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**APT REPORT ON**

**THE USAGE OF ROAD SENSOR NETWORK IN APT MEMBER COUNTRIES**

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**No. APT/AWG/REP-61**

**apt report on**

**the Usage of road sensor network in apt MEMBER countries**

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# Scope

This report describes the current usage and future plan on Road Sensor Network (RSN) in APT member countries in terms of frequency allocations, technologies and standards, applications and deployment plans. The key technologies of RSN are wireless sensor network, road radar and V2X communications. This report has been developed by contributions from APT member countries and will be updated further.

# Acronyms and abbreviations

CCTV: Closed-circuit television

C-ITS: Cooperative intelligent transport systems

DSRC: Dedicated short-range communications

ETC: Electronic toll collection system

RSN: Road sensor network

V2X: Vehicle-to-vehicle and vehicle-to-infrastructure

# Introduction

As the road status monitoring and management is increasingly important, Road Sensor Network (RSN) has been deployed at the road. RSN (Road Sensor Network) means a specific type of wireless sensor network which is installed at the road for ITS applications. Road sensors may be loop detector, magnetic sensors, radar and CCTV camera. These are used for vehicle motion detection, traffic status monitoring and weather conditions, and so on.

Loop detectors are currently used and reliable technology for vehicle detection, which has high cost in maintenance. However, magnetic sensor network will be a new technology for vehicle detection, which has lower cost in installation and maintenance. And CCTV camera is currently used technology for road situation monitoring, vehicle plate number detection, which has a lower performance in bad weather condition. Radar is a reliable technology for vehicle speed detection and object ranging in bad weather condition. Thus, sensor fusion of road radar and CCTV will provide more accurate and reliable technology. Figure 1 shows the concept of RSN.

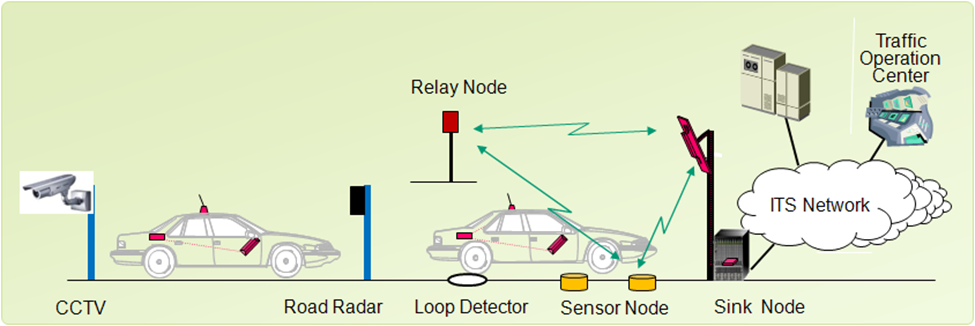


Fig. 1 Concept of RSN

In AWG-14 meeting, TG-ITS agreed to create a new work item on Road Sensor Network which was proposed by Republic of Korea. In the next AWG-15 meeting, TG ITS developed a survey questionnaire to collect information on ITS from each APT countries. In the AWG-16 and AWG-17 meeting, TG ITS developed the preliminary draft report and reviewed it to reflect the opinions from APT countries.

The purpose of the questionnaire is to develop an informative report for further study of regional/international ITS harmonization.

The Survey results consist of the responses to the questionnaire received to the TG ITS questionnaire from 7 administrations/associated administrations, Australia, China, Islamic Republic of Iran, Japan, Korea(Republic of), Singapore, Sri Lanka(in alphabetic order).

This Report identifies the survey results on current and planned usage of RSN, frequency bands, status of service deployment in APT member countries. The results of the survey are summarized and attached in Annex.

Survey consists of the following main questions:

* *What frequency band(s) is/are used for road sensor network in your country as of   
  2013?*
* *What frequency bands are allocated for road sensor network technology on your   
  frequency allocation table in your country?*
* *Which technologies and/or standards is/are being used in the frequency band(s)   
  mentioned in Question 1? (For example, such as ZigBee)*
* *In addition to the answers above, would you provide the future plan for the designation of ITS frequency band(s)?*

Based on the replies, major deployed ITS systems in APT countries were classified as vehicle detection, road radar, V2X communication. In this report, we described service overview, established standards, frequency plan, and implication in each ITS system.

# RSN Deployment in APT countries/regions

* 1. **Wireless Sensor Network**

ZigBee technology is a typical wireless sensor network with small power and 10-100 meters radio distance. By integrating magnetic sensors, vehicle detection is possible and can be applied for electronic parking system and traffic monitoring. It has 2.4GHz spectrum with IEEE 802.15.4 standard. Also, Bluetooth may be used for traffic monitoring.

* 1. **Road Radar**

Road radar technology detects the distance to the moving vehicles with sharp beam width less than 150 meters. Road radar in 24 and 31 GHz spectrum will detect status on vehicle and road. It will be functional in case of bad weather condition.

* 1. **V2X**

Vehicle to vehicle and vehicle to Infrastructure communication provides ETC and C-ITS applications. 5.8GHz DSRC is widely used for ETC and 5.9GHz technology will be used for vehicle safety and C-ITS applications

This is a working draft to summarize response to questionnaire on road sensor network from 7 APT countries (Australia INP-22, China INP-83, Japan INP-09, Korea INP-101, Singapore INP-13, Sri Lanka INP-33, during AWG-16 meeting in Pattaya, Thailand, and Islamic Republic of Iran INP-50 during AWG-17 meeting in Macao, China.

APT countries currently are using 2.4GHz and 5.8GHz radio communication, 24GHz and 34GHz radar in Road Sensor Network. 2.4GHz and 5.8GHz radio communications provide vehicle detection and travel time survey, and ETC application. And 24GHz and 34GHz radar provide vehicle detection and road condition detection. The current use of RSN in APT countries is summarized in table 1.

APT countries have a plan to use 5.8GHz and 5.9 GHz in Road Sensor Network for vehicle management and ITS applications, which is summarized in table 2.

Table 1 The current use of RSN in APT countries

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Countries** | **Frequency Band**  **(Q1, Q2)** | **Technology/**  **Standard**  **(Q3, Q4)** | **Application**  **(Q5)** | **Deployment or plan**  **Year(Q5)** | **Other**  **Comment** |
| Australia | 2.4-2.4835 GHz | Wireless in-pavement sensors using Zig-Bee IEEE802.15.4 | Vehicle detection  (volume, speed, occupancy, classification) | Deployed from 2010 | Other wireless detectors are used, but these utilize either radar or infrared which is outside of the radio frequency spectrum. |
| 2.4-2.4835  GHz | Bluetooth readers | Travel time and origin-destination surveys | Ad hoc projects from 2013 |  |
| 5.795-5.815 GHz | CEN DSRC for in-vehicle toll tags & road gantries | Electronic Toll Collection (ETC), and travel time | Deployed from 2000 |  |
| Korea | 2.4~2.4835 GHz | IEEE 802.15.4  (ZigBee) | . Vehicle Detection | 2012 | Parking Management System |
| 34.275~ 34.875 GHz | Road Radar | . Incident Detection  . Road Condition  Detection  . Vehicle Detection | 2014 | Technical regulation is fixed determined in September, 2014 |
| P.R. China | 24.150 GHz  ± 100MHz  Radio  Location | Technology.  Use Frequency-Modulated Continuous-Wave (FMCW) Radar for vehicle detection, and distance measurement. | Traffic information collection including volume, average speed, occupancy, classification, direction, speed, etc. |  | Related products have been developed about 7 years ago |
| Singapore | 2.4~2.4835 GHz | Spread Spectrum | Electronic Parking System | Around 2000 |  |

Table 2 The future plan of RSN in APT countries

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Countries** | **Frequency Band**  **(MHz)** | **Technology/**  **Standard** | **Service** | **Deployment or plan**  **Year** | **Other**  **Comment** |
| Australia | 5.850-5.925 GHz | Dedicated short range communications (DSRC), based on IEEE802.11p | Cooperative ITS, including vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications | Planned from 2016 onwards |  |
| Islamic Republic of Iran | 5.875-5.925 GHz | ETSI EN 302 663  ETSI EN 302 571 | Road sensor networks | Probably 2017 |  |
| Japan | 5.770-5.850 GHz | DSRC | Vehicles management for logistics, (eg.  route guidance) by  probe car  information using  ITS-spot uplink. | N/A |  |
| Singapore | 5.9 GHz | TBD | Intelligent Transports System (ITS) | 2020 (Estimated) |  |

# Summary

APT countries currently are using 2.4GHz and 5.8GHz radio communication, 24GHz and 34GHz radar for Road Sensor Network. 2.4GHz and 5.8GHz radio communications provide vehicle detection and travel time survey, and ETC application. And 24GHz and 34GHz radar provide vehicle detection and road condition detection. APT countries have a plan to use 5.8GHz and 5.9 GHz in Road Sensor Network for vehicle management and ITS applications.

# References

[1] AWG-16/TMP-26, “Summary on Usage of RSN in APT countries according to input documentation on “response to questionnaire on RSN” by Korea.

[2] AWG-16/INP-22, “Summary on Usage of RSN in APT countries according to input documentation on “response to questionnaire on RSN” by Australia

[3] AWG-16/INP-09, “Summary on Usage of RSN in APT countries according to input documentation on “response to questionnaire on RSN” by Japan

[4] AWG-16/INP-101, “Summary on Usage of RSN in APT countries according to input documentation on “response to questionnaire on RSN” by Korea

[5] AWG-16/INP-83, “Summary on Usage of RSN in APT countries according to input documentation on “response to questionnaire on RSN” by China

[6] AWG-16/INP-33, “Summary on Usage of RSN in APT countries according to input documentation on “response to questionnaire on RSN” by Sri Lanka

[7] AWG-16/INP-13, “Summary on Usage of RSN in APT countries according to input documentation on “response to questionnaire on RSN” by Singapore

[8] AWG-17/INP-50, “Summary on Usage of RSN in APT countries according to input documentation on “response to questionnaire on RSN” by Islamic Republic of Iran

**ANNEX**

**- Questionnaire and Responses**

**Question 1:** What frequency band(s) is/are used for road sensor network in your country as of   
2013?

**Question 2:** What frequency bands are allocated for road sensor network technology on your   
frequency allocation table in your country?

**Question 3:** Which technologies and/or standards is/are being used in the frequency band(s)   
mentioned in Question 1? (For example, such as ZigBee)

**Question 4:** If above question 1 and 2 were answered, would you provide the summary   
of technologies and/or standards used in the frequency band(s) mentioned in Question 1 and 2?

**Question 5:** If above question 1, 2 and 3 were answered, would you provide the summarized   
current status of application deployment used in the frequency band(s) mentioned in Question 1   
and 2? (For example, parking management system, road condition detection system)

**Answers to Questions 1, 2, 3, 4 and 5:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Frequency Band(MHz)**  **(Q1, Q2)** | **Technology/**  **Standard**  **(Q3, Q4)** | **Application**  **(Q5)** | **Deployment or plan**  **Year(Q5)** | **Other**  **Comment** |
|  |  |  |  |  |
|  |  |  |  |  |

**Answer to Question 6: None**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Frequency Band(MHz)** | **Technology/**  **Standard** | **Service** | **Deployment or plan**  **Year** | **Other**  **Comment** |
|  |  |  |  |  |

1. **Administrations that submitted responses to APT during AWG-16 and AWG-17**
2. Australia
3. Islamic Republic of Iran
4. Japan
5. Korea
6. China
7. Sri Lanka
8. Singapore
9. **Responses**
10. **Australia**

Q1~Q5)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Frequency Band(MHz)**  **(Q1, Q2)** | **Technology/**  **Standard**  **(Q3, Q4)** | **Application**  **(Q5)** | **Deployment or plan**  **Year(Q5)** | **Other**  **Comment** |
| 2.4-2.4835 GHz | Wireless in-pavement sensors using Zig-Bee IEEE802.15.4 | Vehicle detection (volume, speed, occupancy, classification) | Deployed from 2010 |  |
| 2.4-2.4835 GHz | Bluetooth readers | Travel time and origin-destination surveys | Ad hoc projects from 2013 |  |
| 5.795-5.815 GHz | CEN DSRC for in-vehicle toll tags & road gantries | Electronic Toll Collection (ETC), and travel time | Deployed from 2000 |  |

**Note** – other wireless detectors are used, but these utilize either radar or infrared which is outside of the radio frequency spectrum.

**Q6)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Frequency Band(MHz)** | **Technology/**  **Standard** | **Service** | **Deployment or plan**  **Year** | **Other**  **Comment** |
| 5.850-5.925 GHz | Dedicated short range communications (DSRC), based on IEEE802.11p | Cooperative ITS, including vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications | Planned from 2016 onwards |  |

1. **Islamic Republic of Iran**

Q1~Q5)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Frequency Band(MHz)**  **(Q1, Q2)** | **Technology/**  **Standard**  **(Q3, Q4)** | **Application**  **(Q5)** | **Deployment or plan**  **Year(Q5)** | **Other**  **Comment** |
| 5.875-5.925GHz | ETSI EN 302 663  ETSI EN 302 571 | Road sensor networks | Probably 2017 |  |

**Q6)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Frequency Band(MHz)** | **Technology/**  **Standard** | **Service** | **Deployment or plan**  **Year** | **Other**  **Comment** |
|  |  |  |  |  |

1. **Japan**

Q1~Q5)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Frequency Band(MHz)**  **(Q1, Q2)** | **Technology/**  **Standard**  **(Q3, Q4)** | **Application**  **(Q5)** | **Deployment or plan**  **Year(Q5)** | **Other**  **Comment** |
|  |  |  |  |  |

**Q6)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Frequency Band(MHz)** | **Technology/**  **Standard** | **Service** | **Deployment or plan**  **Year** | **Other**  **Comment** |
| 5.770-5.850GHz | DSRC | Vehicles management for logistics, (eg.  route guidance) by  probe car  information using  ITS-spot uplink. | N/A |  |

1. **Korea**

Q1~Q5)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Frequency Band(MHz)**  **(Q1, Q2)** | **Technology/**  **Standard**  **(Q3, Q4)** | **Application**  **(Q5)** | **Deployment or plan**  **Year(Q5)** | **Other**  **Comment** |
| 2.4-2.4835 GHz | IEEE 802.15.4  (ZigBee) | . Vehicle Detection | 2012 | Parking Management System |
| 34.275~ 34.875 GHz | Road Radar | . Incident Detection  . Road Condition  Detection  . Vehicle Detection | 2014 | Technical regulation will be determined in March, 2014 |

**Q6)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Frequency Band(MHz)** | **Technology/**  **Standard** | **Service** | **Deployment or plan**  **Year** | **Other**  **Comment** |
|  |  |  |  |  |

1. **China**

Q1~Q5)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Frequency Band(MHz)**  **(Q1, Q2)** | **Technology/**  **Standard**  **(Q3, Q4)** | **Application**  **(Q5)** | **Deployment or plan**  **Year(Q5)** | **Other**  **Comment** |
| 24.150 GHz  ± 100MHz  RADIO LOCATION | Technology.  - Use Frequency-Modulated Continuous-Wave (FMCW) Radar for vehicle detection, and distance measurement. | Traffic information collection including volume, average speed, occupancy, classification, direction, speed, etc. | Related products have been developed about 7 years ago. |  |

**Q6)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Frequency Band(MHz)** | **Technology/**  **Standard** | **Service** | **Deployment or plan**  **Year** | **Other**  **Comment** |
| TBD |  |  |  |  |

1. **Sri Lanka**

Q1~Q5)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Frequency Band(MHz)**  **(Q1, Q2)** | **Technology/**  **Standard**  **(Q3, Q4)** | **Application**  **(Q5)** | **Deployment or plan**  **Year(Q5)** | **Other**  **Comment** |
| NA |  |  |  |  |
| NA |  |  |  |  |

**Q6)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Frequency Band(MHz)** | **Technology/**  **Standard** | **Service** | **Deployment or plan**  **Year** | **Other**  **Comment** |
|  |  |  |  |  |

1. **Singapore**

Q1~Q5)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Frequency Band(MHz)**  **(Q1, Q2)** | **Technology/**  **Standard**  **(Q3, Q4)** | **Application**  **(Q5)** | **Deployment or plan**  **Year(Q5)** | **Other**  **Comment** |
| 2.4~2.4835 GHz | Spread Spectrum | Electronic Parking System | Around 2000 |  |

**Q6)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Frequency Band(MHz)** | **Technology/**  **Standard** | **Service** | **Deployment or plan**  **Year** | **Other**  **Comment** |
| 5.9GHz | TBD | Intelligent Transports System (ITS) | 2020 (Estimated) |  |

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