5.9 GHz
DEDICATED SHORT RANGE COMMUNICATION (DSRC)
OVERVIEW
What is it?

Who developed it?

When would it be advantageous to use it?

When will products be available?

When will it be available as original equipment in new cars?

What plug replaceable technology can be used for some data transfer applications in the interim?

What model deployments are being planned for next year?

How will this affect Toll Agencies?

When should state agencies start planning to deploy it?

What will be required from the frequency coordinator?
WHAT IS IT ???
5.9 GHz DSRC CONCEPT

5.9 GHz DSRC (Dedicated Short Range Communications) is a short to medium range communications service that supports both Public Safety and Private operations in roadside to vehicle and vehicle to vehicle communication environments. DSRC is meant to be a complement to cellular communications by providing very high data transfer rates in circumstances where minimizing latency in the communication link and isolating relatively small communication zones are important.
NORTH AMERICAN DSRC STANDARDS STRUCTURE OVERVIEW

CORE DSRC STANDARDS STRUCTURE

- Standards that must be modified or completed
- Standards that must be written
- Established Standards and procedures that are referenced or used as necessary
- Only a subset of IEEE 802.2 functions are required to support Layer 3

- 5.9 GHz North American Architecture Specification ASTM ????-A
- 5.9 GHz Test Procedure Specification ASTM ????-T

- Management Flow
- Data Flow

SAP 1 for Network Services

SAP 2 for Network Services

Resource Manager IEEE 1455
Application Layer/ Layers 3-7 IEEE 1455
Layer 2 Medium Access Control (MAC) IEEE 802.11
Layer 1 Physical Layer/ (PHY) IEEE 802.11a

Application Manager IEEE 1609.1
Application and Network Layers Layers 3 – 7 IEEE 1609.3 (Streamlined ISO 21210)
Logical Link Layer (LLC) Layer 2b IEEE 802.2
Medium Access Layer (MAC) and Physical Layer (PHY) Layers 1 and 2a ASTM E2313-02 ISO 21215

IEEE 802.11
IEEE 802.2
IEEE 1455
IEEE 1609.1
IEEE 1609.3
IEEE 1609.3
IEEE 1455
IEEE 802.2
IEEE 802.11
IEEE 802.11a
ISO TC204 WG-16 CALM ARCHITECTURE

- Standards that must be written
- Standards that must be modified or completed
- Established Standards and procedures that are referenced or used as necessary

EXISTING ITS APPLICATIONS (e.g. ISO14906, Resource manager)

INTERNET ITS APPLICATIONS

Layer 4-7 (TCP) INTERNET STANDARDS

Layer 3 (IPv6) NETWORK INTERFACE Routing and Media Switching ISO 21210

Layer 1/2 2/2.5G CELLULAR ISO 21212
Layer 1/2 3G CELLULAR ISO 21213
Layer 1/2 CALM IR ISO 21214
Layer 1/2 CALM M5 ISO 21215
Layer 1/2 CALM 60 ISO 21216

North American DSRC Standard

CALM – Communications Air Interface Long and Medium Range

SAP

- Service Access Point – defined by standard below SAP

North American DSRC Standard
5.9 GHz DSRC TECHNOLOGY CHARACTERISTICS

- Approach: Active
- Bandwidth: 75 MHz (5.850 - 5.925 GHz)
- Modulation: QPSK OFDM (with 16QAM and 64QAM options) (BPSK preamble)
- Channels: 7 - 10 MHz channels (optional combinations of 10 and 20 MHz channels)
- Data Rate: 6, 9, 12, 18, 24, and 27 Mbps with 10 MHz Channels (3 Mbps preamble)
  (or 6, 9, 12, 18, 24, 36, 48, and 54 Mbps with 20 MHz Channel option) (6 Mbps preamble)
- Max Tx Pwr: 28.8 dBm (at the antenna input)
- RSU EIRP: Nominal 0 - 33 dBm (1 mW - 2 W) / Max. 44.8 dBm (30 W)
- OBU EIRP: Nominal 0 - 20 dBm (1 - 100 mW) / Max. 44.8 dBm (30 W)
- RSU and OBU Sensitivity: -82 dBm (QPSK) / -65 dBm (64QAM)
- C/I: 4 - 6 dB (for QPSK @ 10^-4 BER coded) / 16 - 17 dB (for 64QAM @ 10^-4 BER coded)
- Band Sharing Strategy - Frequency Coordination. Selection of alternate channels for adjacent zones. Use CSMA to prevent interference between users in the channel.
## DSRC CAPABILITIES COMPARISON

(in the designated ITS RADIO SERVICE bands)

<table>
<thead>
<tr>
<th>PARAMETERS</th>
<th>902 - 928 MHz Band</th>
<th>5850 - 5925 MHz Band</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spectrum Used</td>
<td>12 MHz (909.75 to 921.75 MHz)</td>
<td>75 MHz</td>
</tr>
<tr>
<td>Data Rate</td>
<td>0.5 Mbps</td>
<td>6 Mbps - 27 Mbps</td>
</tr>
<tr>
<td>Coverage</td>
<td>One communication zone at a time</td>
<td>Overlapping communication zones</td>
</tr>
<tr>
<td>Allocation Status</td>
<td>No protection</td>
<td>Primary Status (high protection)</td>
</tr>
<tr>
<td>Interference Potential</td>
<td>Many 900 MHz Phones, Many Rail Car AEI Readers, Many Spread Spectrum Devices, Wind Profile Radars</td>
<td>Sparsely located Military Radars, Very Sparsely located Satellite Uplinks</td>
</tr>
<tr>
<td>Maximum Range</td>
<td>300 ft (at required- 30 dBm sensitivity)</td>
<td>1000 m (~ 3000 ft)</td>
</tr>
<tr>
<td>Minimum Separation</td>
<td>1500 ft (except where carefully planned)</td>
<td>50 ft (on small zone channels)</td>
</tr>
<tr>
<td>Channel Capacity</td>
<td>1 to 2 channels</td>
<td>7 channels</td>
</tr>
<tr>
<td>Power (Downlink)</td>
<td>Nominally less than 40 dBm (10 W)</td>
<td>Nominally less than 33 dBm (2 W)*</td>
</tr>
<tr>
<td>Power (Uplink)</td>
<td>Nominally less than 6 dBm (&lt; 4mW)</td>
<td>Nominally less than 33 dBm (2 W)*</td>
</tr>
</tbody>
</table>

*Note - As a special case up to 44.77 dBm (30 W) may be use for qualified public safety applications.*

ITS RADIO SERVICE is the FCC Part 90 designation for the 915 MHz and 5.9 GHz DSRC spectrum.
DSRC PERFORMANCE ENVELOPES

5850 - 5925 MHz Band
Performance Envelope
(Approximate)

902 - 928 MHz Band Performance Envelope

Data Transfer and Internet Access Services

Safety Message Services

Emergency Vehicle Services

Toll and Payment Services

Data Rate (Mbps)

Range (ft)

0.5 Mbps

200 400 600 800 1000 1200 1400 1600 1800 2000 2200 2400 2600 2800 3000 3200 3400 3600

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5.9 GHz DSRC
BASIC OPERATING FACTORS

• PUBLIC SAFETY and PRIVATE APPLICATIONS share the band
• INTEROPERABILITY
• LICENSED OPERATION
• PUBLIC SAFETY INSTALLATION PRIORITY
• NON-MUTUAL EXCLUSIVITY FOR PRIVATE INSTALLATIONS
• LIMITED RANGE FOR PRIVATE OPERATIONS
• FREQUENCY COORDINATOR USED TO ASSIGN LICENSES
5.9 GHz DSRC BASIC CONCEPTS

- Channels in 5.850 to 5.925 GHz follow FCC CFR part 90 and Industry Canada rules
- 10 MHz channels, optional capability to combine 2 channel sets into 20 MHz channels
- RSU EIRP Limit 44.8 dBm (Public Safety), 33 dBm (Private)
- OBU Device EIRP Limit 44.8 dBm (Public Safety), 33 dBm (Private)
- Out of channel emission – 25 dBm (All devices)
- Dedicated Control Channel for announcements and warnings
- Control Channel transmissions comply with ASTM/IEEE XXXX standard
- A dedicated channel is reserved for Vehicle to vehicle communications.
- Intersection application operations are conducted in a dedicated channel.
- 2 small zone Service Channels are designated for extended data transfers.
- 2 medium zone Service Channels are designated for extended data transfers.
- Channels in the UNII band may be used as unlicensed Service Channels.
- OBUs follow RSU instructions in Service Channels.
- OBUs implement a time limit on Service Channel transactions.
HARMONIZED 5.9 GHz DSRC BAND PLAN

Canadian Special License Zones*
US Spread Spectrum Allocation
“Reserved” for harmonization with potential extension of the UNII band

Control Channel
Service Channels
Vehicle to Vehicle

Primarily Public Safety High-power App.

US and Potential Mexican DSRC Allocation
Optional 20 MHz

Proposed Canadian DSRC Allocation
Optional 20 MHz

Potential UNII Expansion Channels

10 MHz Channels with 20 MHz combination options

* - The use of channels overlapping these zones may be restricted in some locations in Canada.
5.9 GHz DSRC BAND PLAN
with 10 MHz CHANNELS & POWER LIMITS
5.9 GHz DSRC BAND PLAN
with 20 MHz CHANNELS & POWER LIMITS

<table>
<thead>
<tr>
<th>Frequency (GHz)</th>
<th>Power Limit</th>
<th>UpLink</th>
<th>DownLink</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.825-5.830</td>
<td>44.8 dBm</td>
<td>33 dBm</td>
<td>23 dBm</td>
</tr>
<tr>
<td>5.835-5.840</td>
<td>40 dBm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.845-5.850</td>
<td>33 dBm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.855-5.860</td>
<td>44.8 dBm</td>
<td>33 dBm</td>
<td>23 dBm</td>
</tr>
<tr>
<td>5.865-5.870</td>
<td>40 dBm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.875-5.880</td>
<td>33 dBm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.885-5.890</td>
<td>44.8 dBm</td>
<td>33 dBm</td>
<td>23 dBm</td>
</tr>
<tr>
<td>5.895-5.900</td>
<td>40 dBm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.905-5.910</td>
<td>33 dBm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.915-5.920</td>
<td>44.8 dBm</td>
<td>33 dBm</td>
<td>23 dBm</td>
</tr>
<tr>
<td>5.925-5.930</td>
<td>40 dBm</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Canadian Special License Zones*
5.7250 to 5.925 GHz
DSRC and UNII CHANNELS

Private
Unlicensed
Shared Public Safety/Private
Control Med Rng Service Short Rng Service
Dedicated Public Safety
Veh-Veh Intersections

US UNII Allocation
Un-licensed
US Spread Spectrum Allocation
US DSRC Allocation
Licensed

Uplink
Downlink

Ch 149 Ch 153 Ch 157 Ch 161
Ch 172 Ch 175 Ch 178 Ch 181 Ch 184

Ch - Channel
Frequency (GHz)
A

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WHO DEVELOPED IT ???
ASTM and IEEE 5.9 GHz DSRC STANDARDS WRITING GROUP PARTICIPATION

- 3-M
- AASHTO
- ACUNIA
- AMTECH
- ARINC
- ARMSTRONG CONSULTING
- AHEROS
- CALTRANS
- DAIMLER-CHRYSLER
- DENSO
- GM
- GTRI
- HIGHWAY ELECTRONICS
- HITACHI
- IDMICRO
- IMEC
- INTERSIL
- ITS-A
- JHU/APL
- KING COUNTY METRO TRANSIT
- MARK IV
- MiCOM Spa
- MICHIGAN STATE DOT
- MITRETEK
- MOTOROLA
- NISSAN
- N.Y. THRUWAY AUTHORITY
- OKI ELECTRIC
- PATH
- RAYTHEON
- SIRIT
- SUMITOMO ELECTRIC
- TECHNOCOM
- TOSHIBA
- TRANSCORE
- VISTEON
- WASHINGTON STATE DOT
- Wi-LAN
### ASTM and IEEE 5.9 GHz DSRC Standards Development Activity

#### MEETINGS SINCE REPORT AND ORDER

| October 1999 | December 1999 |
| February 2000 | March 2000 |
| May 2000 | June 2000 |
| July 2000 | September 2000 |
| October 2000 | November 2000 |
| December 2000 | January 2001 |
| March 2001 | April 2001 |
| May 2001 | |  

* - Technology Selection Meeting

#### MEETINGS SINCE REPORT AND ORDER

| June 2001 | July 2001 |
| August 2001* | October 2001 |
| December 2001 | January 2001 |
| February 2002 | March 2002 |
| May 2002 | June 2002 |

#### MEETINGS CURRENTLY SCHEDULED

| July 2002 | August 2002 |
| September 2002 | |
5.9 GHz DSRC TECHNOLOGY SELECTION

- The final selection between the Motorola entry and the OFDM forum entry was made by the ASTM E17.51 DSRC Standards Writing Group on August 24, 2001. THE WINNER was the OFDM forum entry.

- The writing group selection was confirmed by letter ballot vote of the Larger ASTM E17.51 subcommittee in October 2001.

- The ASTM DSRC STD E2313-02 was approved on 5/10/02.

- The ASTM DSRC STD E2313-02 will undergo validation and verification testing as well as further review which is expected to result in another version with slight modifications by 12/02.
When would it be advantageous to use it?

5.9 GHz DSRC APPLICATIONS
DSRC APPLICATIONS
PUBLIC SAFETY and PRIVATE

PUBLIC SAFETY

• APPROACHING EMERGENCY VEHICLE (WARNING) ASSISTANT (3)
• EMERGENCY VEHICLE SIGNAL PREEMPTION
• ROAD CONDITION WARNING
• LOW BRIDGE WARNING
• WORK ZONE WARNING
• IMMINENT COLLISION WARNING (D)
• CURVE SPEED ASSISTANCE [ROLLOVER WARNING] (1)
• INFRASTRUCTURE BASED – STOP LIGHT ASSISTANT (2)
• INTERSECTION COLLISION WARNING/AVOIDANCE (4)
• HIGHWAY/RAIL [RAILROAD] COLLISION AVOIDANCE (10)
• COOPERATIVE COLLISION WARNING [V-V] (5)
• GREEN LIGHT - OPTIMAL SPEED ADVISORY (8)
• COOPERATIVE VEHICLE SYSTEM – PLATOONING (9)
• COOPERATIVE ADAPTIVE CRUISE CONTROL [ACC] (11)
• VEHICLE BASED PROBE DATA COLLECTION (B)
• INFRASTRUCTURE BASED PROBE DATA COLLECTION
• INFRASTRUCTURE BASED TRAFFIC MANAGEMENT – [DATA COLLECTED from] PROBES (7)
• TOLL COLLECTION
• TRAFFIC INFORMATION (C)
• TRANSIT VEHICLE DATA TRANSFER (gate)
• TRANSIT VEHICLE SIGNAL PRIORITY
• EMERGENCY VEHICLE VIDEO RELAY
• MAINLINE SCREENING
• BORDER CLEARANCE
• ON-BOARD SAFETY DATA TRANSFER
• VEHICLE SAFETY INSPECTION
• DRIVER’S DAILY LOG

PRIVATE

• ACCESS CONTROL
• DRIVE-THRU PAYMENT
• PARKING LOT PAYMENT
• DATA TRANSFER / INFO FUELING (A)
  – ATIS DATA
  – DIAGNOSTIC DATA
  – REPAIR-SERVICE RECORD
  – VEHICLE COMPUTER PROGRAM UPDATES
  – MAP and MUSIC DATA UPDATES
  – VIDEO UPLOADS
• DATA TRANSFER / CVO / TRUCK STOP
• ENHANCED ROUTE PLANNING and GUIDANCE (6)
• RENTAL CAR PROCESSING
• UNIQUE CVO FLEET MANAGEMENT
• DATA TRANSFER / TRANSIT VEHICLE (yard)
• TRANSIT VEHICLE REFUELING MANAGEMENT
• LOCOMOTIVE FUEL MONITORING
• DATA TRANSFER / LOCOMOTIVE

ATIS - Advanced Traveler Information Systems
CVO - Commercial Vehicle Operations
EV - Emergency Vehicles
IDB - ITS Data Bus
THRU – Through
V-V – Vehicle to Vehicle
(#) – Applications Submitted by GM/Ford/Chrysler
(A- Z) – Applications Submitted by Daimler-Chrysler
DSRC APPLICATIONS
by COMMUNICATION CATEGORIES

ALL VEHICLES - Short Range (0 – 15 m)
• ACCESS CONTROL
• TOLL COLLECTION
• DATA TRANSFER / INFO FUELING (A)
• TRAFFIC INFORMATION (C)
• DRIVE-THRU PAYMENT
• PARKING LOT PAYMENT
• INFRASTRUCTURE BASED PROBE DATA COLLECTION
• RENTAL CAR PROCESSING

ALL VEHICLES - Extended Range (90 – 335 m)
• CURVE SPEED ASSISTANCE [ROLLOVER WARNING] (1)
• INFRASTRUCTURE BASED - STOP LIGHT ASSISTANT (2)
• INTERSECTION COLLISION WARNING/AVOIDANCE (4)
• COOPERATIVE COLLISION WARNING [V-V] (5)
• VEHICLE BASED PROBE DATA COLLECTION (B)
• COOPERATIVE ADAPTIVE CRUISE CONTROL (ACC)
• COOPERATIVE VEHICLE SYSTEM – PLATOONING (9)
• HIGHWAY/RAIL [RAILROAD] COLLISION AVOIDANCE (10)
• IMMINENT COLLISION WARNING (D)
• EMERGENCY VEHICLE VIDEO RELAY
• ROAD CONDITION WARNING
• WORK ZONE WARNING

ALL VEHICLES – Short - Medium Range (0 – 90 m)
• TOLL COLLECTION
• DATA TRANSFER / INFO FUELING (A)
• DATA TRANSFER / CVO / TRUCK STOP
• DATA TRANSFER / TRANSIT VEHICLE (yard)
• DATA TRANSFER / LOCOMOTIVE

CVO – Short - Medium Range (0 – 90 m)
• MAINLINE SCREENING
• BORDER CLEARANCE
• ON-BOARD SAFETY DATA TRANSFER
• UNIQUE CVO FLEET MANAGEMENT
• DRIVER’S DAILY LOG
• VEHICLE SAFETY INSPECTION
• TRANSIT VEHICLE DATA TRANSFER (gate)
• TRANSIT VEHICLE REFUELING MANAGEMENT
• LOCOMOTIVE FUEL MONITORING
• ROLLOVER WARNING
• LOW BRIDGE WARNING

PUBLIC SAFETY - Long Range (300 – 1000 m)
• APPROACHING EMERGENCY VEHICLE ASSISTANT (3)
• EMERGENCY VEHICLE SIGNAL PREEMPTION
• TRANSIT VEHICLE SIGNAL PRIORITY
• GREEN LIGHT - OPTIMAL SPEED ADVISORY (8)

APPLICABILITY UNDER INVESTIGATION
• ENHANCED ROUTE PLANNING and GUIDANCE (6)
• INFRASTRUCTURE BASED TRAFFIC MANAGEMENT – [DATA COLLECTED from] PROBES (7)

(#) – Applications Submitted by GM/Ford/Chrysler
(A) – Applications Submitted by Daimler-Chrysler

A
DSRC INTEROPERABILITY

• The “E-ZPass”, “Title 21”, ASTM V6, and “Sandwich Specification” equipment will continue to be used where cost and regional/national mandates or both require continued operation for those applications that fall within the performance envelope.

• The 5.9 GHz Standards and Equipment will be used for applications that cannot be done with the 915 MHz technology and where service providers want to take advantage of OBUs being built into the vehicles.

• INTEROPERABILITY will be achieved by implementing 5.9 GHz equipment in all DSRC installations. This means adding 5.9 GHz equipment to operate in conjunction with 915 MHz equipment in current and future 915 MHz operations.

• Roadside 5.9 GHz equipment will cost much less than current 915 MHz equipment and per lane installations are few, making dual mode installations very cost effective.
POSSIBLE IN–VEHICLE CONFIGURATIONS
Common Vehicle
On-Board Equipment (Basic Configuration Example 1)

- 5.850-5.925 GHz Multi-Application OBU (retrofit installation)
- 87.5-107.9 MHz FM sub carrier
- 800 to 900 MHz Cellular Phone
- 1575.42 MHz GPS Receiver
- 1800 to 1900 MHz PCS Phone
- 2322.5-2345 MHz for XM Radio Satellite Radio band
- Multiple Bands Two-way Radio
- 76-77 GHz Collision Avoidance Radar

909.75-921.75 MHz Toll & Parking OBU (Add-on when needed)
5.850-5.925 GHz Multi-Application OBU (retrofit installation)

Not to scale
The multi-application OBUs use a 360 deg. horizontal pattern for all applications.
**Common Vehicle On-Board Equipment (Basic Configuration Example 2)**

<table>
<thead>
<tr>
<th>Other ITS Communications Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>87.5-107.9 MHz FM sub carrier</td>
</tr>
<tr>
<td>800 to 900 MHz Cellular Phone</td>
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<tr>
<td>1575.42 MHz GPS Receiver</td>
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<tr>
<td>1800 to 1900 MHz PCS Phone</td>
</tr>
<tr>
<td>2322.5-2345 MHz for XM Radio Satellite Radio band</td>
</tr>
<tr>
<td>Multiple Bands Two-way Radio</td>
</tr>
<tr>
<td>76-77 GHz Collision Avoidance Radar</td>
</tr>
</tbody>
</table>

- **5.850-5.925 GHz Multi-Application OBU (factory or retrofit installation)**
- **909.75-921.75 MHz Toll & Parking OBU (Add-on when needed)**

Not to scale
The multi-application OBUs use a 360 deg. horizontal pattern for all applications.
Common Vehicle On-Board Equipment
(Enhanced Configuration Example)

- 5.850-5.925 GHz Multi-Application OBU/w 360 degree antenna (factory installation) (connected to the IDB)
- 800 to 900 MHz and 1800 to 1900 MHz Cellular Phone Antenna
- 909.75-921.75 MHz Toll & Parking OBU (Add-on when needed)
- Infrared OBU (Add-on when needed for super high data rates)
- Interface Devices (Built-in Display, Annunciator, Microphone, Keypad, etc. connected to the Computer, which is connected to the IDB)
- 1800 to 1900 MHz 2.5/3G PCS Phone (which is connected to the IDB)
- Computer (factory installation) (connected to the IDB)

Other ITS Communications Equipment
- 87.5-107.9 MHz FM sub carrier
- 1575.42 MHz GPS Receiver
- 2322.5-2345 MHz for XM Radio Satellite Radio band
- Multiple Bands Two-way Radio
- 76-77 GHz Collision Avoidance Radar

Not to scale
The multi-application OBUs use a 360 deg. horizontal pattern for all applications.
Common Vehicle
On-Board Equipment
(Alternate Configuration Example)

- **87.5-107.9 MHz**: FM sub carrier
- **1575.42 MHz**: GPS Receiver
- **2322.5-2345 MHz**: for XM Radio Satellite Radio band
- **Multiple Bands Two-way Radio**
- **76-77 GHz**: Collision Avoidance Radar

- **5.850-5.925 GHz**: Multi-Application OBU (mounted in the roof at the factory) (connected to multiple antennae) (connected to the IDB)
- **909.75-921.75 MHz**: Toll & Parking OBU (Add-on when needed)
- **800 to 900 MHz and 1800 to 1900 MHz**: Cellular Phone Antenna
- **5.850-5.925 GHz**: Multi-Application OBU (mounted in the roof at the factory) (connected to multiple antennae) (connected to the IDB)
- **1800 to 1900 MHz**: 2.5/3G PCS Phone (which is connected to the IDB)
- **Computer** (factory installation) (connected to the IDB)
- **Infrared OBU** (Add-on when needed for super high data rates)
- **800 to 900 MHz and 1800 to 1900 MHz**: Cellular Phone Antenna
- **87.5-107.9 MHz**: FM sub carrier
- **1575.42 MHz**: GPS Receiver
- **2322.5-2345 MHz**: for XM Radio Satellite Radio band
- **Multiple Bands Two-way Radio**
- **76-77 GHz**: Collision Avoidance Radar

Not to scale
The multi-application OBUs use multiple antennae to obtain a 360 deg. horizontal pattern for all applications.
Common Vehicle
On-Board Equipment
(Emergency Vehicle Configuration Example)

5.875-5.885 and 5.915-5.925 GHz
Emergency Vehicle Application
OBU (2)
with a multidirectional antenna
mounted on the light bar
(connected to the IDB)

5.850-5.925 GHz
Multi-Application/
OBU (1)

Computer
(connected to the IDB)

Interface Devices
(Built-in Display, Annunciator,
Microphone, Keypad, etc.
connected to the Computer,
which is connected to the
IDB)

909.75-921.75 MHz
Toll & Parking
OBU (3)
(Add-on when needed)

87.5-107.9 MHz
FM sub carrier

800 to 900 MHz
Cellular Phone

1575.42 MHz
GPS Receiver

1800 to 1900 MHz
PCS Phone

??? band
Satellite Radio

Multiple Bands
Two-way Radio

76-77 GHz
Collision
Avoidance Radar

Not to scale
The emergency vehicle operator can select the emergency warning forward pattern, the rearward pattern, or the 360 degree multiple antenna pattern depending on the requirements of the application being implemented.
CVO
On-Board Equipment

5.850-5.925 GHz
Multi-Application
Antenna
(360 deg horizontal pattern)

909.75-921.75 MHz,
Multi-Application
OBU
(Built-in and connected to the
SAE-1708 or 1939 bus)

5.850-5.925 GHz
Multi-Application/
Vehicle to Vehicle
OBU
(installed in the computer)

Interface Devices
(Built-in Display, Annunciator,
Microphone, Keypad, etc.
connected to the Computer,
which is connected to the
SAE-1708 or 1939 bus)

Computer
(connected to the in-vehicle
SAE-1708 or 1939 bus)
TRANSIT
On-Board Equipment

5.850-5.925 GHz
Multi-Application
OBU
(360 deg horizontal pattern)
(Built-in and connected to the SAE-1708, 1939, or EIA-709 LonWorks interface bus)

Interface Devices
(Built-in Display, Annunciator, Microphone, Keypad, etc. connected to the Computer, which is connected to the SAE-1708, 1939, or EIA-709 LonWorks interface bus)
RAIL ENGINE
On-Board Equipment

5850-5.925 GHz Multi-Application OBU
(360 deg horizontal pattern)
(Built-in and connected to an SAE-1708, 1939, or EIA-709 LonWorks interface bus)

Interface Devices
(Built-in Display, Annunciator, Microphone, Keypad, etc. connected to the Computer, which is connected to an SAE-1708, 1939, or EIA-709 LonWorks interface bus)
URBAN/SUBURBAN APPLICATIONS
TYPICAL INTERSECTION

COLLISION ANIMATION FOLLOWS
NO COLLISION AVOIDANCE SYSTEM IN OPERATION
5.9 GHz DSRC VEHICLE TO VEHICLE APPLICATION

EMERGENCY VEHICLE APPROACH WARNING

Note 1: The Emergency OBU transmits a warning to ALERT other vehicles that it is coming.

ANIMATION FOLLOWS
up to 1000 m (3281 ft)

Traffic Signal
Traffic Signal
OBUs on Control Ch

Not to Scale
**5.9 GHz DSRC VEHICLE TO VEHICLE APPLICATION**

**EMERGENCY VEHICLE APPROACH WARNING**

Note 1: The Emergency OBU transmits a warning to ALERT other vehicles that it is coming.
5.9 GHz DSRC ROADSIDE TO VEHICLE APPLICATION

EMERGENCY VEHICLE SIGNAL PREEMPTION

Note 1: OBU Transmitting the Emergency Vehicle Signal Preemption Request on the Intersection Ch

Not to Scale

Emergency Vehicle

RSU located in the center of the intersection

Traffic Signal

RSU on Intersection Ch

OBU on Intersection Ch

Traffic Signal

up to 1000 m (3281 ft)

RSU Horizontal Support

Not to Scale
5.9 GHz DSRC VEHICLE TO VEHICLE APPLICATION

EMERGENCY VEHICLE SIGNAL PREEMPTION with APPROACH WARNING

Note 1: OBU Transmitting the Emergency Vehicle Signal Preemption Request on the Intersection Ch

Note 2: The Emergency OBU transmits a warning to ALERT other vehicles that it is coming on the Control Channel.

RSU located in the center of the intersection

Emergency Vehicle Approach Warning Communication Zone

RSU Horizontal Support

up to 1000 m (3281 ft)

Not to Scale

Emergency Vehicle

Traffic Signal

OBUs on Control Ch

OBU on Intersection Ch and Control Ch

RSU on Intersection Ch
5.9 GHz DSRC ROADSIDE TO VEHICLE APPLICATION

EMERGENCY VEHICLE APPROACH WARNING - INTERSECTION RELAY

Note 1: The Intersection RSU retransmits the Emergency OBU warning to ALERT vehicles approaching on the side streets.

OBU Transmitting the Emergency Vehicle Signal Preemption Request on the Intersection Ch

RSUs Retransmitting on the Control Ch

OBU Receiving the Retransmitted Warning on the Control Ch

Traffic Signal

Traffic Signal

RSU Horizontal Support

Not to Scale

up to 1000 m (3281 ft)
VEHICLE BASED / INFRASTRUCTURE ASSISTED COLLISION AVOIDANCE

w/ STOP LIGHT ASSISTANT

The Central Intersection Communications Subsystem

Traffic Signal - Red
Traffic Signal - Green

Radio Communication

Intersection Collision Avoidance System Equipment Cabinet

Traffic Signal
Traffic Signal
Intersection Radio
Mobile Radio

up to 825 ft range
The Vehicle Tracking Subsystem and the Central Intersection Communications Subsystem

Roadside Communications Subsystem Radio A

Roadside Communications Subsystem Radio B

Traffic Signal - Green

Traffic Signal - Red

Intersection Collision Avoidance System Equipment Cabinet

Roadside Communications Subsystem Radio C

Roadside Communications Subsystem Radio D

Radar Tracking

Radio Communication

Traffic Signal

Traffic Signal

Intersection Radio

Mobile Radio

Dynamic Message Sign (DMS)

Radar System

Roadside Radio

A
The Vehicle Tracking Subsystem and the Central Intersection Communications Subsystem

Intersection Collision Avoidance System Equipment Cabinet

up to 334 ft @ 35 mph

Roadside Communications Subsystem Radio A

Traffic Signal - Red

Traffic Signal - Green

Radar System

Roadside Radio
INFRASTRUCTURE ASSISTED COLLISION AVOIDANCE

Animation

SCP - Straight Crossing Path

Car being Warned and Responding

Not to Scale

334 ft @ 35 mph

Vehicle A

Vehicle B

Traffic Signal - Green

Traffic Signal - Red

Radar Tracking

Radio Communication

Dynamic Message Sign (DMS)

Mobile Radio

Intersection Radio

Traffic Signal - Green

Traffic Signal - Red

STOP

COLLISION

LEFT

Vehicle Brake Lights

Radar System
INFRASTRUCTURE ASSISTED COLLISION AVOIDANCE

ANIMATION

SCP - Straight Crossing Path

Traffic Signal - Green

Traffic Signal - Red

334 ft @ 35 mph

Vehicle A

Car being Warned

Car NOT Stopping

334 ft @ 35 mph

Vehicles

Radar Tracking

Radio Communication

Traffic Signal - Red

Traffic Signal - Green

Intersection Radio

Mobile Radio

Dynamic Message Sign (DMS)

Vehicle Brake Lights

Radar System

Not to Scale
**IMMINENT COLLISION WARNING**

**Note 1:** The OBU in the vehicle recognizing the threat transmits a **WARNING and COLLISION PREPARATION MESSAGE** with the location address of the threat vehicle.

**Note 2:** Only the OBU in the threatening vehicle processes the message because only it matches the threat address.

**Note 3:** **COLLISION PREPARATION** includes seat belt tightening, side air bag deployment, side bumper expansion, etc.

**Radar Threat Identification**

**Car NOT Stopping**
- Traffic Signal
- Traffic Signal
- OBUs on Control Ch

Traffic Signal
5.9 GHz DSRC VEHICLE TO VEHICLE APPLICATION

IMMINENT COLLISION WARNING

IMMINENT FRONT

IMMINENT LEFT

In-Vehicle Displays and Annunciations

ANIMATION

Car NOT Stopping
- Traffic Signal
- Traffic Signal
- OBUs on Control Ch

Not to Scale

IMMINENT FRONT

IMMINENT LEFT
5.9 GHz DSRC ROADSIDE EQUIPMENT

ON-ROAD INFO FUELING and GAS STATION INFO FUELING

The Control Channel is used to announce the data transfer application operating on the designated Service Channel.

The Control Channel:
- RSU on Control Ch 178
- OBU on Control Ch 178

Service Channels:
- RSU on Service Ch 176
- OBU on Service Ch 176
- RSU on Service Ch 180
- OBU on Service Ch 180

Multi-App RSU operates on the Control Ch 178 and Service Ch 176.

Street

Sidewalk

Data Transfer on Service Ch 182
- Info fueling Com. Zone
- Gas Pumps

Data Transfer on Service Ch 180

Traffic Signal

Up to 90 m (300 ft)

Not to Scale
5.9 GHz DSRC ROADSIDE EQUIPMENT

ON-ROAD INFO FUELING and GAS STATION INFO FUELING

- **RSU on Control Ch 178**
- **OBU on Control Ch 178**
- **RSU on Service Ch 182**
- **OBU on Service Ch 182**

The Control Channel is used to announce the data transfer application operating on the designated Service Channel.

- **Traffic Signal**
- **RSU on Service Ch 176**
- **OBU on Service Ch 176**

- **Data Transfer on Service Ch 180**
- **Multi-App RSU Operates on the Control Ch 178 and Service Ch 176**

- **Info fueling Com. Zone**
- Traffic Signal
- **OBU on Service Ch 176**
- **RSU on Service Ch 180**
- **RSU on Service Ch 180**

- **Data Transfer on Service Ch 180**
- **Gas Pumps**
- **Street**

Not to Scale
5.9 GHz DSRC ROADSIDE TO VEHICLE APPLICATION

**PROBE DATA COLLECTION and TRAFFIC INFORMATION**

- **RSU on Control Ch 178**
- **OBU on Control Ch 178**
- **RSU on Service Ch 174**
- **OBU on Service Ch 174**

The Control Channel is used to announce the Probe Data Collection and Traffic Information applications on Ch 174.

- **Traffic Signal**
- **Traffic Signal**

The Probe Data Collection and Traffic Information applications operate on Ch 174.

- **Street**
- **Sidewalk**

Multi-App RSU Operates on the Control Ch 178 and Service Ch 174

Not to Scale
5.9 GHz DSRC ROADSIDE EQUIPMENT

TRANSIT VEHICLE ACCESS, FUELING CONTROL, and DATA TRANSFER (GATE)

Transit Vehicle

Not to Scale

RSUs are located over the center of the in-coming and out-going lanes of the Transit Vehicle Parking Facility.

- RSU on Channel 174
- RSU on Channel 176
- RSU on Channel 180
- OBU on Channel 174
- OBU on Channel 176
- OBU on Channel 180

Note: Control Channel is used periodically by each RSU to announce the presence of the applications operating on the Service Channels
5.9 GHz DSRC ROADSIDE TO VEHICLE APPLICATION

= communication zone

NOT TO SCALE

TRANSIT VEHICLE DATA TRANSFER (YARD)

Note: The video upload is suspended whenever a vehicle enters to prevent co-channel interference.

Free Space Loss -87 dB

Worst case RSU antenna gain in the vehicle’s direction 3 dBi. 28+3-3=28
**5.9 GHz DSRC ROADSIDE TO VEHICLE APPLICATION**

- **OBU on Service Ch 172**
- **RSU on Service Ch 180**
- **OBU on Service Ch 180**
- **RSU on Control Ch 182**

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**The Control Channel** is used to announce the data transfer application operating on the designated Service Channel.

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**SURFACE LEVEL PARKING LOT**

- **RSU on Service Ch 172**
- **OBU on Service Ch 172**
- **RSU on Service Ch 174**
- **OBU on Service Ch 174**

---

- **Traffic Signal**
- **Traffic Signal**
- **RSU on Control Ch 178**
- **RSU on Control Ch 178**

---

- **Not to Scale**
The Control Channel is used to announce the data transfer application operating on the designated Service Channel.

5.9 GHz DSRC ROADSIDE TO VEHICLE APPLICATION

The Control Channel is used to announce the data transfer application operating on the designated Service Channel.

SURFACE LEVEL PARKING LOT

- RSU on Control Ch 182
- OBU on Control Ch 182
- OBU on Service Ch 174
- RSU on Service Ch 174
- RSU on Service Ch 178
- OBU on Service Ch 180
- OBU on Service Ch 180
- Traffic Signal
- Traffic Signal
- Communication zones

Not to Scale
5.9 GHz DSRC ROADSIDE TO VEHICLE APPLICATION

SURFACE LEVEL PARKING LOT

- Communication zone

- Traffic Signal
- Traffic Signal

- Payment Station

- RSU on Service Ch

Not to Scale
5.9 GHz DSRC ROADSIDE TO VEHICLE APPLICATION

GARAGE DOWNLOAD - PROGRAM UPDATES, TRAFFIC DATA, MUSIC FILES

- An IEEE 802.11a WLAN radio transfers data directly to an IEEE 802.11a capable vehicle DSRC OBU using a channel in the UNII band. The DSRC RSU then sends the data to the vehicle OBU.

- PC transfers data to a DSRC OBU over an Ethernet or USB cable interface. The DSRC RSU then sends the data to the vehicle OBU.

- An IEEE 802.11b WLAN radio transfers data from the home computer to the IEEE 802.11b interface of a DSRC RSU in the garage. The RSU then sends the data to the vehicle OBU.

- PC transfers data to a DSRC OBU over an Ethernet or USB cable interface. The DSRC RSU then sends the data to the vehicle OBU.

Not to Scale

PC WLAN  DSRC OBU w/ IEEE 802.11a
5.9 GHz DSRC ROADSIDE TO VEHICLE APPLICATION

DATA TRANSFER REPAIR SERVICE RECORD

Street

Service Bay Door

Note 1: This facility alternates Service Channels in the service bays to upload and download maintenance data to all the vehicles.

Service Bay

Note 2: The Control Channel 178 is used to announce the service application operating on Service Channel.

Driveway

Vehicle Maintenance Facility

Service Bays

Pico Zone

RSE on Ch 180

OBE on Ch 180

RSE on Ch 182

OBE on Ch 182

RSE radiating straight down

RSE radiating straight down
OPEN ROAD APPLICATIONS
Note 1: The Emergency Vehicle Warning message is sent every 1 sec
5.9 GHz DSRC VEHICLE TO VEHICLE APPLICATION

STOPPED EMERGENCY VEHICLE WARNING

Note 1: The Stopped Vehicle Warning message is sent every 50 ms

Stopped Emergency Vehicle Warning Com. Zone

Grass Divider

In-Vehicle Display and Annunciation

Receiving OBU Control Channel

Transmitting OBU Control Channel

OBUs on Control Channel

Emergency Vehicle

Disabled Vehicle

up to 1100 ft range

Not to Scale
5.9 GHz DSRC ROADSIDE TO VEHICLE APPLICATION

WORK ZONE WARNING

- In-Vehicle Display and Annunciation
- Flashing Arrow
- RSU on Control Channel
- Grass Divider
- Micro Zone
- Work Zone Warning Com. Zone
- Work Zone

Traffic Cones

up to 1100 ft range

Not to Scale
5.9 GHz DSRC VEHICLE TO VEHICLE APPLICATIONS

Vehicle to Vehicle Data Transfer

Map Data being sent

Grass Divider

Traffic Data being sent

OBU Transmitting on Veh-Veh Channel

Not to Scale

car = .53
range = 8.29

300 ft range
1) Vehicles with vehicle to vehicle (v-v) communications capability transmit the vehicle’s position, speed, direction of travel, and acceleration at 12 Mbps. One transmission will be sent every 300 ms. This transmission is intended for all vehicles within 10 sec travel time, thus the transmit power (range) will vary with vehicle speed up to a maximum range of 300 meters (~1000 ft). The minimum range will be 110 m (~367 ft). For example, vehicles traveling at 60 mph would transmit at a power level appropriate to reach approximately 270 m (~880 ft) and vehicles traveling at 25 mph or lower would transmit at a power level appropriate to reach approximately 110 m (~367 ft). All vehicles capable of doing so (having OBU and with vehicle speed and position data available) will transmit these messages and all OBU will receive these messages.

2) Vehicles that receive these transmissions and have collision avoidance processing capability compute the position and probability of collision for all transmitting vehicles every 100 ms.

3) A Caution is given to drivers when a possibility of collision is computed with an avoidance maneuver requirement that exceeds .35 g or the equivalent acceleration for the conditions.

4) A Warning is given to drivers when a possibility of collision is computed with an avoidance maneuver requirement that meets or exceeds .50 g or the equivalent acceleration for the conditions.

5) If it can be determined that two vehicles are on an intercepting course, both will use the transmission range of the faster vehicle.
5.9 GHz DSRC VEHICLE TO VEHICLE APPLICATIONS

COOPERATIVE COLLISION WARNING/AVOIDANCE
(with closely spaced vehicles @ 60 mph)

- OBU Receiving on the Vehicle to Vehicle channel
- OBU Transmitting and Receiving on the Vehicle to Vehicle channel @ 12 Mbps

Note: The vehicle's position, speed, direction and acceleration message is nominally sent every 300 ms with a range of 300 m (~1000 ft).
5.9 GHz DSRC VEHICLE TO VEHICLE APPLICATIONS

COOPERATIVE COLLISION WARNING/AVOIDANCE

(with closely spaced vehicles @ 25 mph)

- OBU Receiving on the Vehicle to Vehicle channel
- OBU Transmitting and Receiving on the Vehicle to Vehicle channel @ 12 Mbps

Note: The vehicle’s position, speed, direction and acceleration message is nominally sent every 300 ms with a range of 110 m (~367 ft).
5.9 GHz DSRC VEHICLE TO VEHICLE APPLICATIONS

COOPERATIVE COLLISION WARNING/AVOIDANCE

STOPPING VEH. WARNING

- Routine position, speed, direction messages
- Vehicle Brake Lights
- □ OBU Listening to Control Channel
- ● OBU Transmitting on Control Channel

In-Vehicle Display and Annunciation

Road Blocked

Stopping message

Not to Scale
Note 1: The Stopped Vehicle Warning message is sent in the direction of arriving traffic when the stopping vehicle’s brakes are being applied and its speed drops **20 mph** below the speed limit of the road or its speed drops below **5 mph**.

Note 2: The Stopped Vehicle Warning message is sent every **100 ms** with a range of **1000 ft**.
5.9 GHz DSRC VEHICLE TO VEHICLE APPLICATION

COOPERATIVE COLLISION WARNING B - SECOND STOPPED VEHICLE

Note 2: Once another stopped vehicle, immediately to the rear, starts transmitting the stopped vehicle message the first vehicle reverts to the original position, speed, and direction message. The range will reach the second stopped vehicle.

Note 2: The Stopped Vehicle Warning message is sent every 100 ms with a range of 1000 ft.
5.9 GHz DSRC VEHICLE TO VEHICLE APPLICATIONS

COOPERATIVE COLLISION WARNING/AVOIDANCE

SLOWED OR STOPPED TRAFFIC

Note 1: Once traffic slows to 10 mph or below the vehicles transmit the position, speed, and direction message every 100 ms at 15 m range.

- OBU Receiving on the Vehicle to Vehicle channel
- OBU Transmitting and Receiving on the Vehicle to Vehicle channel @ 12 Mbps

Note 2: The vehicle’s position, speed, direction and acceleration message is sent every 100 ms with a range of 15 m (~50 ft) but 300 m (1000 ft) when receiving a faster vehicle’s signal.
5.9 GHz DSRC ROADSIDE EQUIPMENT

HIGHWAY/RAIL INTERSECTION WARNING


EXAMPLE MICRO/PICO-CELL COMMUNICATION ZONES

HIGHWAY/RAIL INTERSECTION WARNING

Train 20 to 40 sec away
- Traffic Signal
- Train Transmitter on Railroad Frequency
- RSU in Railroad Warning Sign on Control Ch
- OBU on Control Channel

Note 1: The RSU is most cost effectively employed at the Railroad Warning Signal where it can receive power without incurring remote power installation costs and provide communication to the driver all the way to the cross bar.

HIGHWAY/RAIL INTERSECTION WARNING

- Train 20 to 40 sec away
  - Traffic Signal
  - Train Transmitter on Railroad Frequency
  - RSU in Railroad Warning Sign on Control Ch
  - OBU on Control Channel

Note 1: The RSU is most cost effectively employed at the Railroad Warning Signal where it can receive power without incurring remote power installation costs and provide communication to the driver all the way to the cross bar.

EXAMPLE MICRO/PICO-CELL COMMUNICATION ZONES

HIGHWAY/RAIL INTERSECTION WARNING

- Railroad Warning Signal/ Cross Buck and Train Detection Receiver
- Highway/rail Intersection Warning Comm. Zone
- Traffic Signal
- Train Transmitter on Railroad Frequency
- RSU in Railroad Warning Sign on Control Ch
- OBU on Control Channel
- Vehicle Brake Lights

Not to Scale
Warning signs should provide adequate time for the driver to perceive, identify, decide, and perform any necessary maneuver. This is generally referred to as PIEV.

PIEV
- Perception
- Identification/understanding
- Emotion/decision making
- Volition/execution of decision

The PEIV time can vary from about 3 seconds for general warning signs to 10 seconds for high driver judgement condition warning signs. (This includes sign legibility distance and braking or maneuvering distance.)

5.9 GHz DSRC ROADSIDE TO VEHICLE APPLICATION

NARROW BRIDGE - WARNING SIGN


5.9 GHz DSRC ROADSIDE TO VEHICLE APPLICATION

NARROW BRIDGE - WARNING SIGN + DSRC RSU

Warning Sign and Multi-Application RSU

RSU on Control Ch

OBU on Control Ch

Up to 650 ft forward of the Potential Hazard (see Note 1)

90 m (300 ft) range

Micro Zone

Emotion and Volition

Perception and Identification

---

Note 1: The Manual on Uniform Traffic Control Devices states that, “Table II-1 lists suggested minimum sign placement distances....” (1988 edition, Para. 2C-3)

Note 2: The Sight distance of the sign is usually 125 to 200 ft.

Note 3: The RSU can be configured to have a range of up to 1100 ft.
5.9 GHz DSRC ROADSIDE EQUIPMENT

ROAD CONDITION WARNING

- RSU on Control Ch
- OBU on Control Ch

- Up to 650 ft forward of the Hazard
- 90 m (300 ft) range
- Dynamic Message Sign and Multi-App RSU on the Control Channel
- Road Condition Warning Com. Zone
- Micro Zone
- Perception and Identification
- Emotion and Volition
- Not to scale

- Road Sensor Station
- Median
- ICE
- BRIDGE
5.9 GHz DSRC ROADSIDE TO VEHICLE APPLICATION

LOW BRIDGE WARNING and ROLL OVER WARNING

The tractor-trailer receives curve parameters from the RSU in the rollover warning sign. The on-board computer calculates the proper speed for this vehicle’s loading and warns the driver if a rollover is indicated.

Tractor-trailer can pull over here if it is Over the Height limit for the bridge

Tractor-trailer can exit here if it is Over the Height limit for the bridge

The tractor trailer receives curve parameters from the RSU in the rollover warning sign. The on-board computer calculates the proper speed for this vehicle’s loading and warns the driver if a rollover is indicated.

Tractor-trailer with OBU receiving rollover parameters from the warning sign at the curve on Control Channel

Application submitted by Carl W. Compton, KANSAS TURNPIKE AUTHORITY

Not to Scale
5.9 GHz DSRC ROADSIDE TO VEHICLE APPLICATION

LOW BRIDGE WARNING and ROLL OVER WARNING

Small Zone RSE on height measuring gantry receives ID from OBE on vehicle and sends link information for Warning RSE

Vehicle OBE sends ID to measurement gantry RSE and receives link for Warning RSE

Over-height vehicle can stop on shoulder or exit before bridge structure

Laser height sensor on gantry

Warning RSE, located downstream from gantry and networked to gantry RSE, broadcasts pullover / exit warning to over-height vehicle
5.9 GHz DSRC ROADSIDE TO VEHICLE APPLICATION

TOLL COLLECTION (Open Road) in service channel

The Toll Collection RSU operates on a Service Channel and is located on the gantry above the lanes.

Note 1: OBU approaching the toll zone are instructed to switch to a service channel in order to conduct the transaction.

Note 2: Users are allowed to proceed at highway normal speeds while the toll is paid.

Note 3: Implementers use Time Division to isolate vehicle communications and angle of signal arrival to locate vehicle.

A
5.9 GHz DSRC ROADSIDE EQUIPMENT

TOLL COLLECTION (Lane Based) on the Service channels

RSUs are located on the gantry above the center of each lane.

- RSU Antennas
- Capture zone
- Gantry
- Toll Zone Announcement RSU on Control Channel
- Traffic Signal
- RSU on Control Channel 178
- RSU on Channel 180
- RSU on Channel 182
- OBU on Channel 180
- OBU on Service Channel 182

Not to Scale
5.9 GHz DSRC ROADSIDE EQUIPMENT

TOLL COLLECTION (Lane Based) on the Control channel

RSUs are located on the gantry above the center of each lane using Control Channel.

Note 1: Users must slow down to pay the toll and may proceed only when the light is green.

Note 2: Implementers may use Time Division to isolate lanes.

Not to Scale
5.9 GHz DSRC ANSWERS

What is it? Short to medium range, low latency, high data rate communications.

Who developed it? Government and Industry in ASTM and IEEE standards groups.

When would it be advantageous to use it? Any situation requiring short to medium range communications between vehicles and the roadside or between vehicles where the environment is changing or data needs to be transferred at high rates (See the example Applications). Think short-range highway advisory radio.

When will products be available? Estimated Mid 2004.

When will it be available as original equipment in new cars? Estimated 2006 to 2008.

What plug replaceable technology can be used for some data transfer applications in the interim? IEEE 802.11a.

What model deployments are being planned for next year? DIRECT by Michigan DOT.

How will this affect Toll Agencies? North American Interoperability.

When should state agencies start planning to deploy it? Early 2003.

What will be required from the frequency coordinator? Application processing, channel recommendations, interference mitigation where necessary. See slide below.
OVERLAPPING COMMUNICATIONS ZONE URBAN APPLICATION MAP

Small Communication Zones | Large Com. Zones

- Parking Lot 1
- Parking Lot 2
- Service Station
- Bus Parking
- Garage/Data Download
- Bus Maintenance Facility/Data Download
- Service Station/Data Upload
- Up to 1000 ft

- RSU on Control. Ch
- RSU on Service Ch 172
- RSU on Service Ch 174
- RSU on Slot D Hi-Pwr Ch
- RSU on Slot E Hi-Pwr Ch
- RSU on Slot F Hi-Pwr Ch
- RSU on Slot G Hi-Pwr Ch
- RSU on Slot ... Hi-Pwr Ch
- RSU on Service Ch 182
- RSU on Service Ch 184

Not to Scale
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