ITS Car-to-Car Communications Standards

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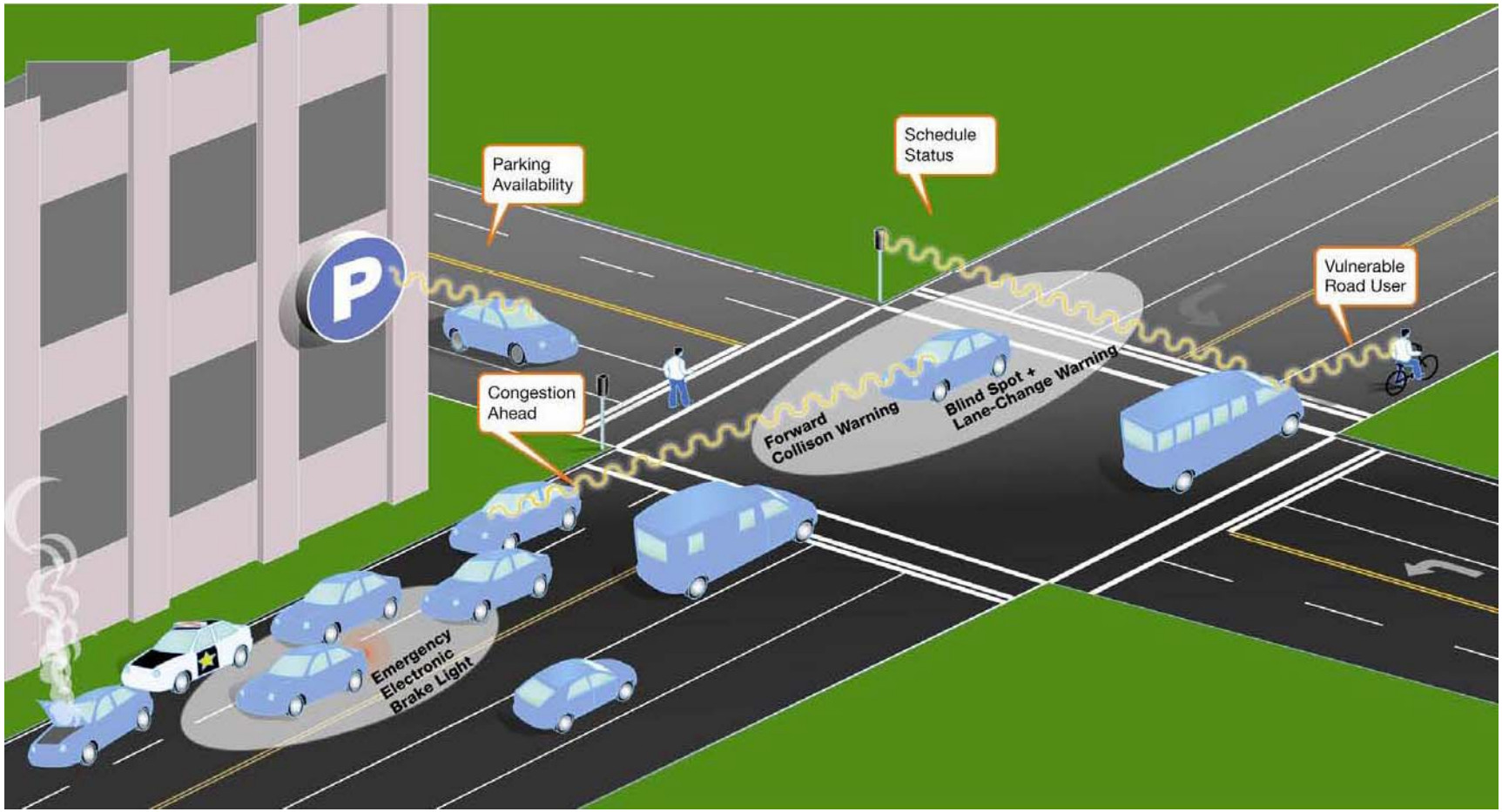
IntelliDrive^{SM} Concept



IntelliDrive Communications

- DSRC (Digital Short-Range Communications) in the 5.9 GHZ band provides the kind of low-latency communications link needed for IntelliDrive safety applications.
- Existing data sources and communications media (e.g., mobile phone, radio frequency) could be used for non-safety applications when “instant” communications are not required.

DSRC Characteristics

- Uses 75 MHz of bandwidth (5.850 - 5.925 GHz)
- Similar to IEEE 802.11p
- Data rate up to 27 Mbps in its 10 MHz channel
- Uses SAE standard J2735 for its message set
- Line-of-sight communications up to 1000 meters between DSRC devices.

DSRC – Old vs New

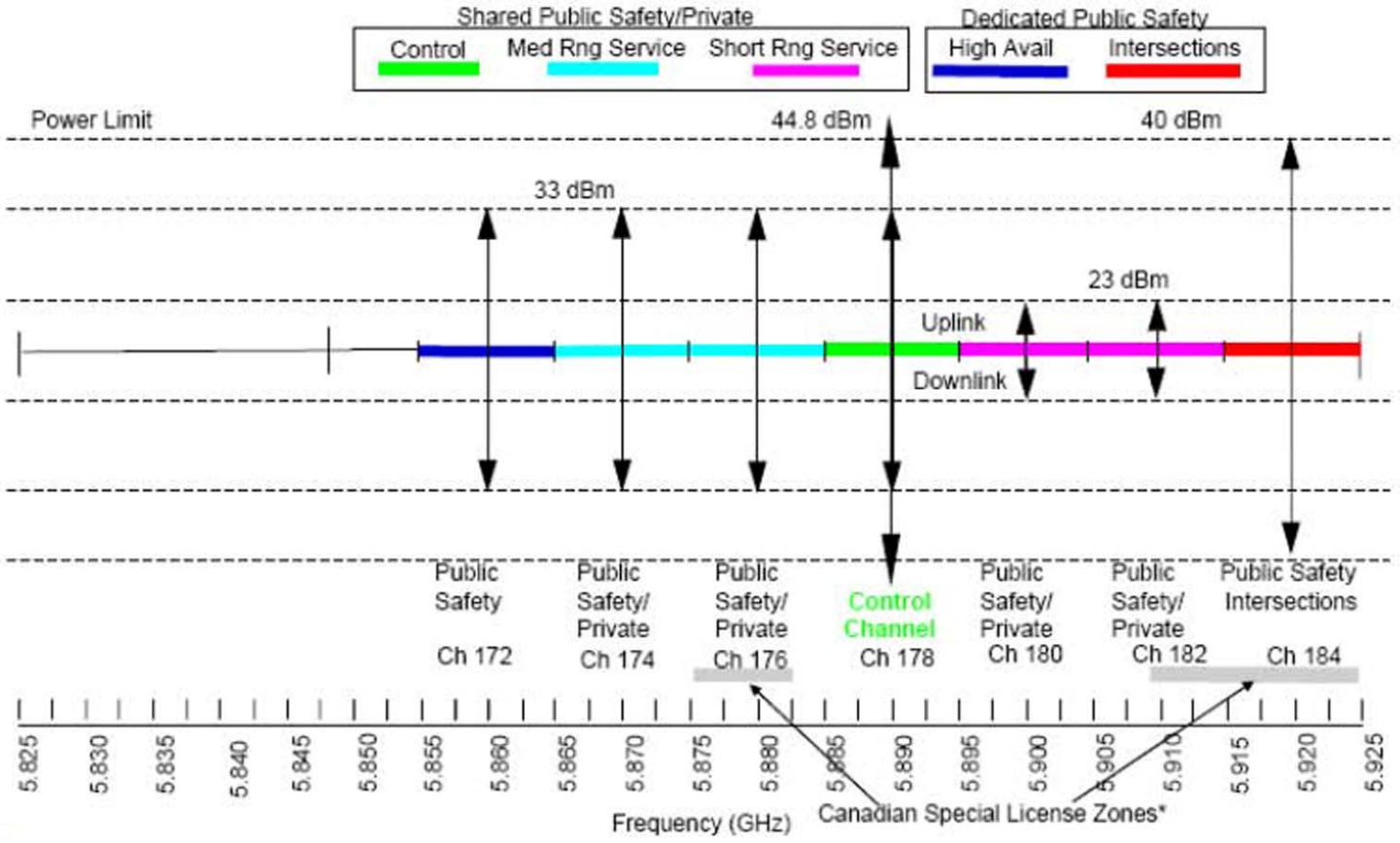
OLD DSRC

- 915 MHz
- Range less than 30 m
- Data rate ~0.5 Mbps
- Designed for electronic toll collection
- Vehicle-to-roadside
- Command-response

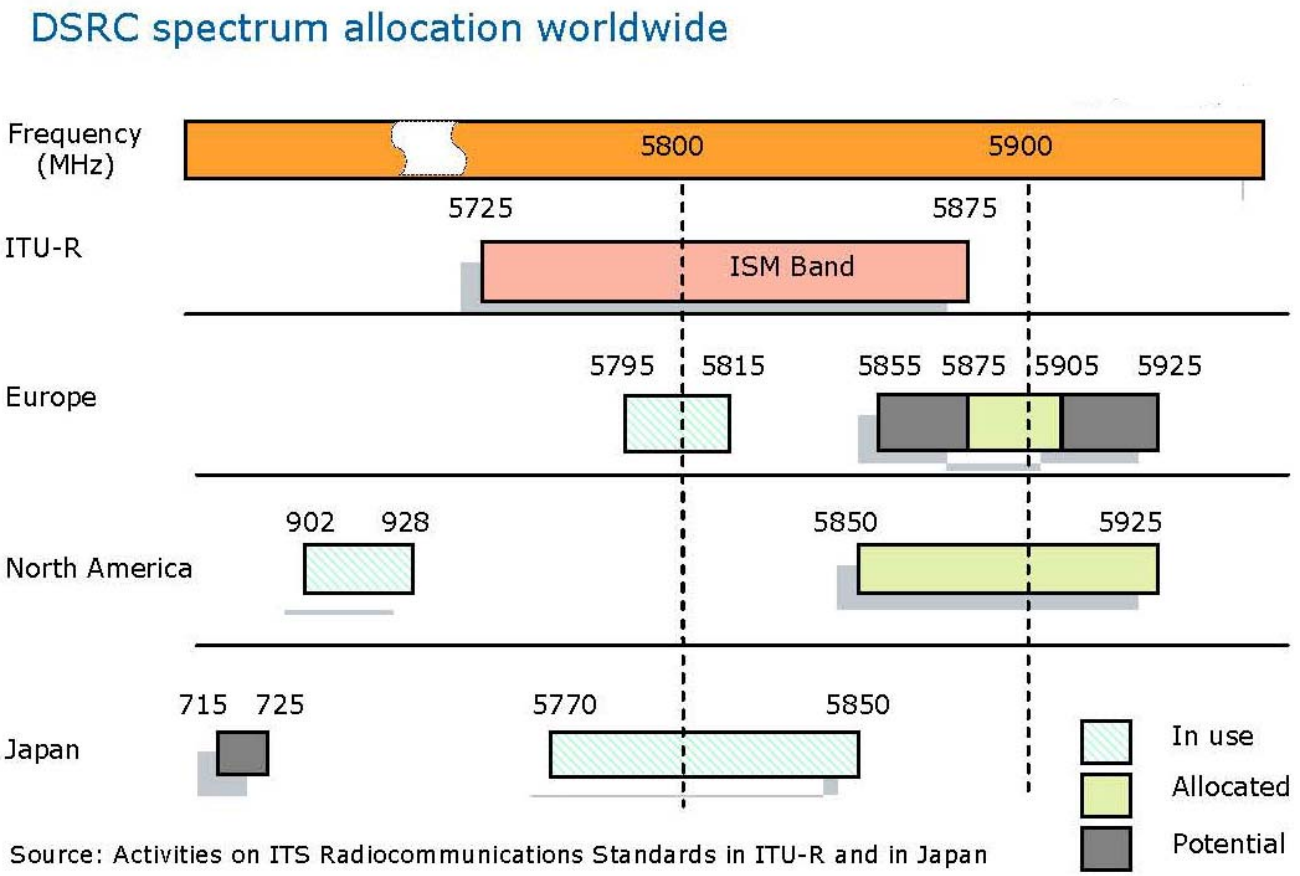
NEW DSRC

- 5.9 GHz
- Range up to 1 km
- Data rate up to 27 Mbps
- Designed for Internet access
- V2I and V2V
- Command-response and peer-to-peer

The 5.9 GHz DSRC Band



DSRC Around the World



How DSRC V2I Works

The roadside unit broadcasts 10 times per second:

- The applications it supports and
- On which channels of the 5.9 GHz band

The unit on-board in the vehicle:

- Listens to channel 172
- Authenticates the roadside unit
- Executes safety applications
- Switches channels to execute non-safety applications
- Goes back to listening

IEEE 802.11p

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What is 802.11p?

- IEEE standard 802.11p is an amendment to the basic 802.11 wireless local area network (WLAN) standard that adds wireless access in vehicular environments (WAVE).
- Vehicles could be running at up to 200 km/h up to 1000 meters apart.
- A nationwide network in the USA is envisioned where vehicles can “talk” to other vehicles or to the roadside infrastructure.

Why 802.11p?

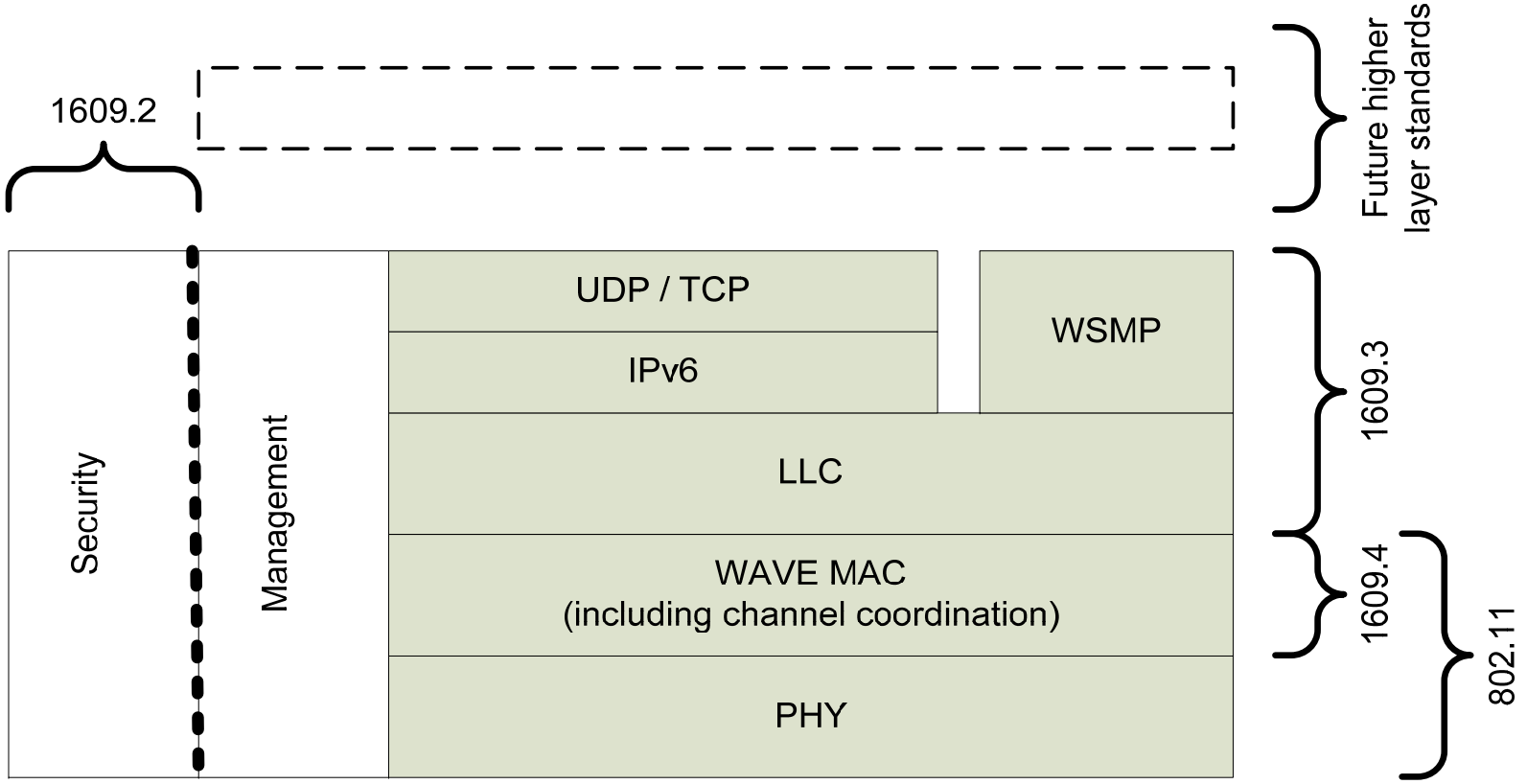
- Make the existing IEEE 802.11 standard suitable for interoperable communications to and between vehicles.
- Adapt to the highly variable transportation environment and deal with the very short latencies required for safety applications (some must complete multiple data exchanges in as little as 4ms).
- The original US ITS systems architecture identified DSRC as the a primary means of communicating between the roadside and vehicles, and from one vehicle to another.

IEEE 1609.x

The 1609 Family of Standards

- IEEE P1609.0™, *WAVE – Architecture*
- IEEE P1609.1™-2006(Revision), WAVE - *Resource Manager*
- IEEE P1609.2™-2006(Revision), *WAVE - Security Services for Applications and Management Messages*
- IEEE P1609.3™-2007(Revision), *WAVE - Networking Services*
- IEEE P1609.4™-2006(Revision), *WAVE - Multi-channel Operations*
- IEEE P1609.5™, *WAVE – Communication Manager*
- IEEE P1609.11™ - *WAVE - Over-the-Air Data Exchange Protocol for ITS Interoperability – Electronic Payment Services*

IEEE 1609 Wave Architecture



Notes on 1609

- The IEEE 1609 family of standards is intended to operate with IEEE 802.11p, *Wireless Access in Vehicular Environment (WAVE*).
- It is the wireless communication system component of the USDoT IntelliDrive^{SM} program that uses 5.9GHz allocated wireless spectrum for North America.

More Notes on 1609

- The IEEE 1609 Family of Standards for Wireless Access in Vehicular Environments (WAVE) defines:
  - the architecture,
  - communications model,
  - management structure,
  - security mechanisms and
  - physical access for high speed (up to 27 Mb/s) short range (up to 1000m) low latency wireless communications in the vehicular environment.
- The primary architectural components defined by these standards are the On Board Unit (OBU), Road Side Unit (RSU) and WAVE interface.
- These standards also define how applications that utilize WAVE will function in the WAVE environment. They provide extensions to the physical channel access defined in IEEE 802.11p to support the WAVE standards.

SAE J2735

SAE J2735

- Supports interoperability among DSRC applications through the use of standardized message sets, data frames and data elements.
- Intended for application developers, equipment manufacturers and system integrators involved with IntelliDrive.

J2735 Message Sets

- The message sets specified in J2735 define the message content delivered by the communication system at the application layer and thus defines the message payload at the physical layer.
- The J2735 message sets depend on the lower layers of the DSRC protocol stack to deliver the messages from applications at one end of the communication system (the vehicle) to the other end (a roadside unit).
- The lower layers are addressed by IEEE 802.11p, and the upper layer protocols are covered in the IEEE 1609.x series of standards.
- The DSRC family of standards developed by various SDOs are meant to operate together.

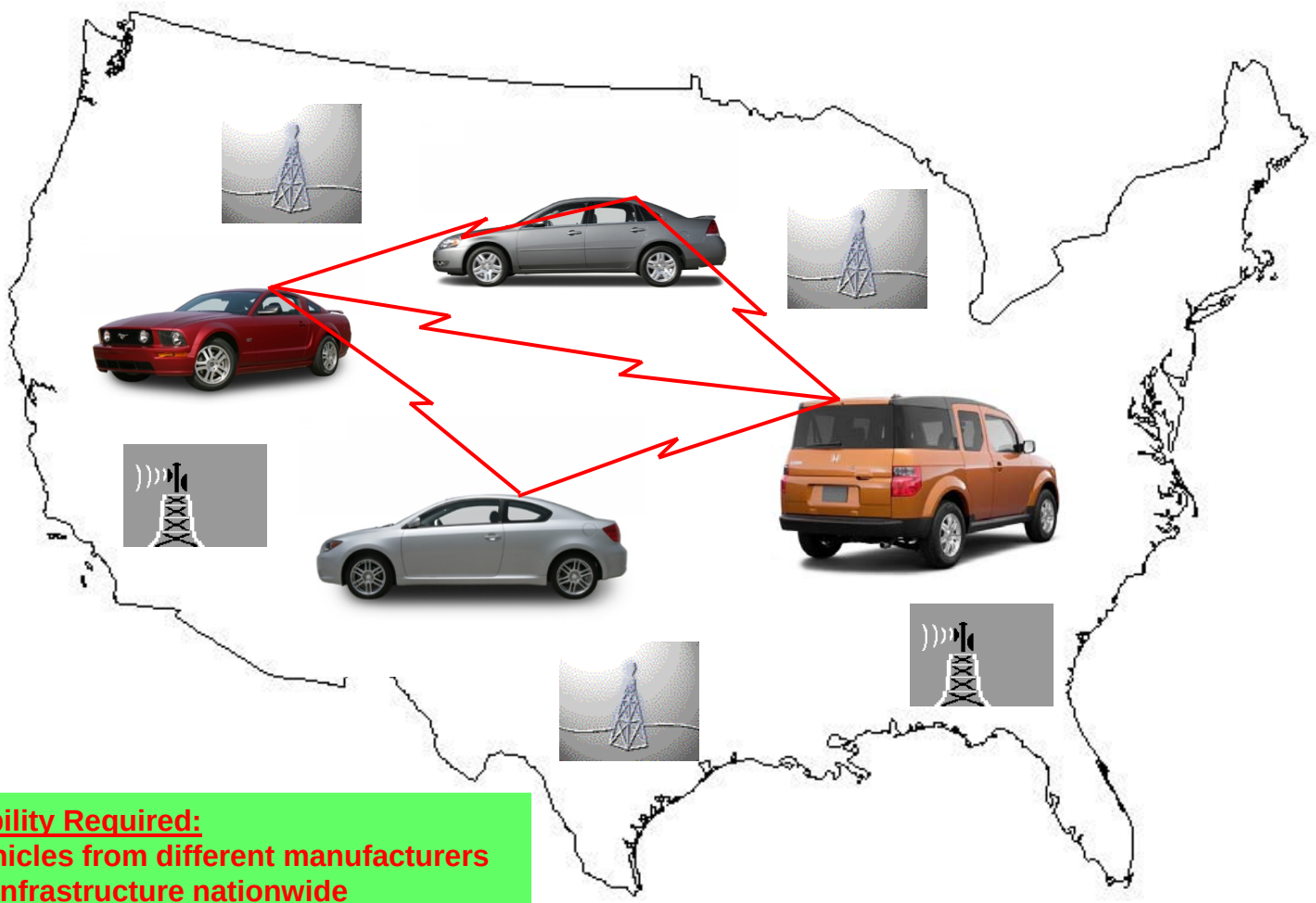
J2735 Standardization Approach

- Specify standard message sets, data frames and data elements that allow interoperability at the application layer without the need to standardize applications.
- Support innovation and product differentiation by providing standard message sets that can be universally generated and recognized by proprietary applications.

J2735 Message Set Dictionary

- 15 Messages
- 72 Data Frames
- 146 Data Elements
- 11 External Data Entries

Interoperability



Interoperability Required:
- **among vehicles from different manufacturers**
- **with road infrastructure nationwide**

“Heartbeat” Message

Frequent transmission of “heartbeat” messages enables the vehicle’s expanded situational awareness to complement autonomous vehicle sensors

Major Attributes
Temporary ID
Time
Latitude
Longitude
Elevation
Speed
Heading
Acceleration
Brake System Status
Vehicle Size

Other Kinds of Messages

- **A la carte message** -- composed entirely of message elements determined by the sender, allowing for flexible data exchange.
- **Basic safety message** -- contains vehicle safety-related information that is periodically broadcast to surrounding vehicles.
- **Emergency vehicle alert message** -- used for broadcasting warnings to surrounding vehicles that an emergency vehicle is operating in the vicinity.
- **Generic transfer message** -- provides a basic means to exchange data across the vehicle-to-roadside interface.
- **Probe vehicle data message** -- contains status information about the vehicle to enable applications that examine traveling conditions on road segments.
- **Common safety request message** -- used when a vehicle participating in the exchange of the basic safety message can make specific requests to other vehicles for additional information required by safety applications.

Basic Safety Message

- Interoperability of vehicle safety applications, without standardization of the applications.
- Multiple vehicle safety applications with the same message.
- Backward-compatible future developments with flexible expansion of messages.

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