Autonomous driving technology and ITS

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Sophia Antipolis, France

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Japan
1. Autonomous driving technology in Japan

2. Next generation ITS

3. WRC-19

4. Summary
 Autonomous driving demonstration by Toyota

Autonomous driving car on highway

Inside of autonomous driving car

GPS Receiver

LIDAR

Millimeter wave Radar
Concept car by Nissan

↑ Nissan 「IDS Concept」 ※IDS : Intelligent Driving System

Source: Nissan HP
The autonomous driving car has many sensors!

ex. Millimeter wave radar, LIDAR, Camera

The picture show the vehicle recognition of surrounding objects.
SIP (Strategic Innovative Promotion Program) - Overview

Aiming to realize Science & Technology Innovation through promoting R&D overlooking from basic research to implementation and commercialization by cross-ministerial cooperation.

Innovation of Automated Driving for Universal Services (SIP-adus)

http://www.sip-adus.jp/

＜ICT for Automated Driving＞

- V-V Communication and V-I Communication
  Drawing up communications protocol and etc.

- V-P (Pedestrian) Communication
  Developing direct communications style which uses dedicated terminals, mobile phone network application style system and etc.

- Infrastructure Radar System
  Developing 79 GHz band high-resolution radar which can identify people, cars and etc.
1. Reducing road crashes and etc. Achieving the national goal: The national infrastructure structure for achieving the national goal

2. Making self-driving system come true and becoming widely used the system: Turning the system into a commercial reality and promoting with research and development through A to Z and concurrent international cooperation

3. Putting into practical use of public transportation system for next-generation: Developing and working with as milestone on the road to Tokyo Olympics and Paralympics
SIP-adus was based on six important themes. Theme leaders are liaison officers for international relations on these themes.

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Enhancement of ITS by effective use of Information Communication Technology

**VICS (Vehicle Information and Communication System)**
- Since 1996
- traffic information through FM-multiplex broadcasting, radio beacons and infrared beacons
- over 47 million vehicles as of June 2015

**Probe information**
- Probe information collection by each car maker
- Providing each users with traffic information

**Target detection system in front**
- On-vehicle radar system using radio waves, supersonic waves and infrared ray, and camera
- Detecting vehicles and obstacles in front
- Warning, emergency brake, keeping inter-vehicle distance

**Obstacles detection system around vehicle**
- radar system using radio waves and supersonic waves, and camera
- Detecting obstacles and warning

**DSRC (Dedicated Short Range Communication)**
**ETC (Electronic Toll Collection) since 2001**
- over 66 million vehicles as of May 2015

**ITS Spot since 2011**
- About 1600 locations mainly on expressways nationwide
- Providing drivers with safe driving support information

**DSSS (Driving Safety Support Systems)**
- V2V, V2I and V2P communications via 700MHz band radio waves
ITS Radio communications in Japan

700 MHz ITS (Advanced Driver Assistance Systems)
Avoiding Vehicle Collisions by vehicle-to-vehicle communications.

Electronic Toll Collection System (ETC)

Millimeter Wave Radar
24/26 GHz Band UWB Radar or 79 GHz Band High-resolution Radar

Roadside Broadcasting (Highway radio)

Vehicle Information and Communication System (VICS)

Dedicated Short Range Communication (DSRC · ITS Spot)
ITS spots provide information detected by roadside sensors.

Frequency Bands:
- 1620 kHz
- 76～90 MHz
- 755.5～764.5 MHz
- 2.5GHz
- 5770～5850 MHz
- 22～29 GHz
- 60～61 GHz
- 76～77 GHz
- 78～81 GHz

Display Types:
1. Text display type
2. Simplified Graphic display type
3. Map display type
ITU-R Recommendation M.2084
“Radio interface standards of vehicle-to-vehicle and vehicle-to-infrastructure communications for Intelligent Transport Systems applications”
World first commercial services of V2V! from TOYOTA in Japan

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<th>Specifications</th>
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<th>TTA (Korea)</th>
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<tr>
<td>Frequency band</td>
<td>5855-5925 MHz</td>
<td>5850-5925 MHz</td>
<td>755.5-764.5 MHz (Single Channel)</td>
<td>5855-5925 MHz</td>
</tr>
<tr>
<td>Channel width</td>
<td>10 MHz</td>
<td>10 MHz or 20 MHz</td>
<td>Less than 9 MHz</td>
<td>Less than 10 MHz</td>
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<tr>
<td>Modulation system</td>
<td>BPSK OFDM, QPSK OFDM, 16QAM OFDM, 64QAM OFDM</td>
<td>64-QAM-OFDM, 16-QAM-OFDM, QPSK-OFDM, BPSK-OFDM 52 subcarriers</td>
<td>BPSK OFDM, QPSK OFDM, 16QAM OFDM</td>
<td>BPSK OFDM, QPSK OFDM, 16QAM OFDM Option : 64QAM OFDM</td>
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<tr>
<td>Data transmission rate</td>
<td>3, 4.5, 6, 9, 12, 18, 24, 27 Mbps</td>
<td>3, 4.5, 6, 9, 12, 18, 24, 27 Mbps (10MHz) 6, 9, 12, 18, 24, 36, 48, 54 Mbps (20MHz)</td>
<td>3, 4.5, 6, 9, 12, 18 Mbps</td>
<td>3, 4.5, 6, 9, 12, 18 Mbps Option : 24, 27 Mbps</td>
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<td>Media Access Control</td>
<td>CSMA/CA</td>
<td>CSMA/CA</td>
<td>CSMA/CA</td>
<td>CSAM/CA, Option : Time slot based CSMA/CA</td>
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<td>FDD/TDD</td>
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What is next generation ITS?

“Awareness” is important for achieving autonomous driving.

Autonomous driving car’s on-board sensors are improving. What can ITS do? …Next generation ITS can support “Awareness”!
Next generation ITS will support “Awareness”.

High-Definition map?
Dynamic map?  
V2V negotiation?

High data rate App.?
V2I with on-road sensor ?
V2V broadcast?
V2P?

On board Sensors

Static  
Dynamic  
Real-time

Real-time App.?

We can turn on blinkers only when we change lanes.

Autonomous driving cars can send the exact message, “I’d like to change lanes” with the V2V communication system.
5G×ITS

The Dynamic Map system is a core technology of the next generation ITS.

5G×ITS will make safe and more comfortable autonomous driving experience.
MIC: ITS workshop

"ICT for Next Generation ITS"

1. Overview

Date: 25 Feb. 2016
Venue: Nikkei Hall, Tokyo
Organizer: MIC, Japan
Attendees: 500
Speakers: 14

2. Presentations

ITS radiocommunications related organizations from overseas (Mr. Arndt from ETSI TC ITS, Dr. Kenney from TOYOTA ITC U.S.A.) and Japan made the following presentations:

- Status report of ITS development, overseas and in Japan
- Report of ITS radiocommunications R&D projects coordinated by MIC
Global or regional harmonization of frequency bands for ITS applications

Resolution 237 [COM6/13 (WRC-15)]

resolves to invite the 2019 World Radiocommunication Conference taking into account the results of ITU Radiocommunication Sector (ITU-R) studies, to consider possible global or regional harmonized frequency bands for the implementation of evolving ITS under existing mobile-service allocations,

invites ITU-R to carry out studies on technical and operational aspects of evolving ITS implementation using existing mobile-service allocations,

invites administrations to contribute actively to the ITU-R studies on this issue.
1. Autonomous driving is a key word for ITS in Japan.

2. 760MHz band ITS services (V2X) were deployed in Japan last year.

3. The Dynamic Map system is a core technology of next generation ITS.

4. The Next generation ITS and 5G have good chemistry. …but can we wait for the deployment of 5G?

5. WRC-19 agenda item ‘Global or regional harmonization of ITS Spectrum’.

*Let’s work together!*