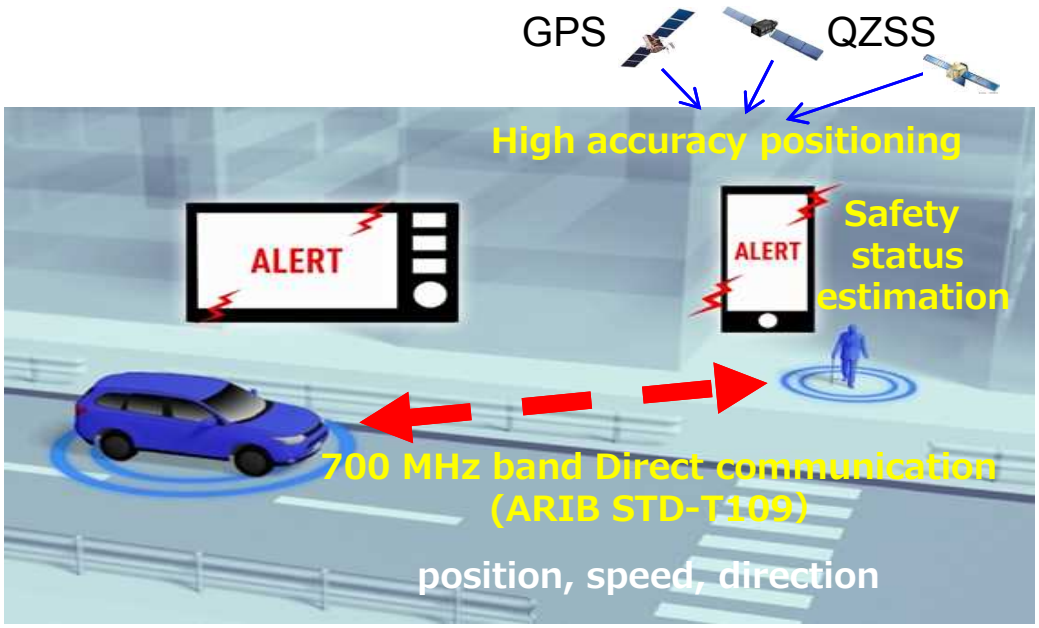
Ⅱ Vehicle to Pedestrian(V2P) Communication Technology

(Panasonic Corporation)

Goal

Realization of a safety support system for pedestrians to reduce traffic fatalities

- ✓ Alert pedestrian or driver timely under potentially dangerous situations
- ✓ Supply competent terminals with superior portability & battery performance



【System Image of V2P Communication】

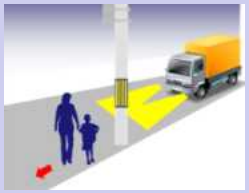
The terminals communicate directly with each other "location" "speed" "direction",

Implemented safety support by predicting collision probability and collision time

Scenarios requiring support


Single road crossing


Non-line of sight intersection

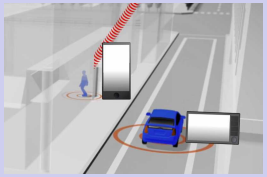

Walking on roadway

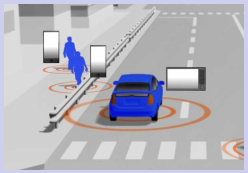


Right/Left turn at intersection

Scenarios not requiring support


Inside vehicle


Inside building

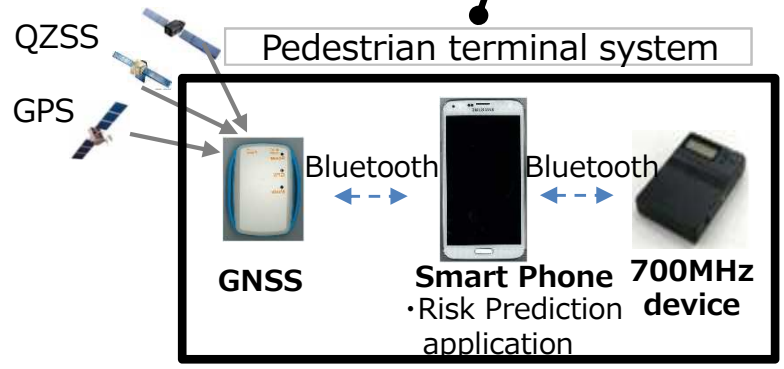

Walking on sidewalk

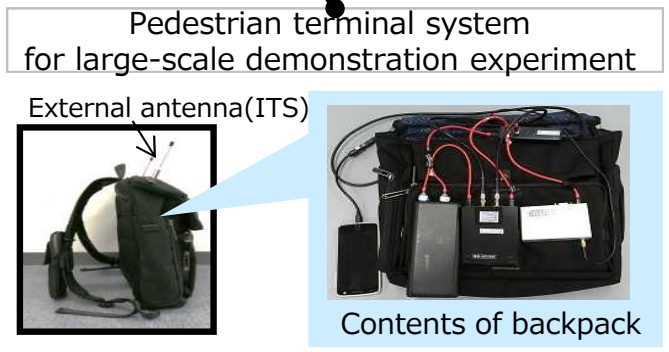

On/Under overpass

R&D overall schedule

Terminal system improvement for large-scale demonstration experiment in the final year

FY	2014	2015	2016	2017	2018	2019	2020
Development of V2P communication technology (Ministry of Internal Affairs and Communications)			【Establishment of elemental technology】 ・High accuracy positioning for pedestrian ・Risk prediction technology advancement				● Tokyo Olympics
			【Terminal prototype】 Prototyping and basic verification of pedestrian terminals and on-board units				
Large-scale demonstration experiment (NEDO)			Issues Extraction	Terminal prototype	Improvement / Terminal provided		
			「Pedestrian accident reduction demonstration experiment」		Preliminary Experiment / Demonstration Experiment		





Remaining issues of preliminary experiment

Confirm success rate was more than 80% (When support is required), and failure rate was less than 20% (When support is not required)
However, it is necessary to optimize support levels and timing, and to improve convenience

Major items	Small items	Issue	Cause	Measures of this year
Scenarios requiring support	Right/Left turn at intersection	Intersection presence notification is excessive	In pre-experiment, set parameters for more notification (As intended by design)	**Change the intersection judgment condition and the notification condition to reduce the frequency of notification**
	General	Information/ Warning may not come out / may be late	Speed fluctuation needs to be considered	**Change the GNSS update cycle (1 Hz→4 Hz)** to improve the collision detection cycle and speed tracking
Scenarios not requiring support	General	Avoid unnecessary operation as much as possible	In pre-experiment, set parameters for more notification (As intended by design)	**Change the judgment condition of whether it is on the sidewalk to reduce the frequency of notification**
Equipment related to operation	700MHz communication terminal	Equipment trouble occurred	USB connector strength, etc.	**Enhancement of USB connector, etc.**
	Backpack-type Pedestrian terminal system	Backpack-type is heavy	Large capacity battery was selected for the operating time of the system	**Reduce size and weight of mobile battery** based on the results of pre-experiment
		It is difficult for primary school students to handle	Primary school students were not covered by the initial requirements	**Develop school bag type terminal** (Add primary school students as candidates for subjects)

FY2018 R&D Plan

Improvement of terminal system based on preliminary experiment result

	FY2017	FY2018
1. Fundamental Technologies		
High accuracy positioning	3D map positioning Real time processing	Detail1 More improvement of positioning accuracy Consideration of antenna for portability
Safety support	Applicable area expansion	Improvement of effectiveness
・Risk prediction	Turn left/right at intersections	Detail2 Risk Prediction application improvement
・Exclusion of support unnecessary situations	Inside vehicle / building, Walking on sidewalk	Examination of evaluation environment to simulate dangerous situation
・Performance improvement	Quick collision prediction, Accurate heading direction estimation	Examination of countermeasure of 700 MHz communication congestion
2. Prototype Terminals and System		
Pedestrian/On-board terminals	Prototype products	Detail3 Terminal improvement for large scale experiments
Terminal unification	Algorithm study for embedded CPU	
Measures before the spread of terminals	Roadside radar cooperation (Functional verification)	Roadside radar cooperation (test course)
Large-scale demonstration experiment	Preliminary Experiment	Examination of the effect for pedestrian accident reduction 5 vehicles 25 pedestrians Demonstration Experiment 5 vehicles 25 pedestrians

Approach and Results (1)

Detail 1

More improvement of positioning accuracy

Improve the positioning correction method by utilizing 3D map,
Confirm positioning performance improvement

Detail 2

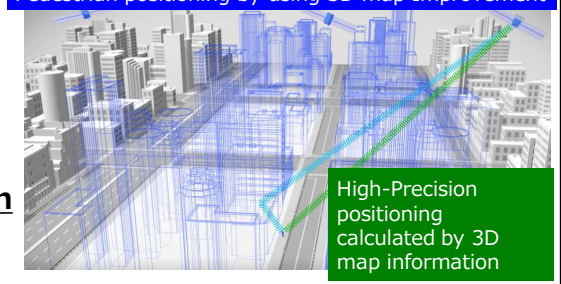
Risk Prediction application improvement

Measures for issues that occurred in Preliminary Experiment
Response improvement, optimization of judgment conditions

■Approach

Improvement of 3D map utilization method

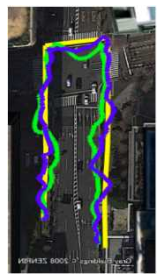
(1) Use of Galileo satellites
(2) Correction by reference station
(3) Map accuracy improvement

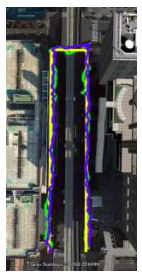


*Technology and license supplied from the University of Tokyo
Source: Urban Pedestrian Navigation Using Smartphone-Based Dead Reckoning and 3D Map-Aided GNSS

■Verification Results

(Target value: Horizontal error is 3 meter at high-rise buildings area)

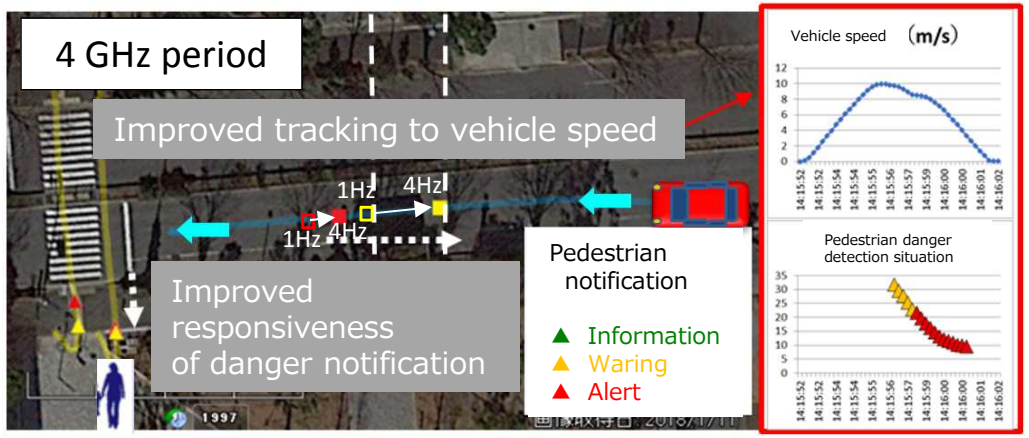




Cumulative Frequency (68%)【m】	Shinjyuku	Hitotsubashi	Shinagawa	Odaiba
2017 results	5.7	3.7	6.5	5.6
2018 results	4.1	3.7	5.9	4.1

【Issue①】Notification may be late in support scene

⇒Improve speed and direction response by changing update cycle of GNSS positioning and collision determination to the hardware limitation (1Hz→ 4Hz)



【Issue②】 More reduction of unnecessary operation rate

2-1) Optimization of judgment on the sidewalk with the expansion of examination area

2-2) Optimization of judgment conditions of intersection presence notification

Approach and Results (2)

Detail 3 Terminal improvement for Large-scale demonstration experiment

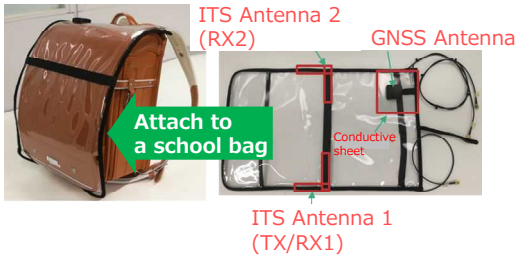
Measures for remaining issues of preliminary experiment, and development of school bag type terminal
(Target communication distance within line of sight ≧ 150 m)

Verification of the effect by risk prediction application improvement in a large scale experiment field
(Target: Success rate when support is required ≧ 80%,
Failure rate when support is not required ≦20% → minimized)

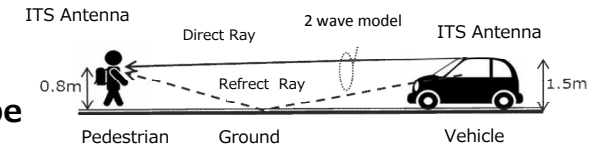
■Approach

Development of school bag type terminal

In order to balance handling and safety, developed a prototype of school bag cover with built-in antenna



V2P communication distance and positioning accuracy were equal or better than backpack type terminal



■Means of support

Pedestrian terminal system

On-board terminal system

Notification by bone conduction earphone

Terminal mounted school bag / backpack

■Risk Prediction Result

V: Vehicle P: Pedestrian		Success Rate		Failure Rate	
		V	P	V	P
Single road crossing		83%	92%	0%	0%
Non-line of sight intersection		96%	95%	0%	0%
Right Turn at intersection		96%	97%	1%	1%
Left Turn at intersection		96%	97%	0%	0%
Walking on roadway		100%	100%	0%	0%

Research results summary

Major category	Minor category	2014～2016	2017	2018	Achievement	Practical challenges
Fundamental technology	Pedestrian positioning	Studying the use of quasi-zenith satellites Multipass elimination Dead Reckoning Using 3D map	Using 3D map (Practicality review with smartphone)	Using 3D map using Galileo ,DGPS	Achieved accumulated error 1σ = 3 meter at high-rise buildings area by 3D map positioning	・Development and distribution of 3D maps in urban areas and accident prone areas ・Combined with other positioning means
	Safety support	Single road crossing / Right turn at intersection Phased notification Support Unnecessary scenes	Preliminary experiment Using Map	Large Scale Experiments Measures for issues	Confirmed system effectiveness in 10 high priority scenes with suppressing unnecessary notification	Expansion of road link information in accident prone areas
	Other		Roadside radar cooperation Examination of countermeasure of 700MHz communication congestion		・Confirmed the effect by infrastructure support ・Proposed countermeasures when communication congestion	Demonstration experiment under the environment where communication congestion actually occurs
Development of terminals	Terminal prototypes for the extensive experiment	Smartphone-type basic design	Backpack-type system prototype	School bag-type system prototype	・Provided terminals to demonstration experiment ・Miniaturization and power saving 1. Examination of power saving mode according to installed function 2. Confirmed the antenna feasibility for mounting on school bag and bicycle, etc.	Miniaturization and power saving ・Development of power saving LSI ・GPS antenna implementation for smartphone and wearable device
	Practical application study	Verification of radio interference with cellular Antenna study for smartphone	Processing load examination for dedicated terminal	Examination for terminal integration (Antenna, etc.)		