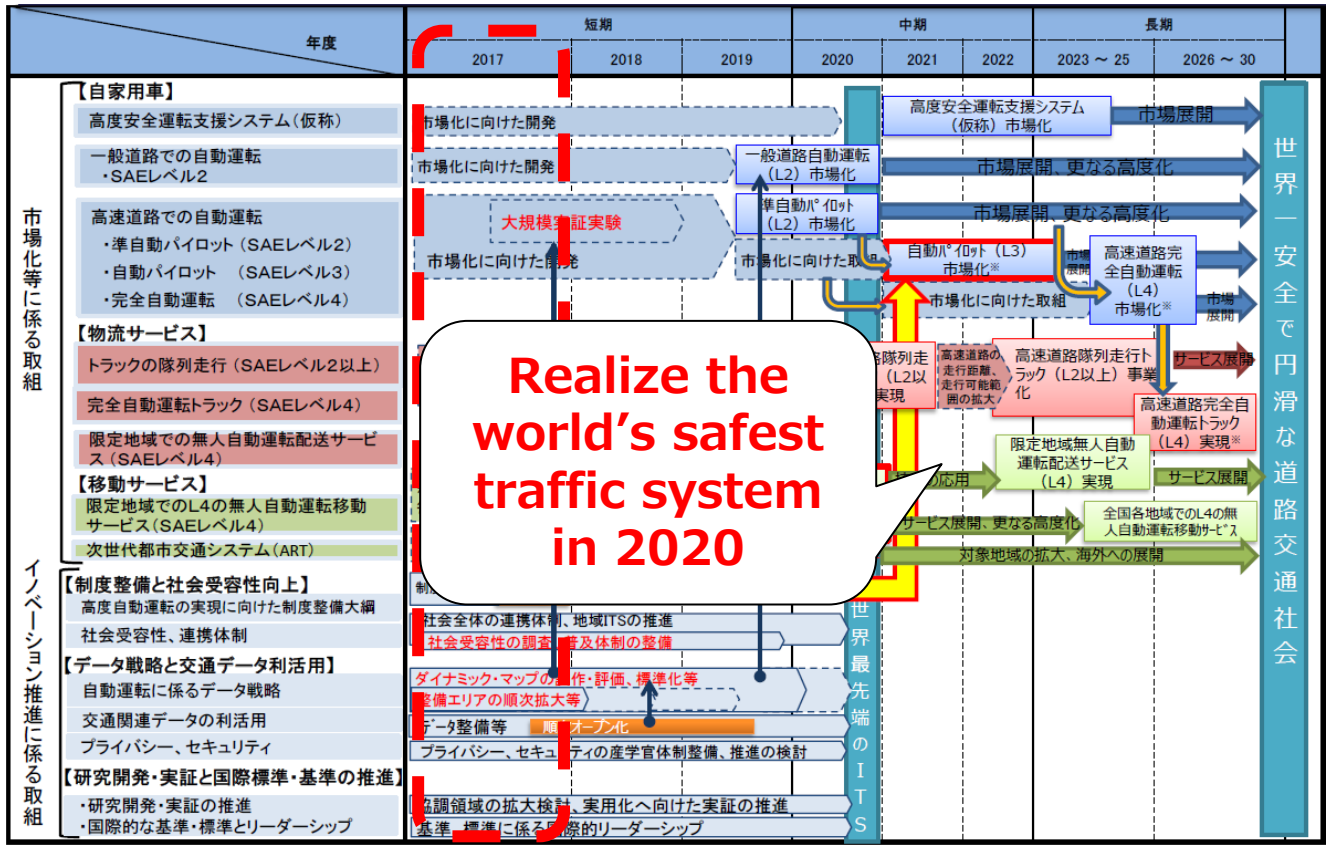


Traversing a road
⇒ **supply some support**

Trends of Governments

Practical V2X systems around 2020 being targeted by both domestic and overseas governments

Domestic



Government Plan: Public-Private ITS Concept / Road Map 2017

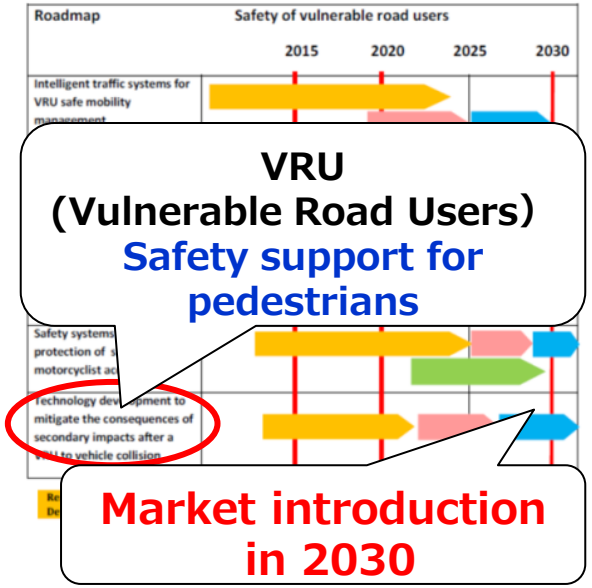
https://www.kantei.go.jp/jp/singi/it2/kettei/pdf/20170530/roadmap.pdf

Overseas

<USA> Source: Nihon Keizai Shimbun 2016/12/14

To prevent accidents US transportation authorities proposed regulation that **"V2Vcommunication" being a mandatory function** for all new vehicles from 2023

<Europe>



ERTICO(ITS Europe)
Standardization and Commercialization now under promotion

On ERTRAC roadmap, **Safety support for pedestrians** becoming popular in 2030

Trends of Companies

Initiative V2X products and services being promoted by companies of different business categories

■ Qualcomm

Announced **a V2X chip(9150 C-V2X) to enhance safety of connected cars**, adopting both standard 4G and next standard 5G. It is scheduled to be installed in mass-produced vehicles in 2019.

2017/09/04 source : CNET News

■ u-blox

Announced V2V/V2I communication module VERA-P1, with complete compatibility with WAVE, DRSC and ETSI ITS G5 standards. 2017/06/22 source : MyNavi NEWS

■ NXP Semiconductors

Demonstration on the communication function between vehicles (**Road Vehicle: V2I**) was conducted at CES 2017

2017/01/16 Source: From the NXP website homepage

■ Renesas Electronics

By combining Renesas V2X SoC of R-Car with Cohda Wireless's V2X and CAV software solution it becomes easy building a **V2X reference system**

Source: From the Renesas Electronics website

■ HUAWEI

Huawei and Vodafone, at MWC 2017
The first demonstration in Europe that demonstrates V2V,V2P,V2I
using a new technology called Cellular V2X (C-V2X)

2017/03/06 Source: From the HUAWEI website homepage

■ TOYOTA

・Development of **connected cars utilizing 5G** under cooperation with NTT being announced

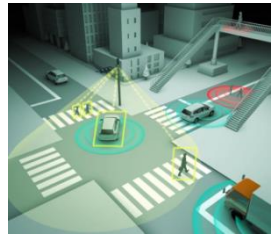
2017/04/10 Source: Nikkei Technology

・**ITS connect** being available for a portion of models of new cars

2016/10/07 Source: Toyota Motor Corporation website

■ Panasonic

Starting field tests in USA in 2017 as a demonstration for all kinds of
V2X communications, including V2V, V2P and V2I systems

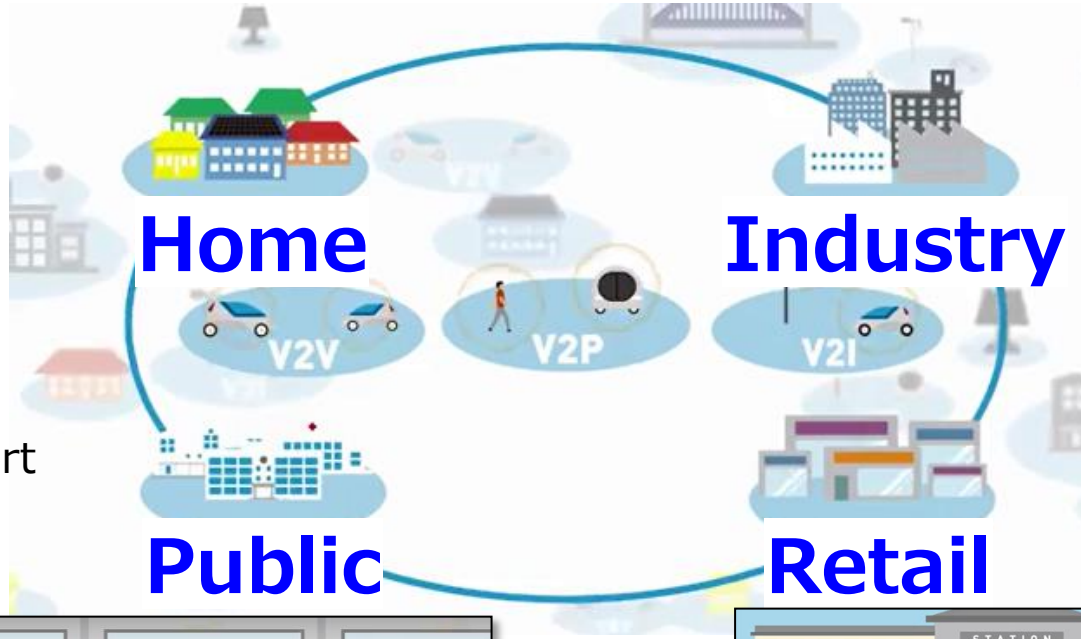


2017/01/04 Source: Nikkan Kogyo Shimbun

From V2X to Smart City

Panasonic aims implementation of smart cities through integrating V2X with our contributions to Home/Public/Retail/Industry domains

Package collection /transport / automatic delivery



V2X

Reduce the risk of accidents with sensing and communication

Comfortable movement with automatic driving vehicle in public facilities

Mobility service

Move by unmanned on-demand bus

From ITS World Conference 2016 Panasonic Concept Picture
(Reference URL ： https://channel.panasonic.com/jp/contents/19035/)

V2P Research in Panasonic

Founded on the 3-year research about underlying technologies, an evaluation test is now under progress as the preliminary phase for a large-scale field test

FY2014 → FY2015 → FY2016 → FY2017 → FY2018

High accuracy positioning of pedestrians

Stable positioning accuracy even under deteriorate environments

Problem analysis → Measures for multi-pass errors → Measures for reduced number of satellites

Danger prediction for pedestrian supports

Pedestrian support with acceptable receptivity

Supports towards typical pedestrian accidents → ・Multi-level supports ・Measures towards false alarm suppression

Prototype terminals

Prototype terminals applicable to large-scale field test

Problem analysis on practical applications → Prototype development Hard/Soft

Large-scale field test

Preliminary test → Field test

Technologies to practical applications

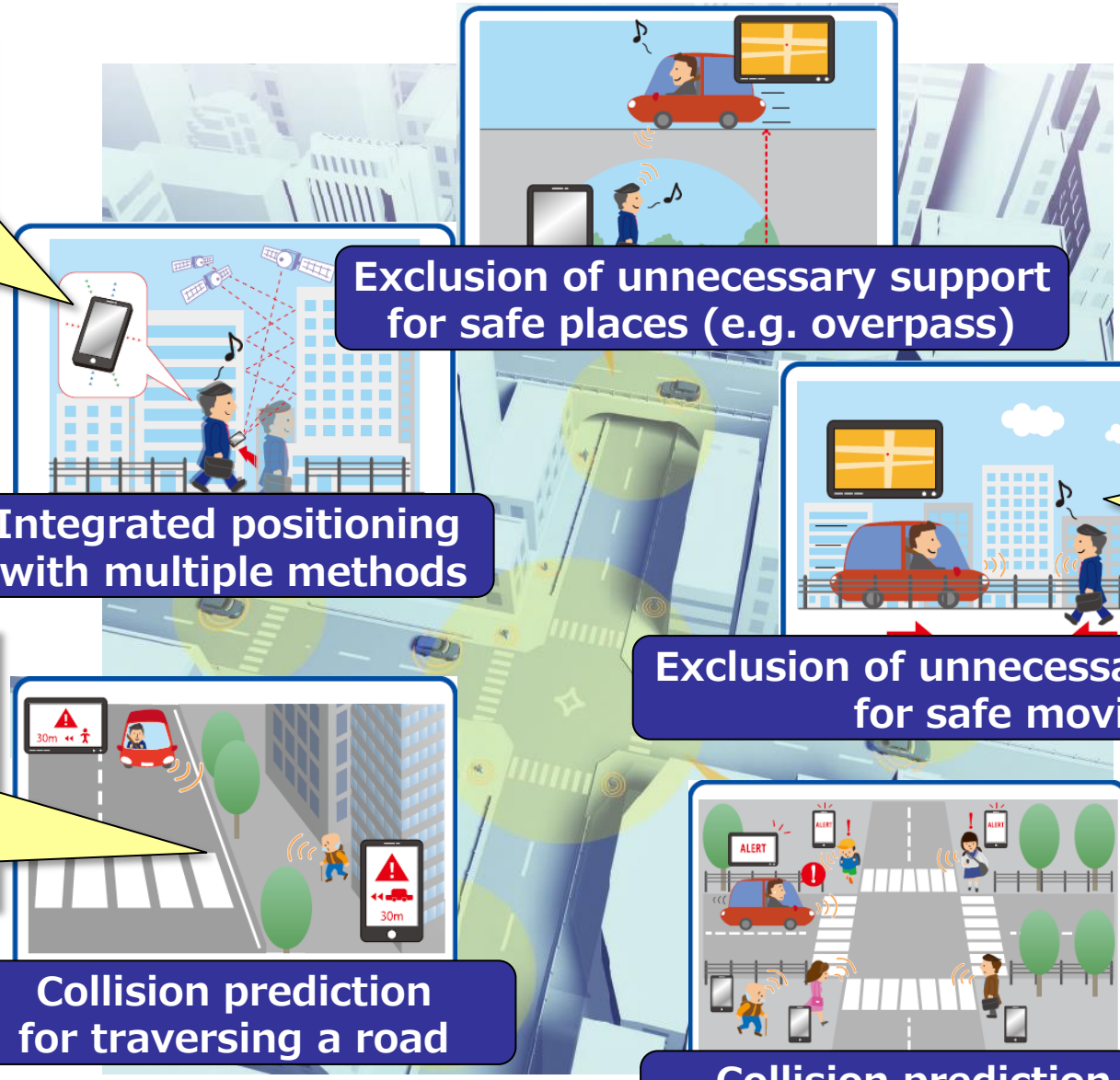
Effectiveness improvement

Adoption of 3D map towards practical positioning accuracy

・HMI improvement
・Exclusion of unnecessary supports to wider areas

Technical Points of Our Research

Stabilization of positioning accuracy in urban areas where satellite positioning deteriorates



Exclusion of unnecessary support for safe places (e.g. overpass)

Integrated positioning with multiple methods

Exclusion of unnecessary support for safe moving

Exclusion of unnecessary supports based on map information and action predictions for a pedestrian

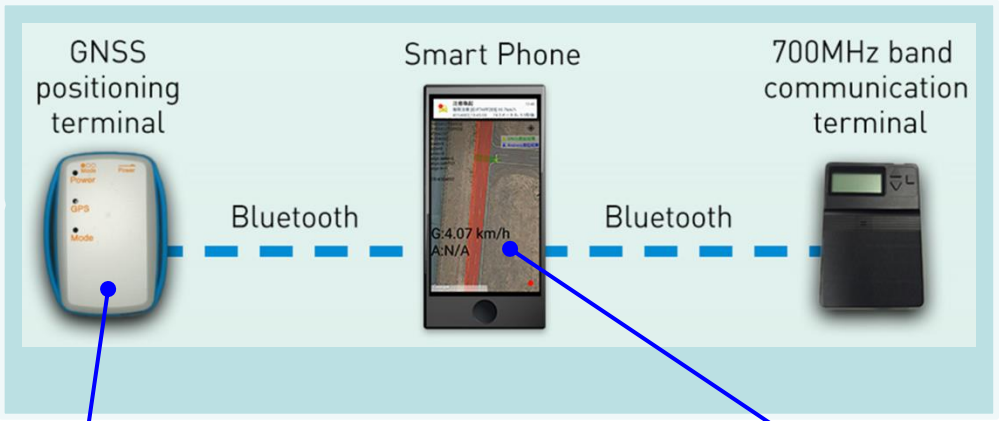
Prediction based on position, speed and heading direction, as well as **supply supports timely**

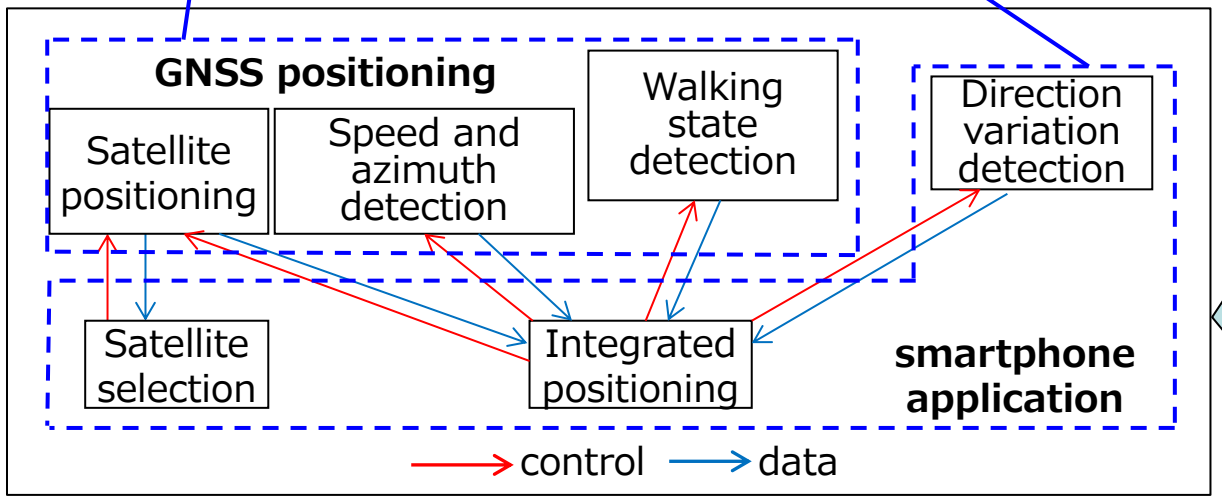
Collision prediction for traversing a road

Collision prediction for multiple objects

Positioning Technology Details

Devices for pedestrian positioning





Configuration of function components

Function	Contents
Satellite positioning	Positioning using GPS, **QZSS**, and GLONASS
Satellite selection	Direct wave satellite selection based on **C/N values**
Speed and azimuth detection	Detecting speed vector **based on Doppler deviation of satellite** radio wave
Walking state detection	Detecting different walking states(Walking/Stop) based on **motion sensors**
Direction variation detection	Detecting variation of directions by **smartphone sensors**
Integrated positioning	Integrating **four different methods** using a **Kalman filter** to obtain stable positioning

Current results

Panasonic

Pedestrian-to-Vehicle Communication System Verification Tests

JARI & Gifu Verification Tests FY 2016

Positioning Accuracy Improvement (1)

Accuracy of ±5m in deteriorate environments is implemented (the final target is <±3m*)

■ Efforts

Improvement of positioning accuracy in satellite acquisition degradation environment


Urban canyon


Underpass

■ Approach

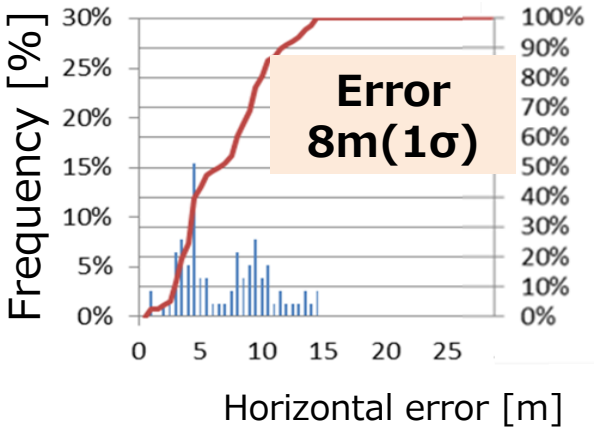
① Satellite positioning error elimination technology

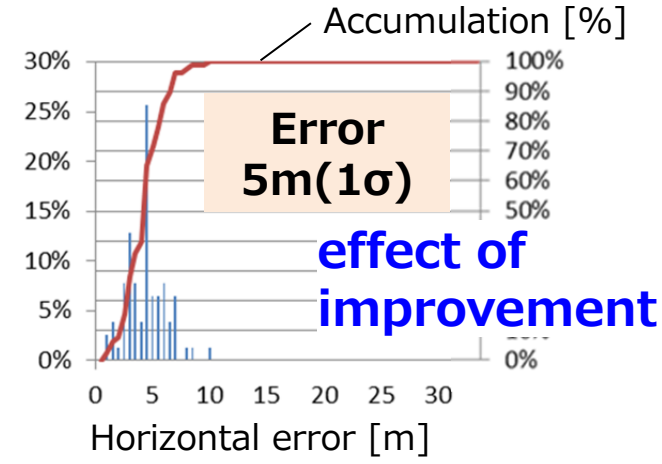
② Combination of complementary positioning technologies based on either satellite positioning or PDR

■ Experiment Results

Error elimination for satellite positioning

Combination of satellite with PDR





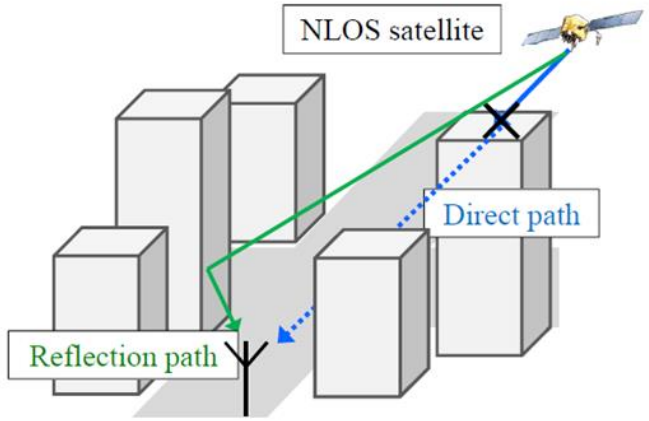
*:On one side 1 lane road (width 7 m)
Error which can distinguish the pedestrian position (left and right) from the vehicle

Positioning Accuracy Improvement (2)

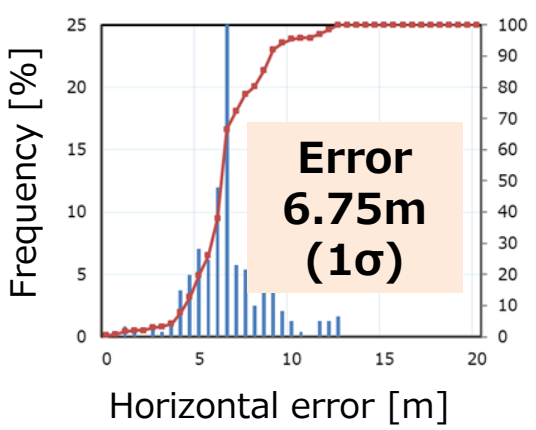
Further improvement to accuracy of about ±3m is being implemented by using 3D maps

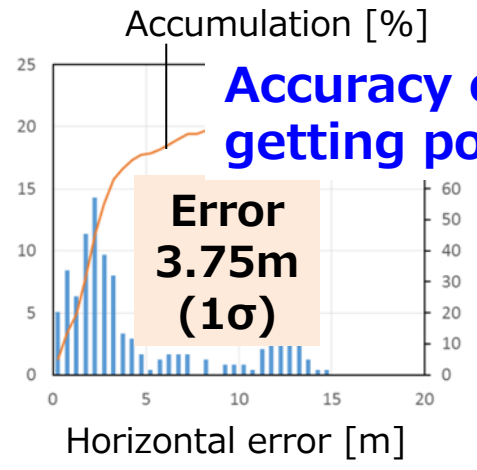
■ Approach

- Utilizing a **3D map** including height information of buildings which makes estimation of reflection path possible
- A unique method* for positioning based on not only direct path but also reflection path of radio waves* An original work of University of Tokyo



■ Experiment Results





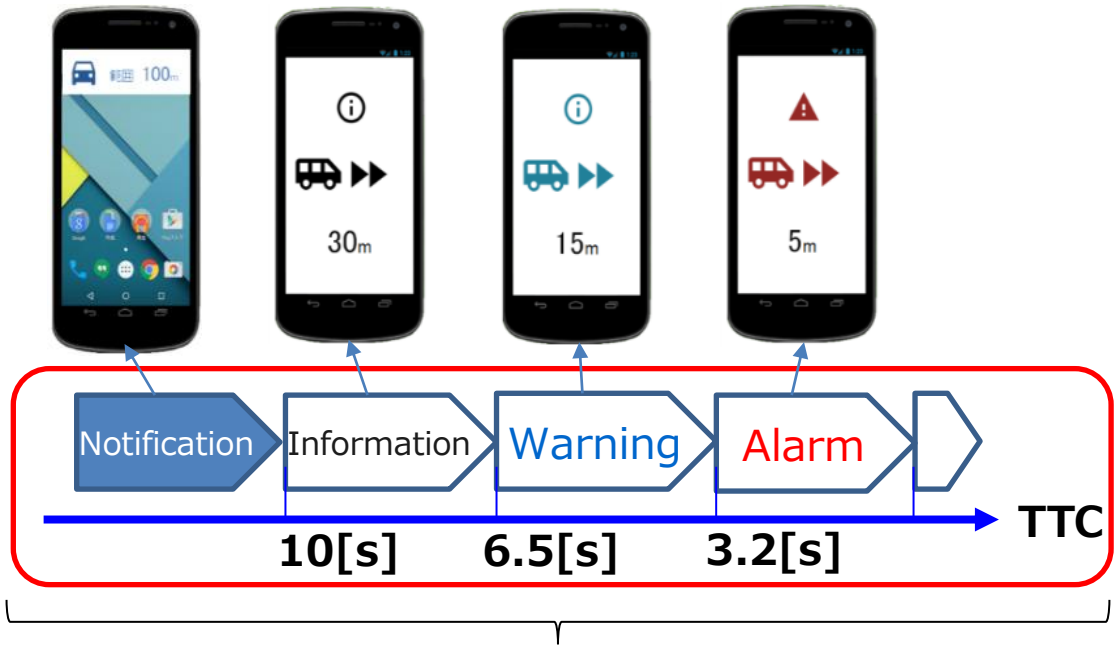
Accuracy of ±3m getting possible

Improvement for Danger Prediction (1)

Taking into consideration practical usages with multi-step danger prediction

■ Approach

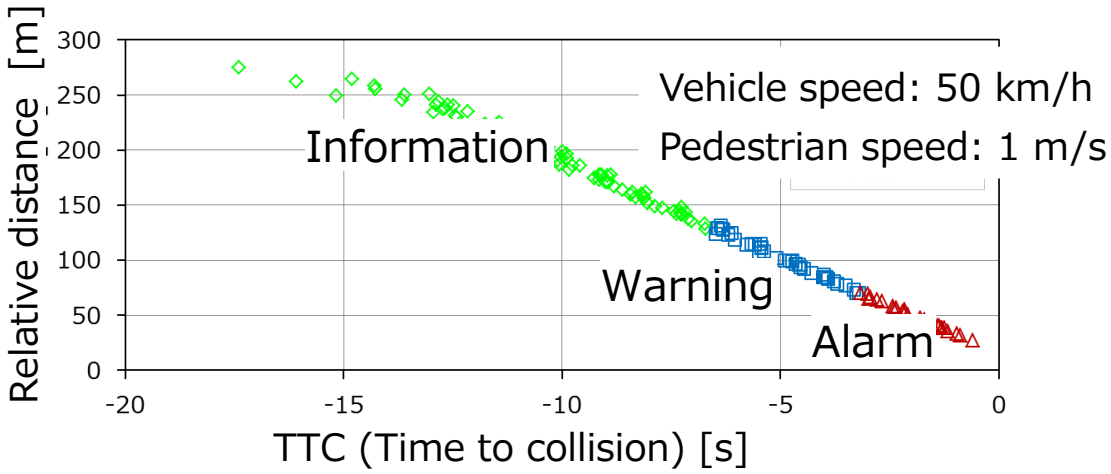
Practically receptivity of support time and manner is important. **A multi-step alarming** according to TTC is developed to avoid excessive reactions



Different presentation according to TTC

■ Experiment results

A pedestrian is supported at **multiple steps with respect to different danger levels**



Improvement for Danger Prediction (2)

Taking into consideration exclusion of unnecessary supports

■ Approach

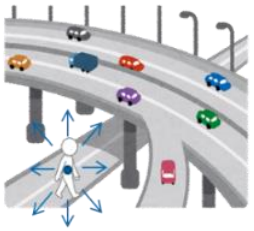
To reduce false alarm rate and to save terminal power, cases where supports are not necessary are detected and excluded.

Some cases where supports are not necessary:

Moving along road

Keeping -away from road

Moving slowly



Staying/walking under overpass

■ Experiment results

Exclusion Cases	Results	Failing Examples
moving along road	△	Cause orientation inaccuracy during stationary
keeping-away from road	△	<Same as above>
moving slowly	○	
walking under overpass	○	Misjudgment in the middle of the slope

Moving along a road

Walking under an overpass

Further Research

Prototype communication terminals as well as fundamental application technologies are under development for a large-scale field test demonstration

1）Prototype communication terminals for pedestrians and vehicles

■ Hardware development

・Pedestrian terminals, in-vehicle terminals, and external antennas

・Improvement of 700MHz communication devices and GNSS reception devices

■ Software development danger determination

・Improvement of positioning accuracy practical for safety support

・Improvement of danger prediction algorithms for various actual environments

An image of prototype terminals

Danger prediction for typical application scenes

Straight road

Intersection

2）Fundamental application technologies

■ High accuracy pedestrian positioning

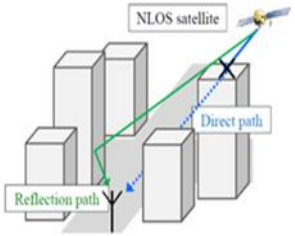
・Incorporation of 3D map with present positioning methods

■ Advanced danger prediction technology

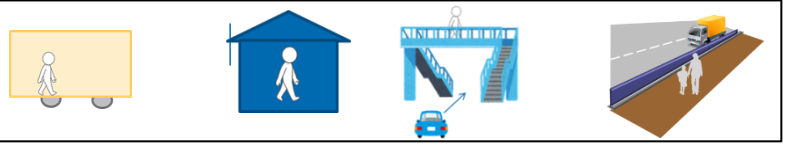
・Pedestrian heading direction estimation and tracking

・Intersection collision prediction based on map information

・Exclusion of unnecessary supports based on both map information and sensor data



Using the 3D map

Typical accidents	
Suppression of false alarms	


Thank you
SIP-adus Workshop 2017
on Connected and Automated Driving Systems