C-ITS Trends in Korea

Contents

1. Background
2. Process of C-ITS Business
3. Technologies and Services
4. Future Plan

2015. 03. 26
LG Electronics
1. Background
Traffic Condition in Korea

Safety
- The number of accidents: 215,354
- The number of deaths: 5,092
- The number of injuries: 328,711
- The number of registered cars: 20,002,967 (2014.11)

Korea National Police Agency, 2013

Mobility
- Congestion cost: 25 billion euros
- In 2015, it might be gone up to 26.5 billion euros which is equivalent to 2.16% of GDP

Korea Transport Institute, 2013

Environment
- 80 million tons of CO2 emission caused by Road section every year
- 85 million tons of CO2 emission caused by Traffic section (road, railroad, vessel, aircraft, etc.)

Korea Transportation Safety Authority, 2011
Cooperative ITS

C-ITS system helps to prevent car accidents and to improve traffic efficiency by exchanging real-time vehicle data between cars and infrastructures.
Services of Cooperative ITS

- **General Driving Situation**
  - General Traffic Information
  - Speed Limit Information
  - Traffic Flow Monitoring

- **Dangerous Situation**
  - Local Dangerous Warning
  - Speed Limit Warning
  - Hard Braking Warning
  - FCW
  - CSW
  - BSW / LCW
  - Construction Site Warning
  - Road Condition Warning

- **Just Before Accident**
  - Time To Collision (TTC)
  - 1 ~ 5 sec
  - 5 ~ 30 sec

- **Accident Situation**
  - EEBL
  - Impact mitigation (Active seat-belt)
  - Airbag Seat-belt
  - Restraint System

- **After Accident**
  - E-Call
  - Emergency Car Priority Control
  - Accident Data Record

**Time To Collision (TTC)**

- ITS
- C-ITS
- Misc.
Services of Cooperative ITS

General Driving Situation
- General Traffic Information
- Speed Limit Information
- Traffic Flow Monitoring

Dangerous Situation
- Local Dangerous Warning
- Speed Limit Warning
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After Accident
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- Emergency Car Priority Control
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Time To Collision (TTC)
- 1 ~ 5 sec
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**Trends of Cooperative ITS over the world**

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**Frequency Allocation for C-ITS**

- Frequency band: 5.855 ~ 5.925 GHz
- Channel bandwidth: 10 MHz/CH, 7 CH
- Countries: EU, US, Canada, Mexico, Australia
- Note: South Korea
  - Currently it is allocated for Mobile Broadcasting
  - Several CH allocation proposals are being reviewed
  - The same mechanism will most likely be applied for global harmonization in near future

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**Frequency Spectrum (GHz)**

- 5.850 ~ 5.925 GHz: 275 MHz
- Countries: EU, US, Canada, Mexico, Australia
- Note: South Korea
- Currently it is allocated for Mobile Broadcasting
- Several CH allocation proposals are being reviewed
- The same mechanism will most likely be applied for global harmonization in near future
Driving Force

Government Projects (2013.5)

- Government Project (84): Advancement of Traffic Safety
- Implementation of Smart and Safe Road & Infrastructure: Introduction of C-ITS

R&D

- U-Transportation based technology (’06~’11)
- SMART Highway development (’08~’14)
- C-ITS Introduction plan research (’13)

Plan

- ITS development strategy (’12.1)
- ITS plan of vehicle & road traffic for 2020 (’12.6)
- Action plan for government project (’13.9)

- Basic Plan for C-ITS (’13.12)
- C-ITS Pilot Project (’14~’16)
- C-ITS Pre-deployment (’17~ )
2. C-ITS Business Plan
C-ITS Overall Plan

**Expressway (V2I Service)**
- 10% Penetration of OBU
- Basic Services (Safety Warning / ETC)
- Expressway 68%

**Metropolitan Area (Advanced V2I, V2V)**
- 50% Penetration of OBU
- Mandatory Equipment for Commercial Cars
- Vehicle Interworking Services
- Expressway 100%
- National Highway 16%
- Urban Roadway 12%

**Local Area (Advanced V2, V2P)**
- 70% Penetration of OBU
- Mandatory Equipment for Individual Cars
- Autonomous Driving Supporting Services
- Expressway 100%
- National Highway 67%
- Urban Roadway 17%

**Long term (‘26~‘30)**
- Totally 3 billion Euros
- Zero(0) Death from Traffic Accidents

**Medium term (‘21~‘25)**

**Short term (‘14~‘20)**
### C-ITS Budget Plan

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<tr>
<th>Stage</th>
<th>Location</th>
<th>OBU Devices</th>
<th>Costs</th>
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<tbody>
<tr>
<td><strong>Pilot Project</strong></td>
<td>Location: 75km (Expressway, National Highway, Urban)</td>
<td>OBU: 3,000 devices</td>
<td>Costs: 14.7 million Euros</td>
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<td>2014 ~ 2016 (3 years)</td>
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<tr>
<td><strong>Short term - Introduction</strong></td>
<td>Location: 3,494km (Expressway) (construction rate: 4%)</td>
<td>OBU: 2 million devices</td>
<td>Costs: 700 million Euros</td>
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<td>2017 ~ 2020 (4 years)</td>
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<tr>
<td><strong>Medium term - Expansion</strong></td>
<td>Location: 11,870km (Metropolitan) (construction rate: 18%)</td>
<td>OBU: 9 million devices</td>
<td>Costs: 1.15 billion Euros</td>
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<td>2021 ~ 2025 (5 years)</td>
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<td>(total: 1.865 billion Euros)</td>
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<td><strong>Long term - Maturity</strong></td>
<td>Location: 10,332km (Local) (construction rate: 30%)</td>
<td>OBU: 5 million devices</td>
<td>Costs: 1.135 billion Euros</td>
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<tr>
<td>2026 ~ 2030 (5 years)</td>
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<td>(total: 3 billion Euros)</td>
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* Basic Plan for C-ITS ('13.12)
C-ITS Pilot Project (2014~2016)

Driving Organizations

- Ministry of Land, Infrastructure and Transport
- Korean Expressway Corporation
- ITS Korea
- The Korea Transport Institute

Pilot Project Summary

<table>
<thead>
<tr>
<th>Category</th>
<th>Specification</th>
<th>Quantity</th>
<th>Expense</th>
</tr>
</thead>
<tbody>
<tr>
<td>OBU / RSU</td>
<td>WAVE Protocol</td>
<td>3,000 / 95</td>
<td>14.7 million Euros</td>
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<tr>
<td>Applications</td>
<td>Safety &amp; Probing Data</td>
<td>15</td>
<td></td>
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<tr>
<td>Center System</td>
<td>Server</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Goal of Pilot Project

1. **Service Development**
   - Implementation of 15 applications
   - Construction of 95 infrastructures
   - Deployment of beta ver. of OBU for analysis of effect

2. **Validity Verification**
   - Safety effect and economical efficiency analysis
   - Driver acceptance analysis

3. **Establishment of Business Foundation**
   - Development of technical standards
   - Research for certification criteria & tools
   - Improvement proposals for law system
Pilot Project Target Area Selection

- **Process for Target Area Selection**
  - Process:
    - Target Search → Evaluation → Selection
  - Consideration:
    - Use of Existing ITS Infra → OBU Supply Condition → Possibility of Implementation

- **Spatial Extent**

![Map Image](image-url)
C-ITS OBU (Example)

- **Architecture in a Car**

- **Human Machine Interface (HMI) Types**

<table>
<thead>
<tr>
<th>Head-Up Display Type</th>
<th>Navigation System Type</th>
<th>Smartphone/Tablet Type</th>
</tr>
</thead>
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<tr>
<td><img src="image1.png" alt="Head-Up Display" /></td>
<td><img src="image2.png" alt="Navigation System" /></td>
<td><img src="image3.png" alt="Smartphone/Tablet" /></td>
</tr>
</tbody>
</table>
3. Technologies and Services
Communication Technology

Wireless Access in Vehicular Environment (WAVE)

- Real-time data
- Safety warning

Providing Safety & Mobility Services using bi-directional communication between Vehicle and/or Infrastructure

- Frequency Band: 5.855 ~ 5.925 GHz
- Transmission Range: ~ 500 m
- Date Rate: 6~27 Mbps
Automatic Events Detection System

Video Detection System
- Video Data Collection (7Ch Video)

Radar Detector
- Radar Data Collection
- Complement of Camera (Night, Bad weather)

Detection Controller
- Video & Radar Data Fusion
- Estimation of the Situation
- Generation Meaningful Info

Sending Video & Radar Data

An Event Occurred

Sending Position Data

Automatic Tracking CCTV
- Automatic Events Monitoring

16
Multiple-Lane Tolling System

1. Entry Detection
   - Laser Detector

2. Communication Start
   - WAVE Antenna

3. Car Number Detection
   - Violation Recorder
   - 97% Accuracy

4. Car Type Detection
   - Car Type Detector
   - 98% Accuracy

Okay for Toll Payment
Fee: 1.5 Euros
Balance: 15 Euros
## Main Services (15 Applications)

<table>
<thead>
<tr>
<th>No</th>
<th>Services</th>
<th>Target Year</th>
<th>Comm. Type</th>
<th>Target Area</th>
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<tr>
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<td></td>
<td><code>14</code></td>
<td><code>15</code></td>
<td><code>16</code></td>
</tr>
<tr>
<td>1) Probing Basic Data</td>
<td>1) Probing location based vehicle information</td>
<td>O</td>
<td>O</td>
<td>O</td>
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<tr>
<td>2) Providing location based traffic information</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
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<tr>
<td>3) Tolling system using WAVE protocol</td>
<td>-</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>2) Proving Probing Basic Data</td>
<td>4) Dangerous location warning</td>
<td>N/A</td>
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<td>O</td>
</tr>
<tr>
<td>5) Providing road condition and weather information</td>
<td>N/A</td>
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<tr>
<td>6) Construction site warning</td>
<td>N/A</td>
<td>O</td>
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<tr>
<td>3) Proving Safety Driving Support</td>
<td>7) Intersection traffic sign violation warning</td>
<td>N/A</td>
<td>N/A</td>
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<td>8) Right turn warning</td>
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<tr>
<td>4) Proving Public Safety Support</td>
<td>9) Bus operation management</td>
<td>N/A</td>
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<tr>
<td>10) Providing yellow bus operation information</td>
<td>N/A</td>
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<tr>
<td>5) Proving VRU Safety Support</td>
<td>11) School zone, silver zone warning</td>
<td>N/A</td>
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<td>12) Pedestrian collision warning</td>
<td>N/A</td>
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<tr>
<td>6) Proving Inter-Vehicle Safety Support</td>
<td>13) Forward collision warning</td>
<td>N/A</td>
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<tr>
<td>14) Emergency vehicle approaching warning</td>
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<td>15) Vehicle emergency situation warning</td>
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</table>

1) Vulnerable Road User
**Expected Effect**

- **Improvement of Congestion Situation**
  - 30 ~ 60% Decrease

- **Congestion Cost Reduction**
  - 650 million Euros / Year

- **Effective Utilization of Road**
  - 13% of Traffic Volume Increase

- **Accident Cost Reduction**
  - 3 billion Euros

- **New Market Creation**
  - 70% of Penetration Rate in 2027

**Additional Expected Benefits**

- **76% of Traffic Accidents Prevention**

**Pie Chart**

- **Head-on Collision (V2V)**: 28.1%
- **Rear-end Collision (V2V)**: 35.7%
- **Head-on Collision (V2V)**: 3.9%
- **Etc. (V2V)**: 6.9%
- **Pedestrian Accident (V2P)**: 21.2%
- **Single Vehicle Accident**: 4.2%
4. Future Plan
C-ITS Pilot Project Overall Schedule

2014

2Q 3Q 4Q 1Q

Design Contract Drawing and Specification Device Deployment Plan

Business Plan Call for Bids / Contracts Device Development & Prototype

Analysis of Needs for 5.9GHz Frequency Discussion with Broadcaster Withdrawal of the Frequency / Compensation for Broadcaster Frequency Allocation

2015

2Q 3Q 4Q 1Q


Research International Trends Service HW Certification Method Proposal Service HW Certification Method Decision

2016

2Q 3Q 4Q

Analysis of Current Law System for Collecting Personal Data Driver Test Planning Survey and Analysis of Driver Acceptance Service Improvement

Effect Analysis Statistical Analysis for Accidents Report

Service Start
Supplier Selection Plan

- **Selection Procedure**
  - PHY layer Test Spec. Release (‘15.2)
  - Call for bids (‘15.3.13)
  - Technical Proposal
  - Price Proposal
  - Supplier Selection (‘15.4.13)

- **Main Test**
  - PHY Spec. Performance Conformity Test
    - Host: Korea certification organization relating wireless technologies
    - Contents: IEEE 802.11p conformity test (maximum PER of 10%)
  - Field Performance Test (Proposal)
    - Location: Yeoju testing road
    - Contents: PHY conformity test while driving
    - Target: OBU, RSU
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  - Urban Roadway 17%
C-ITS Budget Plan

**Pilot Project**
- 2014 ~ 2016 (3 years)
- Location: 75km (Expressway, National Highway, Urban)
- OBU: 3,000 devices
- Costs: 14.7 million Euros

**Short term - Introduction**
- 2017 ~ 2020 (4 years)
- Location: 3,494km (Expressway) (construction rate: 4%)
- OBU: 2 million devices (penetration rate: 10%)
- Costs: 700 million Euros

**Medium term - Expansion**
- 2021 ~ 2025 (5 years)
- Location: 11,870km (Metropolitan) (construction rate: 18%)
- OBU: 9 million devices (penetration rate: 50%)
- Costs: 1.15 billion Euros (total: 1.865 billion Euros)

**Long term - Maturity**
- 2026 ~ 2030 (5 years)
- Location: 10,332km (Local) (construction rate: 30%)
- OBU: 5 million devices (penetration rate: 70%)
- Costs: 1.135 billion Euros (total: 3 billion Euros)

* Basic Plan for C-ITS (‘13.12)
C-ITS Pilot Project (2014~2016)

Driving Organizations

- Ministry of Land, Infrastructure and Transport
- Korean Expressway Corporation
- ITS Korea
- The Korea Transport Institute

Pilot Project Summary

<table>
<thead>
<tr>
<th>Category</th>
<th>Specification</th>
<th>Quantity</th>
<th>Expense</th>
</tr>
</thead>
<tbody>
<tr>
<td>OBU / RSU</td>
<td>WAVE Protocol</td>
<td>3,000 / 95</td>
<td>14.7 million Euros</td>
</tr>
<tr>
<td>Applications</td>
<td>Safety &amp; Probing Data</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Center System</td>
<td>Server</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Goal of Pilot Project

1. Service Development
   - Implementation of 15 applications
   - Construction of 95 infrastructures
   - Deployment of beta ver. of OBU for analysis of effect

2. Validity Verification
   - Safety effect and economical efficiency analysis
   - Driver acceptance analysis

3. Establishment of Business Foundation
   - Development of technical standards
   - Research for certification criteria & tools
   - Improvement proposals for law system
Pilot Project Target Area Selection

- **Process for Target Area Selection**
  - **Process**
    - Target Search ➔ Evaluation ➔ Selection
  - **Consideration**
    - Use of Existing ITS Infra ➔ OBU Supply Condition ➔ Possibility of Implementation

- **Spatial Extent**

Legend
- Expressway (26km)
- National Highway (2.9km)
- Urban Road (52.1km)

Urban Road (Sejong): 23.1km
Urban Road (Daejeon): 29km
National Highway 2.9km
Expressway 18.5km
Expressway 7.5km
Communication Technology

- Wireless Access in Vehicular Environment (WAVE)

- V2V
  - Real-time data
  - Safety warning

- V2I
  - SOS
  - Traffic Info

<Components>

- WAVE Device
- WAVE Chip
- WAVE Controller

- Providing Safety & Mobility Services using bi-directional communication between Vehicle and/or Infrastructure

- Frequency Band: 5.855 ~ 5.925 GHz

- Transmission Range: ~ 500 m

- Date Rate: 6~27 Mbps
Automatic Events Detection System

Video Detection System
- Video Data Collection
  - (7Ch Video)

Radar Detector
- Radar Data Collection
- Complement of Camera
  - (Night, Bad weather)

Sending Video
& Radar Data

Detection Controller
- Video & Radar Data Fusion
- Estimation of the Situation
- Generation Meaningful Info

Sending Position Data

Automatic Tracking CCTV
- Automatic Events Monitoring
**Expected Effect**

- **Improvement of Congestion Situation**
  - 30 ~ 60% Decrease

- **Congestion Cost Reduction**
  - 650 million Euros / Year

- **Effective Utilization of Road**
  - 13% of Traffic Volume Increase

- **Accident Cost Reduction**
  - 3 billion Euros

- **New Market Creation**
  - 70% of Penetration Rate in 2027

**76% of Traffic Accidents Prevention**

- **Rear-end Collision (V2V)**
  - 35.7%

- **Head-on Collision (V2V)**
  - 28.1%

- **Pedestrian Accident (V2P)**
  - 21.2%

- **Etc. (V2V)**
  - 6.9%

- **Single Vehicle Accident**
  - 3.9%
C-ITS Pilot Project Overall Schedule

2014

- Design Contract
- Drawer and Specification
- Device Deployment Plan
- Business Plan
- Call for Bids / Contracts
- Device Development & Prototype
- Analysis of Needs for 5.9GHz Frequency
- Discussion with Broadcaster
- Withdrawal of the Frequency / Compensation for Broadcaster
- Frequency Allocation

2015

- Service, Message, HW Spec. Publish
- Spec. Modification
- Research International Trends
- Service HW Certification Method Proposal
- Service HW Certification Method Decision
- Analysis of Current Law System for Collecting Personal Data
- Driver Test Planning
- Survey and Analysis of Driver Acceptance
- Service Improvement
- Effect Analysis
- Statistical Analysis for Accidents
- Report

2016

- Service Start
Supplier Selection Plan

- Selection Procedure

  1. PHY layer Test Spec. Release (’15.2)
  2. Call for bids (’15.3.13)
  3. Technical Proposal
  4. Price Proposal
  5. Supplier Selection (’15.4.13)

- Main Test

  - PHY Spec. Performance Conformity Test
    - Host: Korea certification organization relating wireless technologies
    - Contents: IEEE 802.11p conformity test (maximum PER of 10%)
  
  - Field Performance Test (Proposal)
    - Location: Yeoju testing road
    - Contents: PHY conformity test while driving
    - Target: OBU, RSU