Applications Supported by Next-Generation 5.9 GHz DSRC

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Topics:

1) What is 5.9 GHz DSRC ?

2) What's leading the drive to it ?

3) How & When Will it Come ?

4) The Applications

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5.9 GHz –

What is it?

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5.9 GHz – What Is It ?

The Next Generation of Vehicular Communication

Transmission Range increases 2 orders of magnitude

From 10 meters to 1000 meters

Transmission Rate increases 2 orders of magnitude

From 0.25 Mbps to 25 Mbps

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5.9 GHz – What Is It ?

The Next Generation of Vehicular Communication

- Primary band allocation
- Tailored to the hi-speed mobile environment
- Near-instant access
- Application prioritization
- Dynamic frequency control
- Dynamic power control
- ‘Bulletproof’ security

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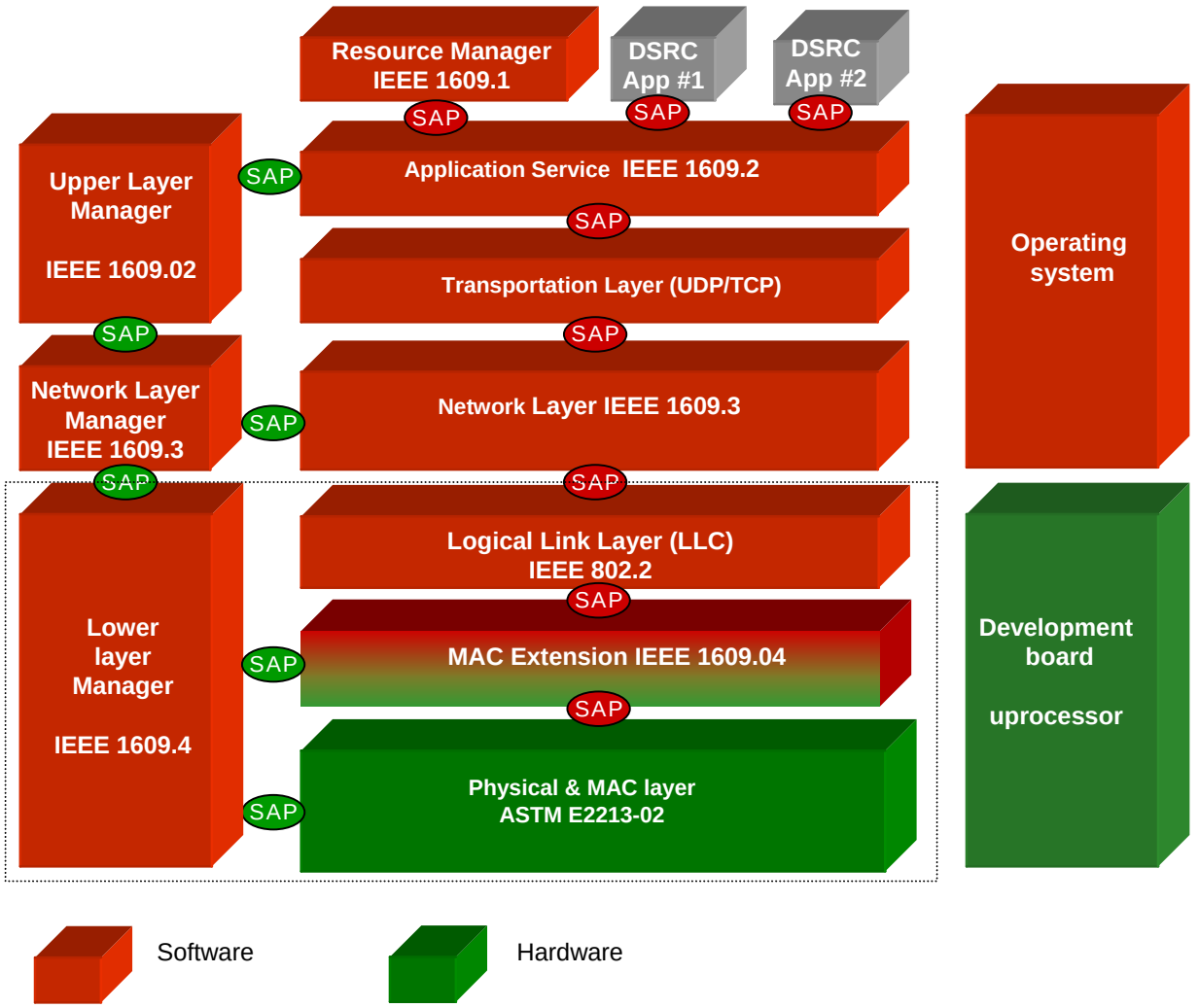
Solution Elements



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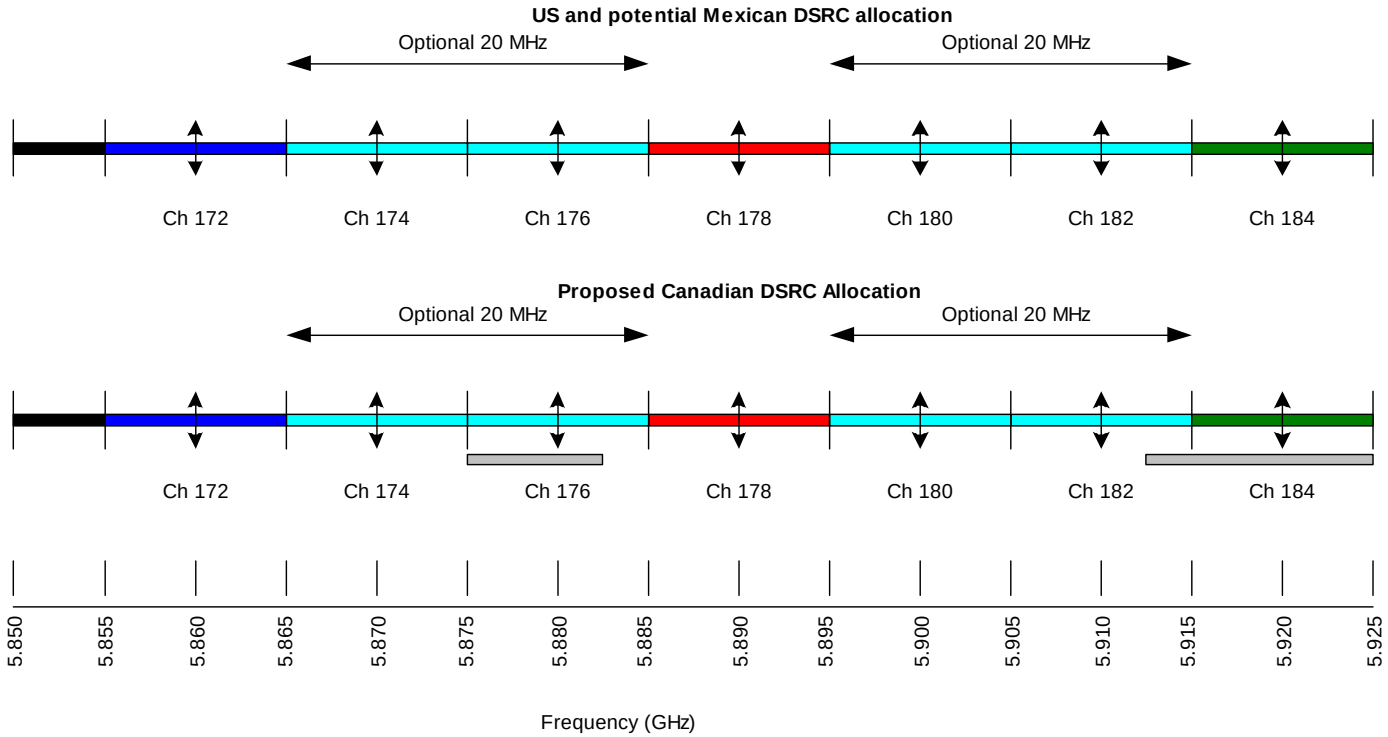
5.9 GHz DSRC Band Plan



- Control Channel
- Service Channel
- Vehicle to vehicle
- Primarily public safety high power applications
- Canadian Special license zone

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Why the Push to it?

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5.9 GHz – Primary Incentive

- Safety is the primary catalyst

- 1960s – safety goal led to the seatbelt
  - Survive the crash
- 1980s – safety goal led to the airbag
  - Survive a worse crash
- 2000s – another goal ?

5.9 GHz – Primary Incentive

- U.S.Congress – 10 year goal to reduce fatalities (50%)
- DOT & automakers charged to make it happen
- Studies are done – results are in
- Answer is NOT simply to PROTECT people better in a crash
- Answer is to ELIMINATE the crash
- The key is situational awareness, and….

- DSRC is a key enabling technology to achieve it

How?

- Know what's around you
  - Other vehicles
  - Road conditions
  - Weather conditions
- Awareness of anomalies
  - Cars moving unexpectedly toward you
  - Unseen hazards
  - Swiftly occurring changes

What's needed?

- Sensing
- Reliable, high-performance communications
  - Vehicle-to-roadside
  - Vehicle-to-vehicle

Having:

  - Longer communication ranges
  - Higher data capacities
  - Faster access times
  - Priority management

- 5.9 GHz 'next-generation' DSRC has appeared to fill the needed role

And There Are Commercial Aspects…..

- New applications = new business opportunities
- New opportunities = real interest in many industry areas
  - Manufacturers
  - System integrators
  - Service / content suppliers

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How / When?

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5.9 GHz Developments

- Concept born more than 5 years ago
- Sporadic progress made over past 4-5 years (mostly related to standards)

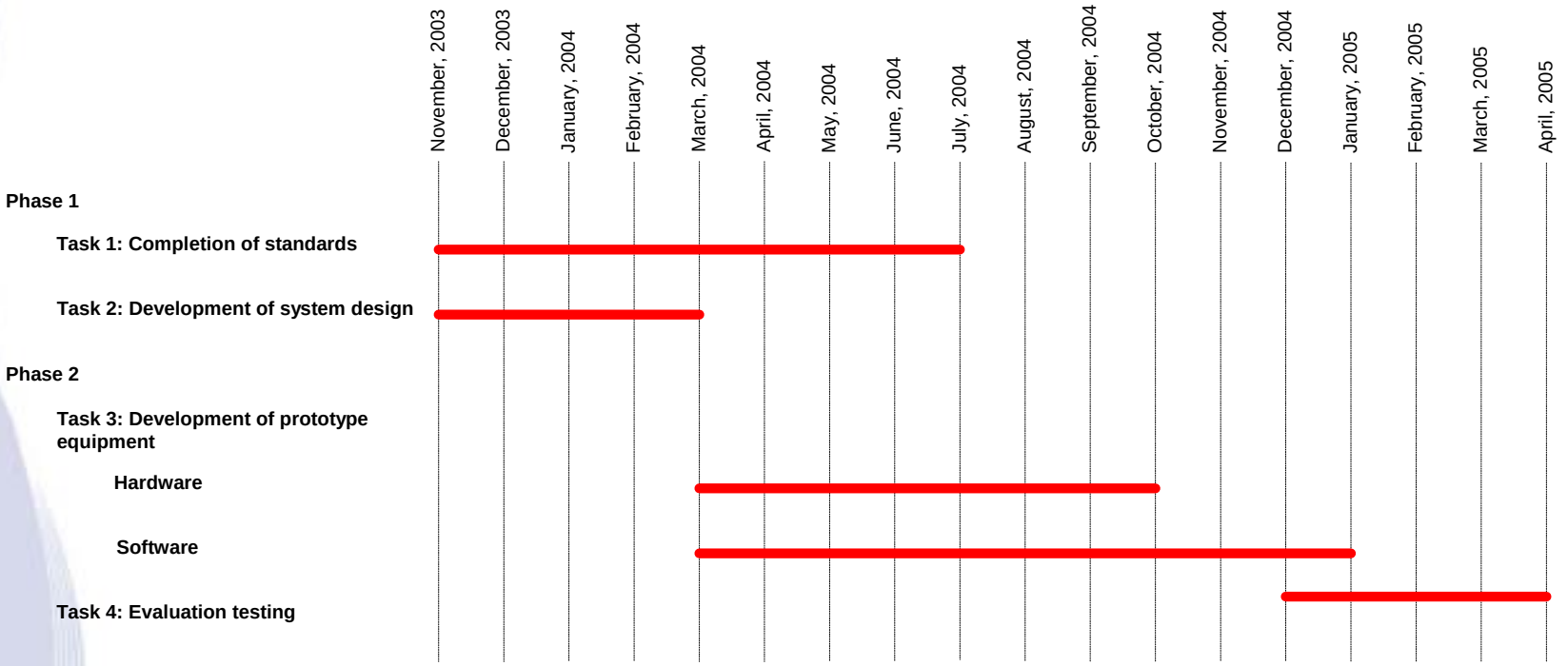
- No guiding light
- No real sponsor
- No killer business model
- No sugar daddy

U.S. DOT (Recently) Requested….

- Fast-paced prototype development program for 5.9 GHz DSRC
  - Industry driven
  - Shared-cost, but heavily funded up front by DOT

- Goals:
  - Prove the standards
  - Provide standard-compliant operational hardware for the vehicle OEMs
  - Perform testing to confirm vitality of the hardware, reasonableness of certain safety applications, and system acceptance by vehicle users
  - Provide a launching pad for industry

Schedule



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Vehicle OEMs are Onboard

- Continued application testing
- Buildup of ‘improved’ (but not fully compliant) test units to gain confidence and improve test results
  - Needed by May 2004
  - Prototype development units coming ‘too late’
- Working toward ‘livable antenna configurations’
- Trying to marry implementation needs with typical OEM product implementation timelines

- Best guess now: 2008/2009 model year

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The Applications?

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Present-day 'Old' Technology Supports….

- Roughly 10 Applications:
  - Electronic tolling
  - Traffic management
  - Parking payments
  - Certain e-commerce (m-commerce)
  - Commercial vehicle weigh-station bypass
  - Electronic border clearance
  - Fleet management
  - Access control
  - Few others

- Limited by basic nature of the technology

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Some Potential DSRC Applications

- **ACCESS POINT OPERATIONS**
  - ACCESS CONTROL
- **TRAFFIC MANAGEMENT**
  - PROBE DATA COLLECTION
  - TRAFFIC INFORMATION
  - TRAVELLER INFORMATION
  - HIGHWAY/RAIL INTERSECTION WARNING
  - IN-VEHICLE SIGNING (numerous)
- **TRAFFIC SIGNAL INTERFACE**
  - INTERSECTION COLLISION AVOIDANCE
  - EMERGENCY VEHICLE SIGNAL PREEMPTION
  - TRANSIT VEHICLE SIGNAL PRIORITY
- **ELECTRONIC PAYMENT (In-motion)**
  - TOLL COLLECTION
  - PARKING PAYMENT
  - RENTAL CAR PROCESSING
- **ELECTRONIC PAYMENT (Stationary)**
  - FUEL
  - FAST FOOD
  - OTHER (numerous)
- **INFORMATION TRANSFER**
  - MAP UPDATES
  - INTERNET ACCESS
  - ENTERTAINMENT (numerous)
- **VEHICLE REGISTRATION**
- **PUBLIC SAFETY**
  - SAFETY WARNINGS (numerous)
  - VEHICLE-TO-VEHICLE DATA TRANSFER
- **COMMERCIAL VEHICLE OPERATIONS (In-motion)**
  - ROLLOVER WARNING
  - WEIGH-STATION BYPASS CLEARANCE
  - BORDER CLEARANCE
  - ON-BOARD SAFETY DATA TRANSFER
  - CVO FLEET MANAGEMENT
  - TRACTOR - TRAILER INTERFACE
- **COMMERCIAL VEHICLE OPERATIONS (Stationary)**
  - DRIVER'S DAILY LOG
  - VEHICLE SAFETY INSPECTION
  - TRACTOR-TRAILER MATCHING
- **TRANSIT DATA TRANSFER**
  - TRANSIT VEHICLE DATA TRANSFER
  - TRANSIT VEHICLE REFUELING
- **MAINTENANCE**
  - REPAIR SERVICE RECORD
  - DIAGNOSTIC DATA TRANSFER
  - VEHICLE SOFTWARE UPDATES

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5.9 GHz Application Types

- Vehicular Safety: 50 - 60 applications
- Public Safety: 10 - 15 applications
- Other – approximately 40 applications
  - Tolling / Traffic management
  - Other payment systems
  - e-commerce
  - Fleet / CVO
  - Everything else

- TOTAL: up to 125 applications presently defined

Vehicle Safety Applications - RSU -> OBU

- Enhanced route guidance and navigation
- Point of interest notification
- Map downloads and updates
- GPS correction
- Curve speed warning
- Highway/rail collision warning
- Adaptive headlight aiming
- Adaptive drivetrain management
- Merge assistant
- Pedestrian crossing information
- Pedestrian/children warning
- School zone warning
- Animal crossing zone information
- Sign information - dips, rough road
- Low parking structure warning
- 'Keep clear' warning
- Wrong-way driver warning
- Low Bridge Warning
- Work Zone Warning
- Left turn assistant
- Stop sign movement assistance
- Infrastructure Intersection Collision Warning
- Traffic Signal Warning
- Stop Sign Warning

Vehicle Safety Applications - OBU -> RSU

- Emergency Vehicle Signal Preemption
- Intelligent on-ramp metering
- Intelligent traffic lights
- Infrastructure based traffic management - probes
- SOS services
- Post-crash warning
- Just-in-time repair notification
- Blind merge warning

Vehicle Safety Applications - OBU -> OBU

- Merge assistant
- Blind merge warning
- Highway/rail collision warning
- Pre-crash sensing
- Cooperative glare reduction
- Instant problem messaging
- Vehicle-based road condition warning
- Vehicle-to-vehicle road feature notification
- Curve speed warning
- Electronic brake lights
- Enhanced differential GPS corrections
- Vehicle-to-vehicle intersection collision warning
- Lane change assistant
- Blind spot warning
- Post-crash warning
- Visibility Enhancer
- Cooperative collision warning
- Cooperative vehicle-highway automation system (platooning)
- Approaching emergency vehicle warning
- Cooperative adaptive cruise control
- Approaching emergency vehicle warning
- Hybrid intersection collision warning
- Left turn assistant
- Stop sign movement assistance

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Public Safety Applications

- Emergency Vehicle Signal Preemption
- Vehicle-to-Vehicle Data Transfer
- Approaching Ambulance, Police Car, Fire Truck
- Video Links
- Safety Warnings (numerous)
- Others

‘Everything Else’ Applications

- All the ‘old’ applications
- Congestion alert – perhaps in time to exit
- Distance to next exit or toll point
- Toll amount at next toll point
- Account balance
- Distance to rest area / service area
- Services available at service area
- Map databases
- News, music, etc.
- Mobile internet
- Traveler Information
- Rental car operations
- Repair service records
- Diagnostic data transfer
- Vehicle software updates
- Safety inspections
- Drivers daily logs
- Tractor-trailer communications
- Tractor-trailer matching
- Transit vehicle data transfer
- Transit vehicle fuel management

And many more

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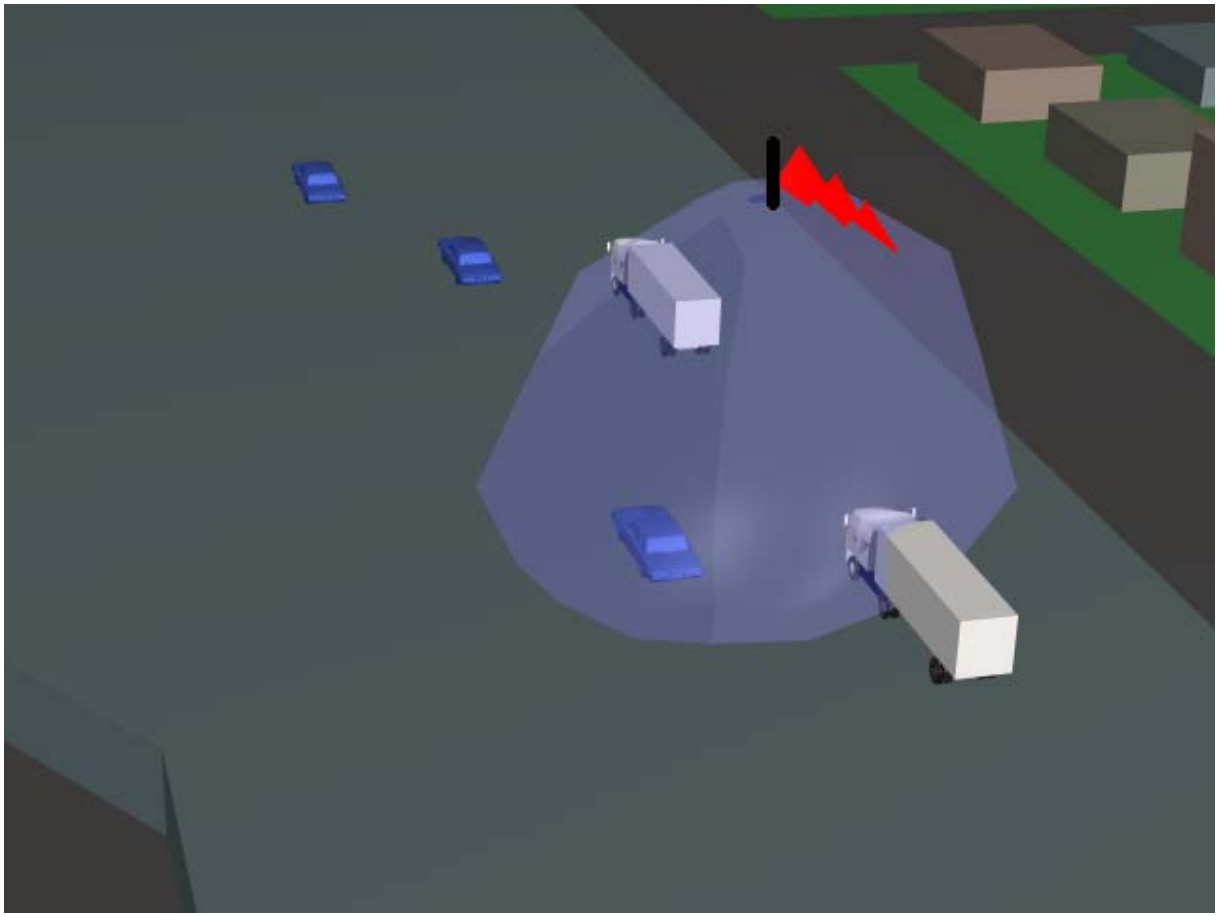
Many Safety Applications are Warnings



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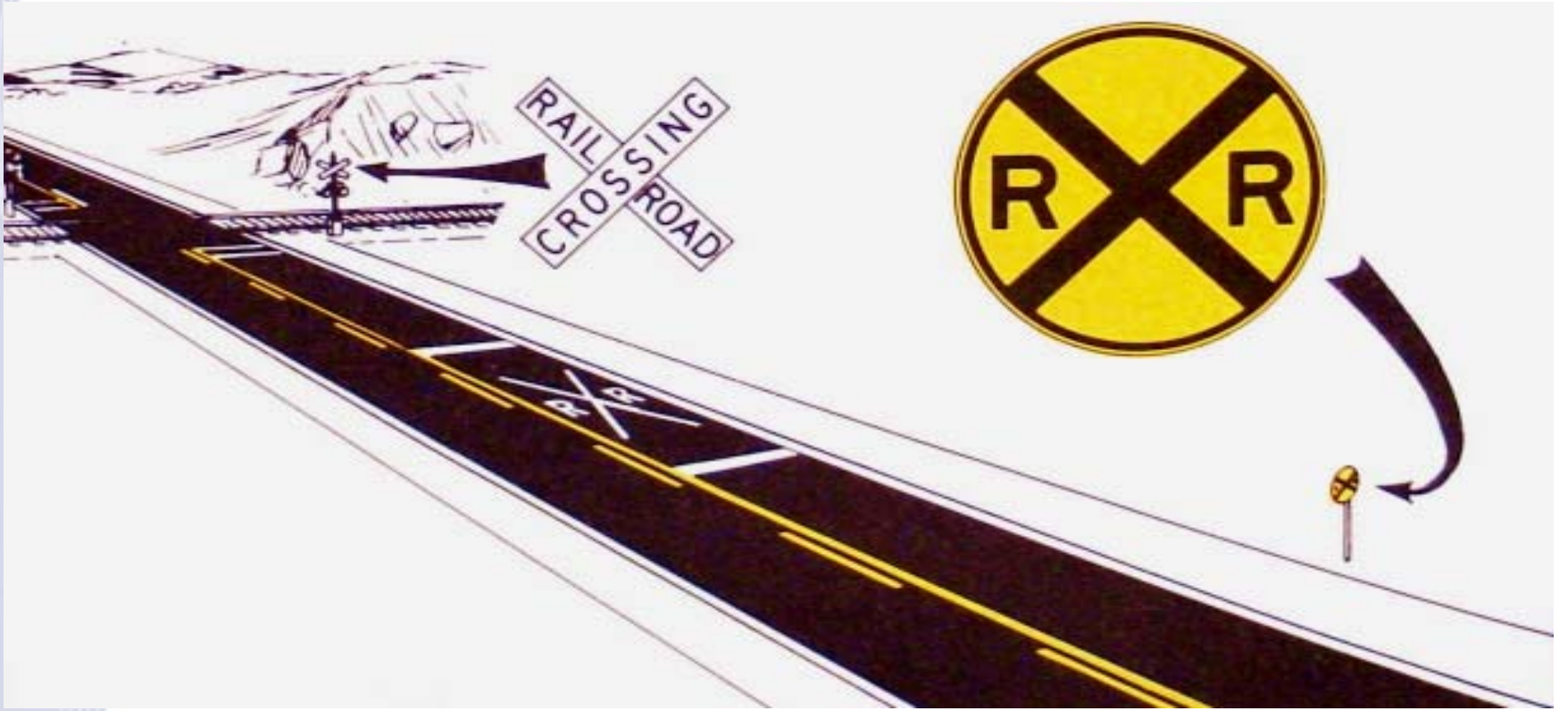
HIGHWAY/RAIL INTERSECTION WARNING



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NARROW BRIDGE - WARNING SIGN

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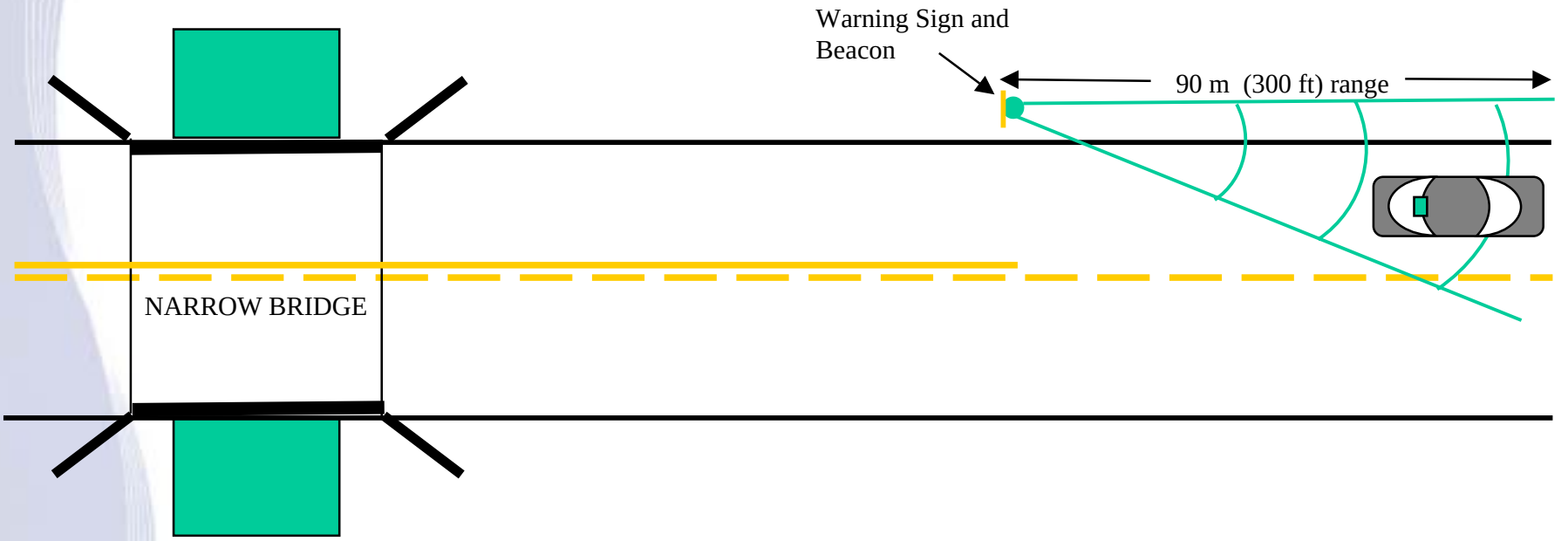
NARROW BRIDGE - WARNING SIGN + DSRC BEACON



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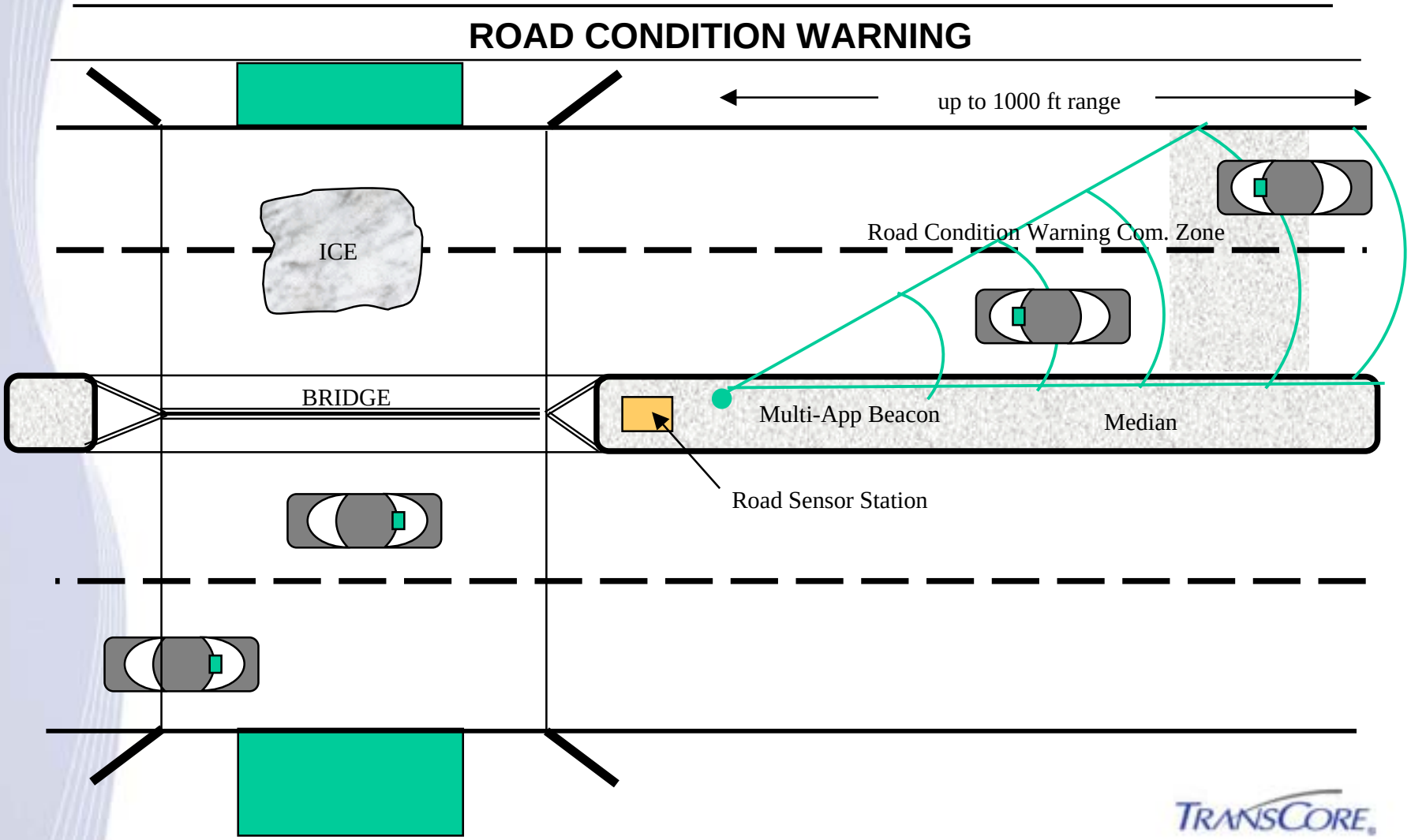
“Icy Bridge Ahead” Warning



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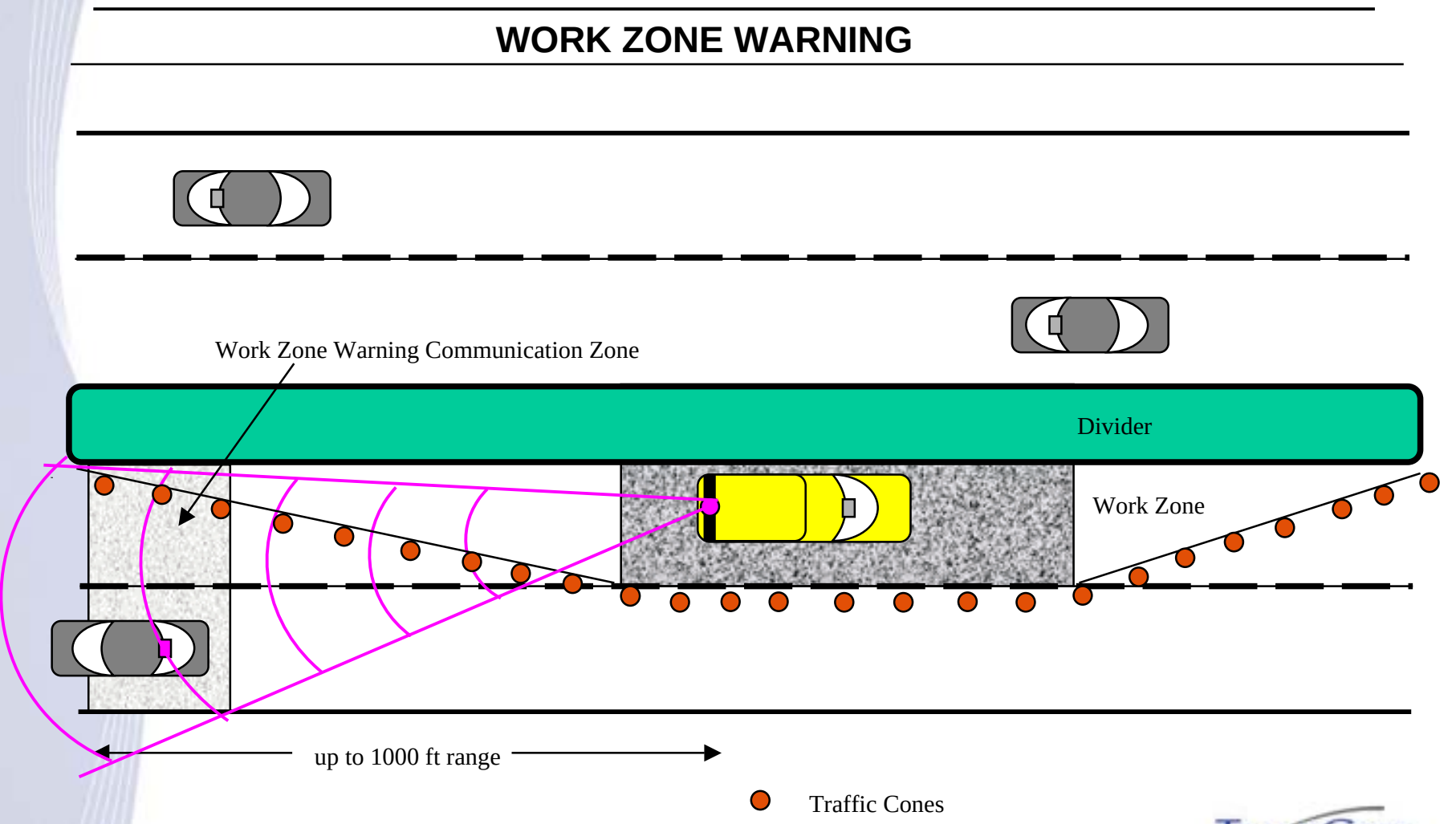
“Work Zone Ahead” Warning



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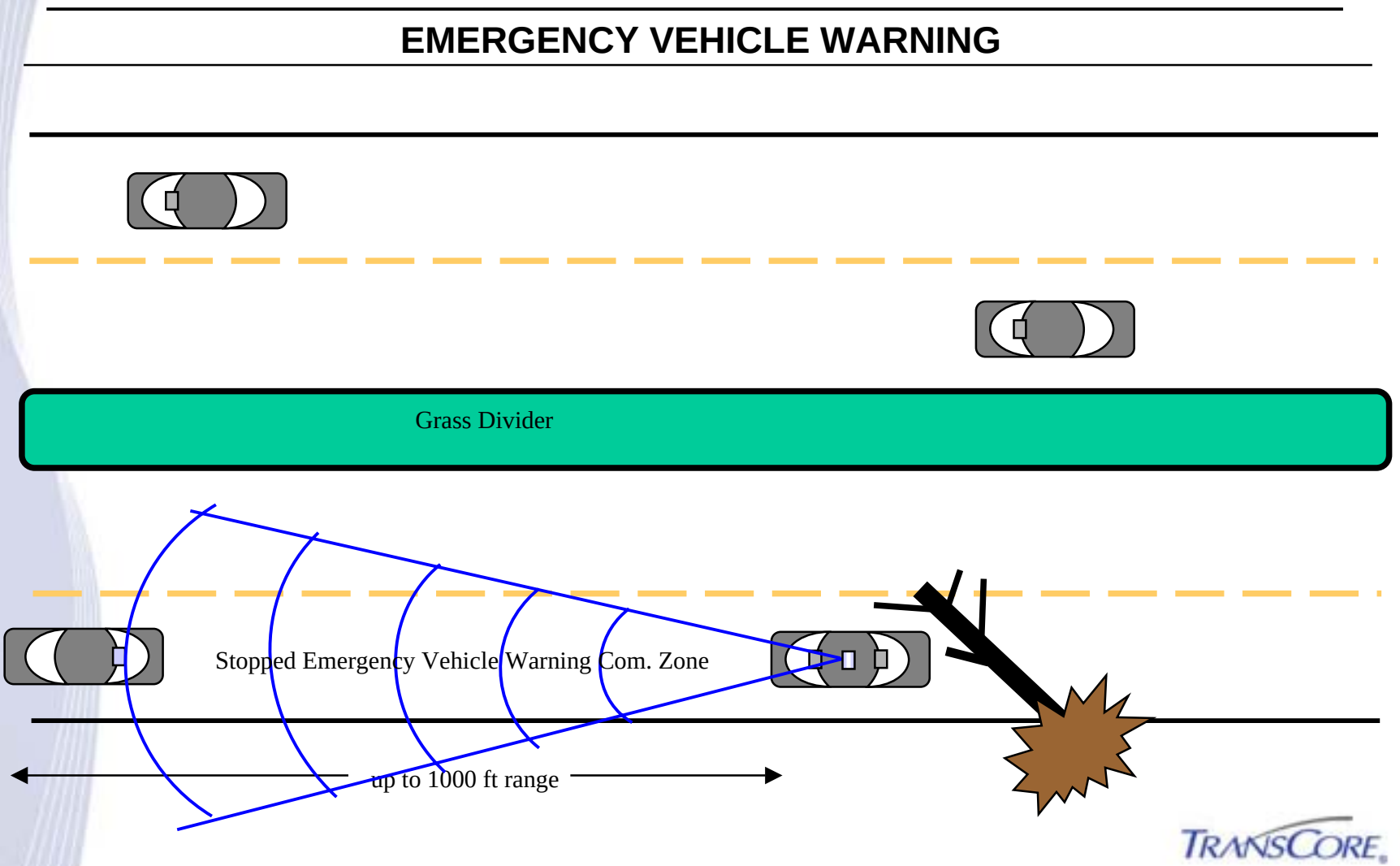
“Roadway Impediment Ahead” Warning



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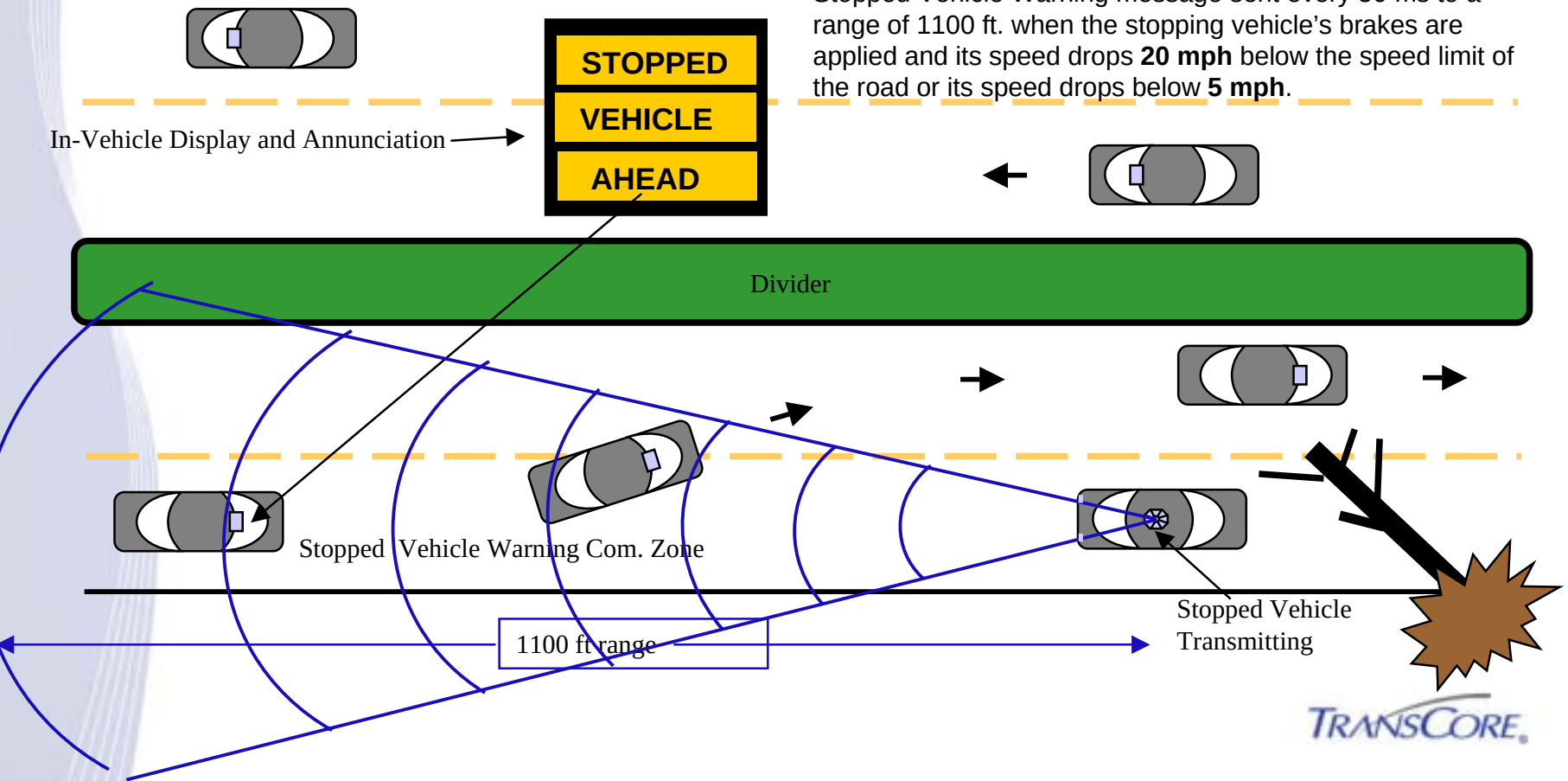
VEHICLE TO VEHICLE COLLISION AVOIDANCE - STOPPED VEH. WARNING

Stopped Vehicle Warning message sent every 50 ms to a range of 1100 ft. when the stopping vehicle's brakes are applied and its speed drops **20 mph** below the speed limit of the road or its speed drops below **5 mph**.



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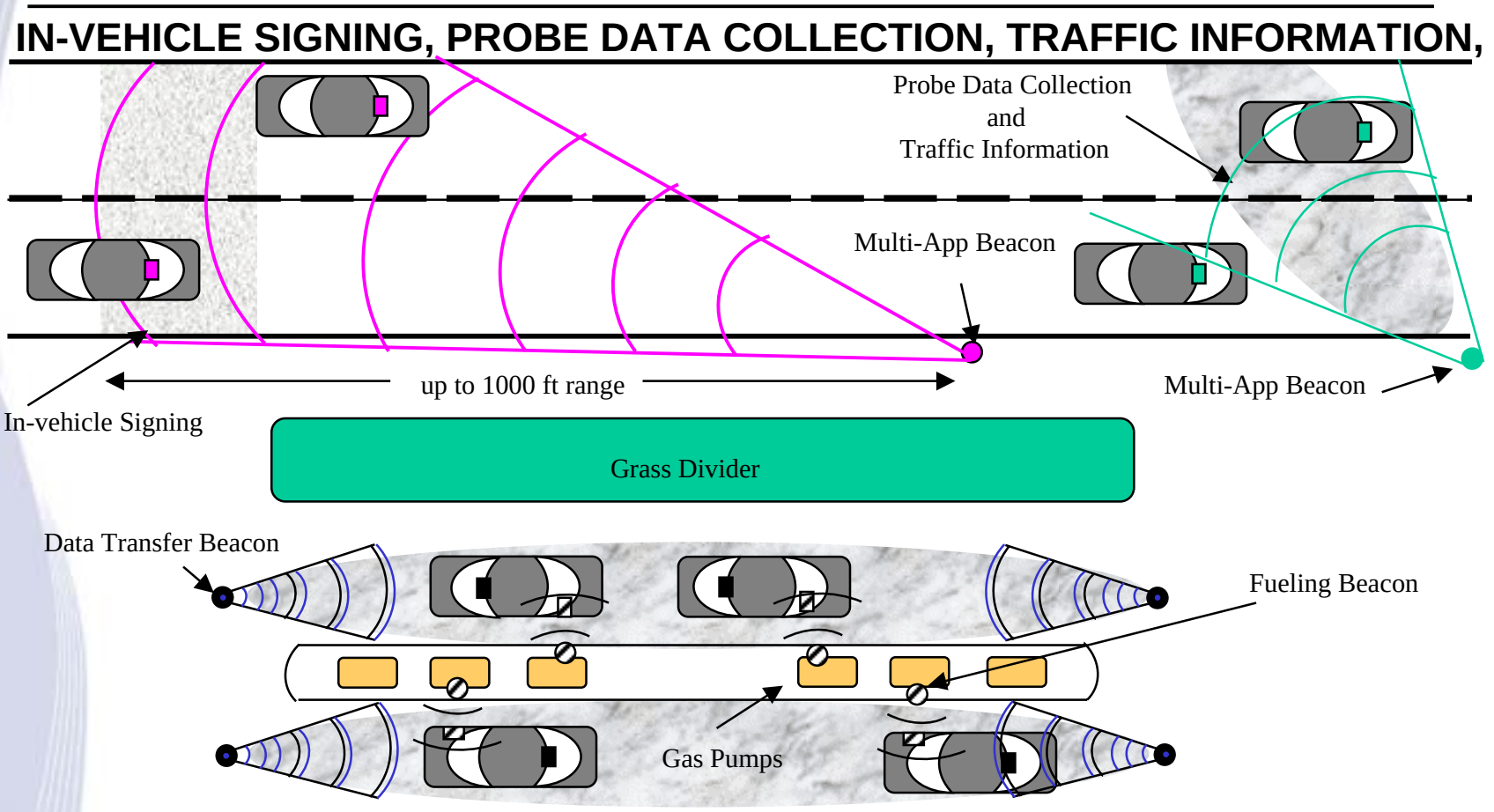
Fueling & Info-Fueling Near the Tollroad



GAS PAYMENT and Data Transfer

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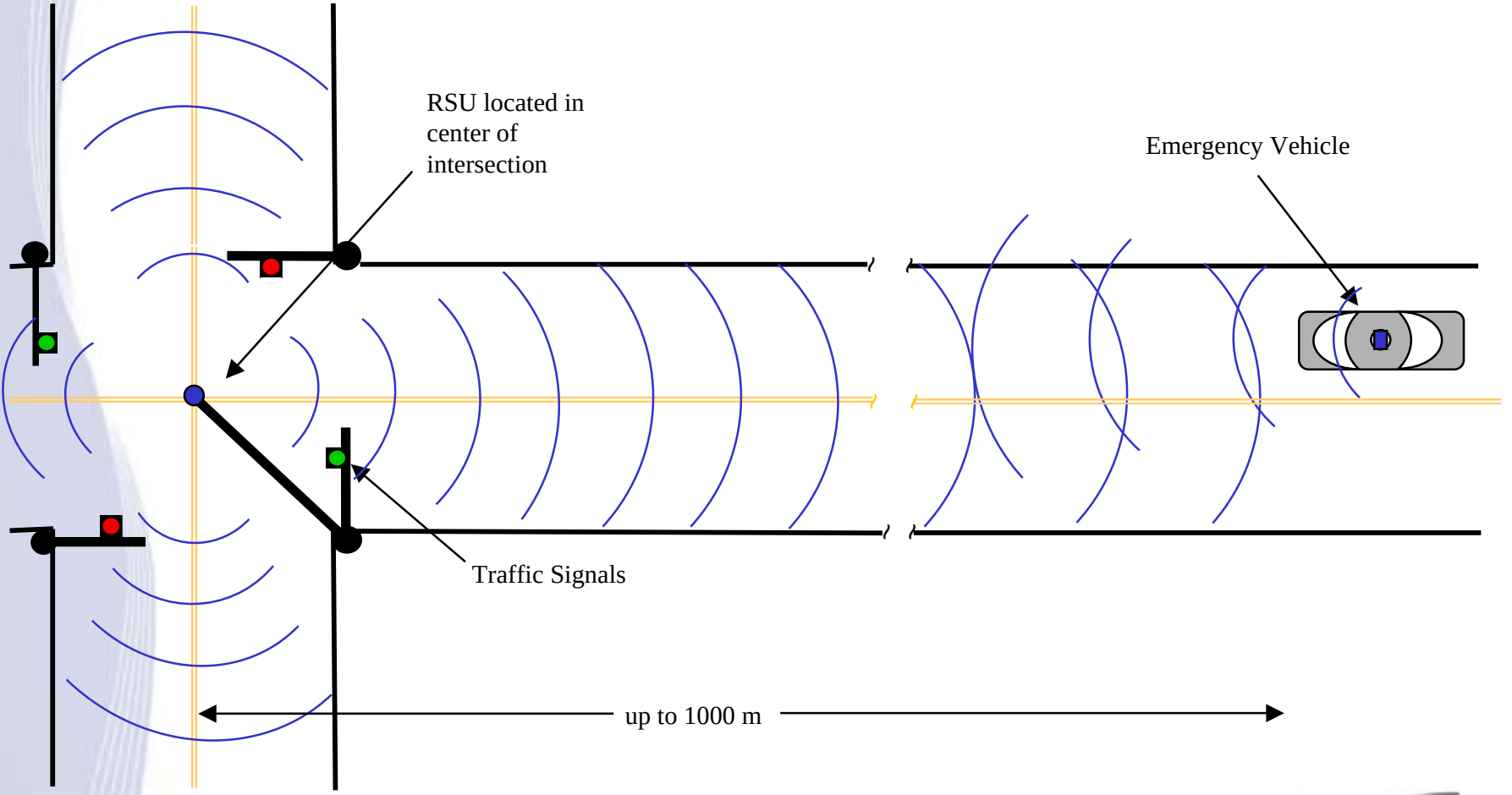
EMERGENGY VEHICLE SIGNAL PREEMPTION



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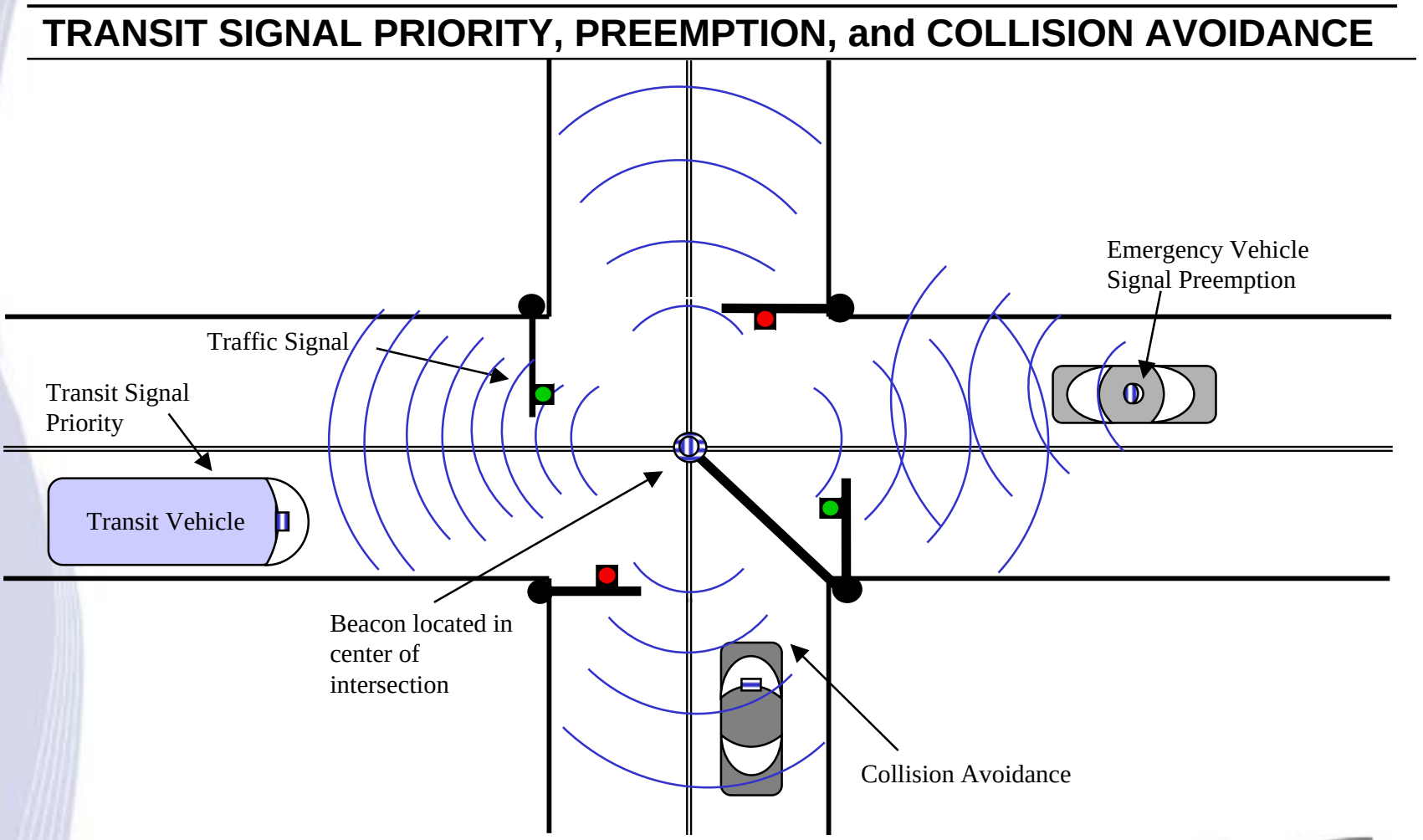

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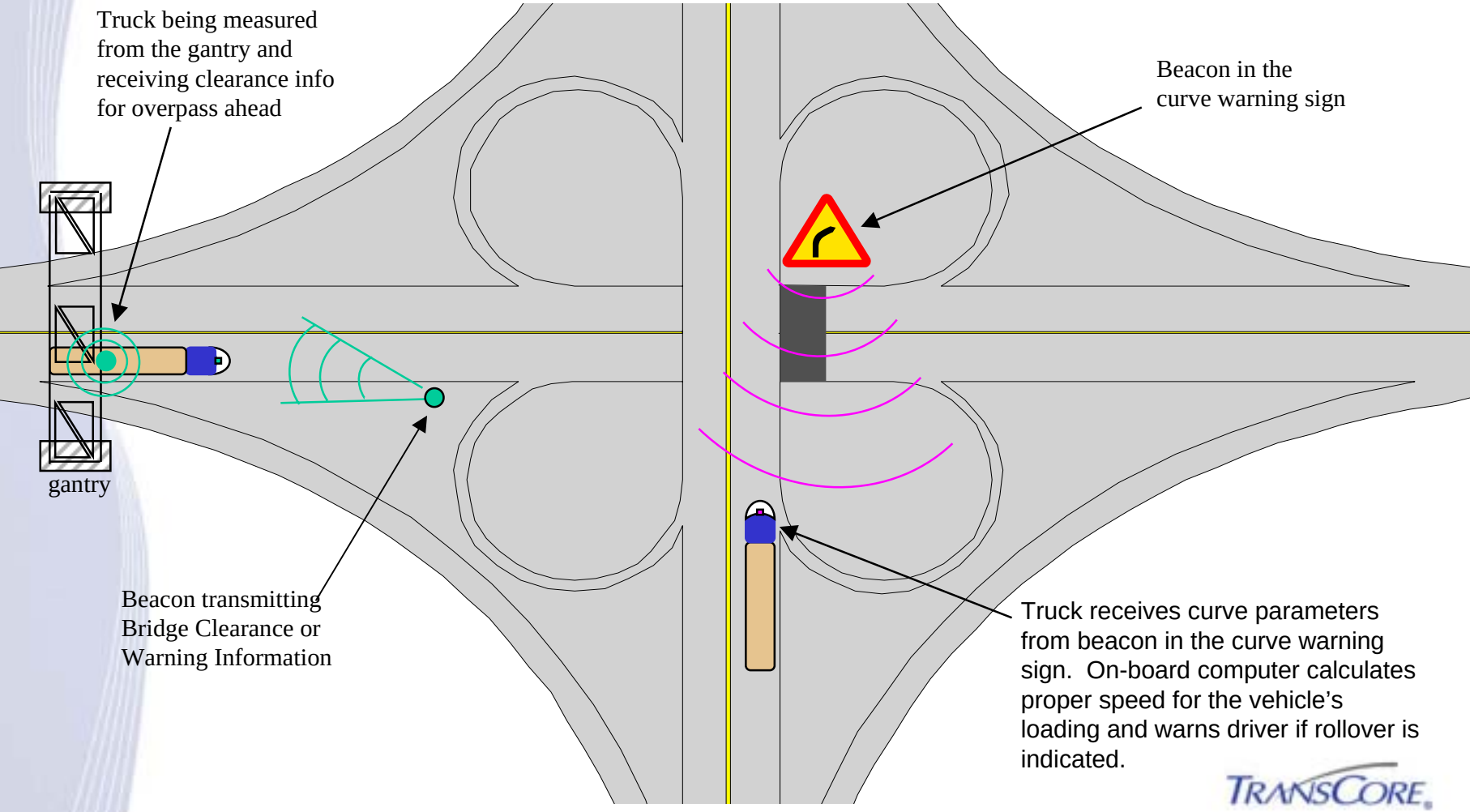
CVO - Centric Applications

LOW BRIDGE WARNING and ROLL OVER WARNING



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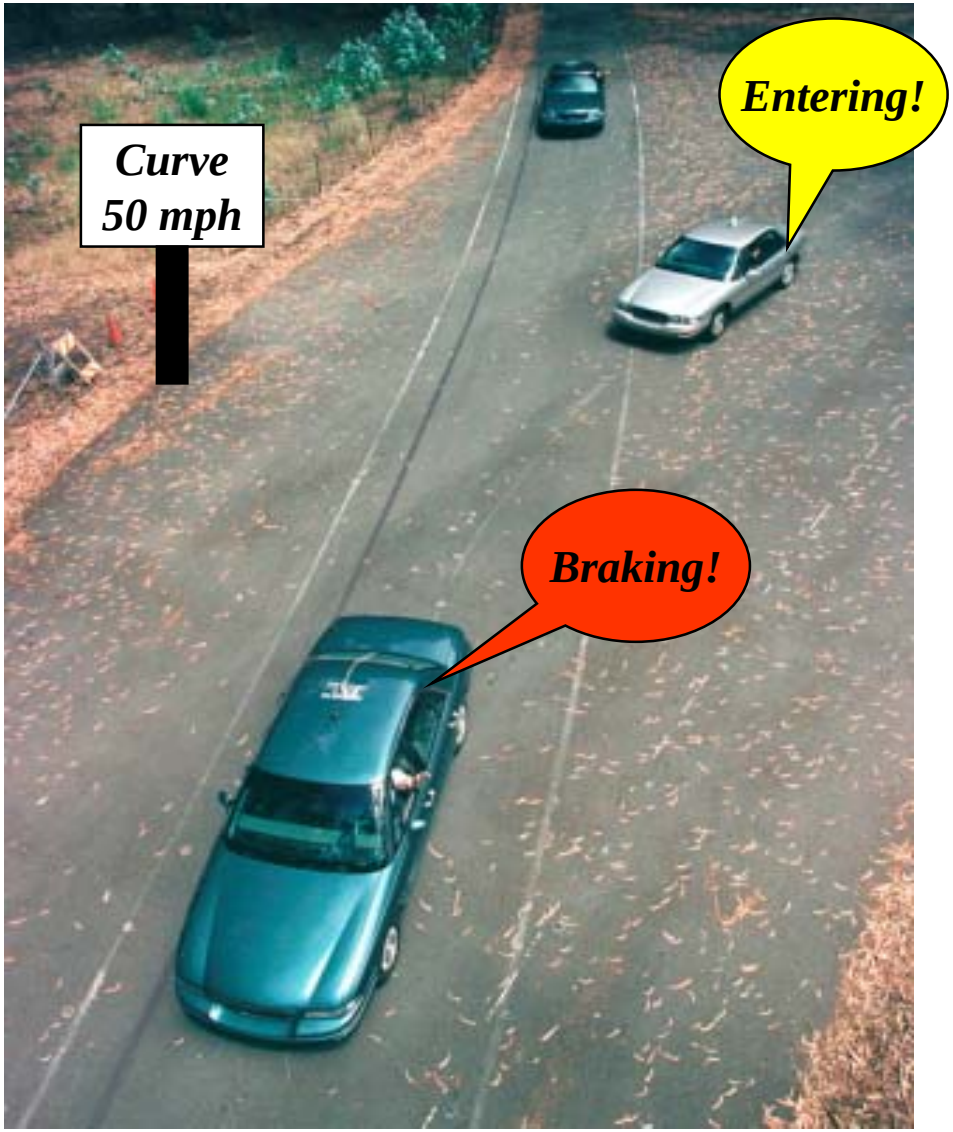
Cooperative Vehicle Operations



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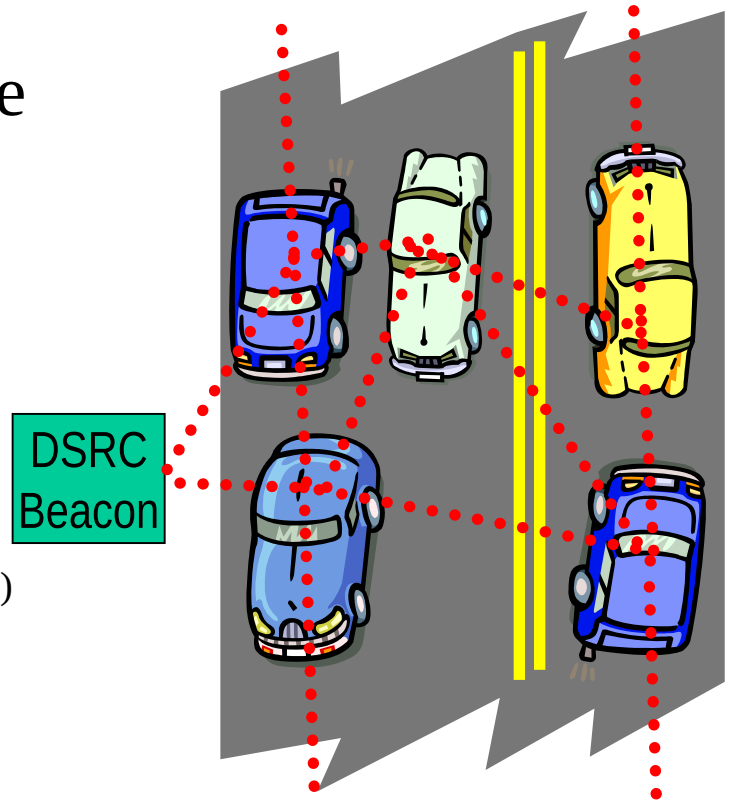
Mobile Networks Include the Roadside

- Cooperative route planning
- Cooperative accident avoidance
- Propagation of data
  - Weather
  - Traffic
  - News
  - Entertainment (audio, MP3 file download)



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Cooperative Crash Avoidance (1)

- Each vehicle sends its location, speed and direction routinely to neighboring vehicles
  - 10 times per second

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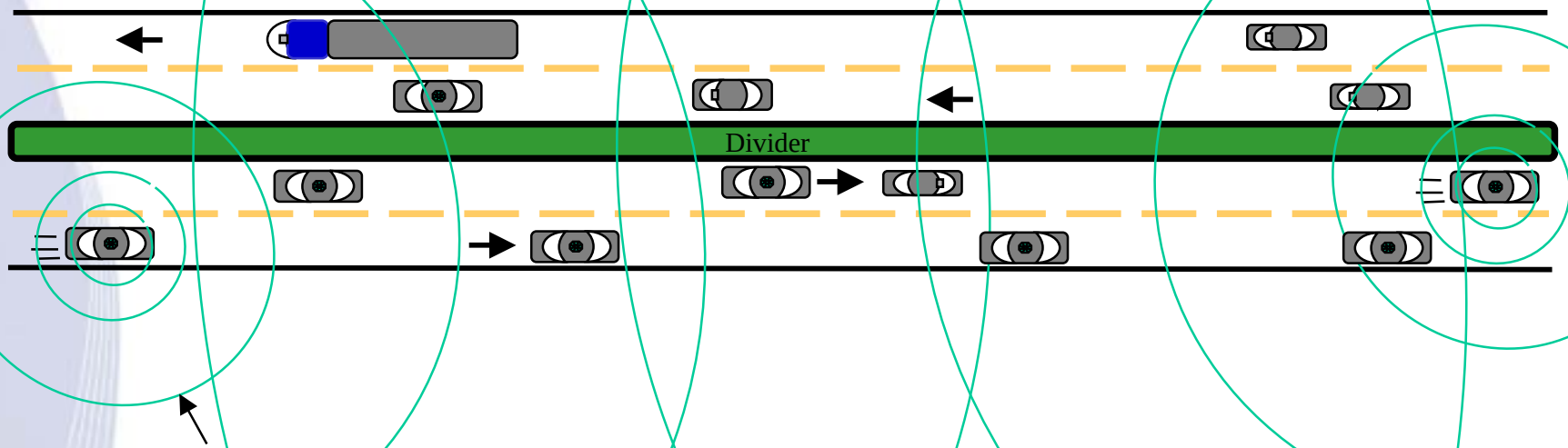
VEHICLE TO VEHICLE COLLISION AVOIDANCE – ROUTINE MESSAGING



Routine position, speed, direction messages

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Cooperative Crash Avoidance (2)

- Vehicles compare received vehicle information with like information from own vehicle
- First evidence of possible collision results in driver warnings

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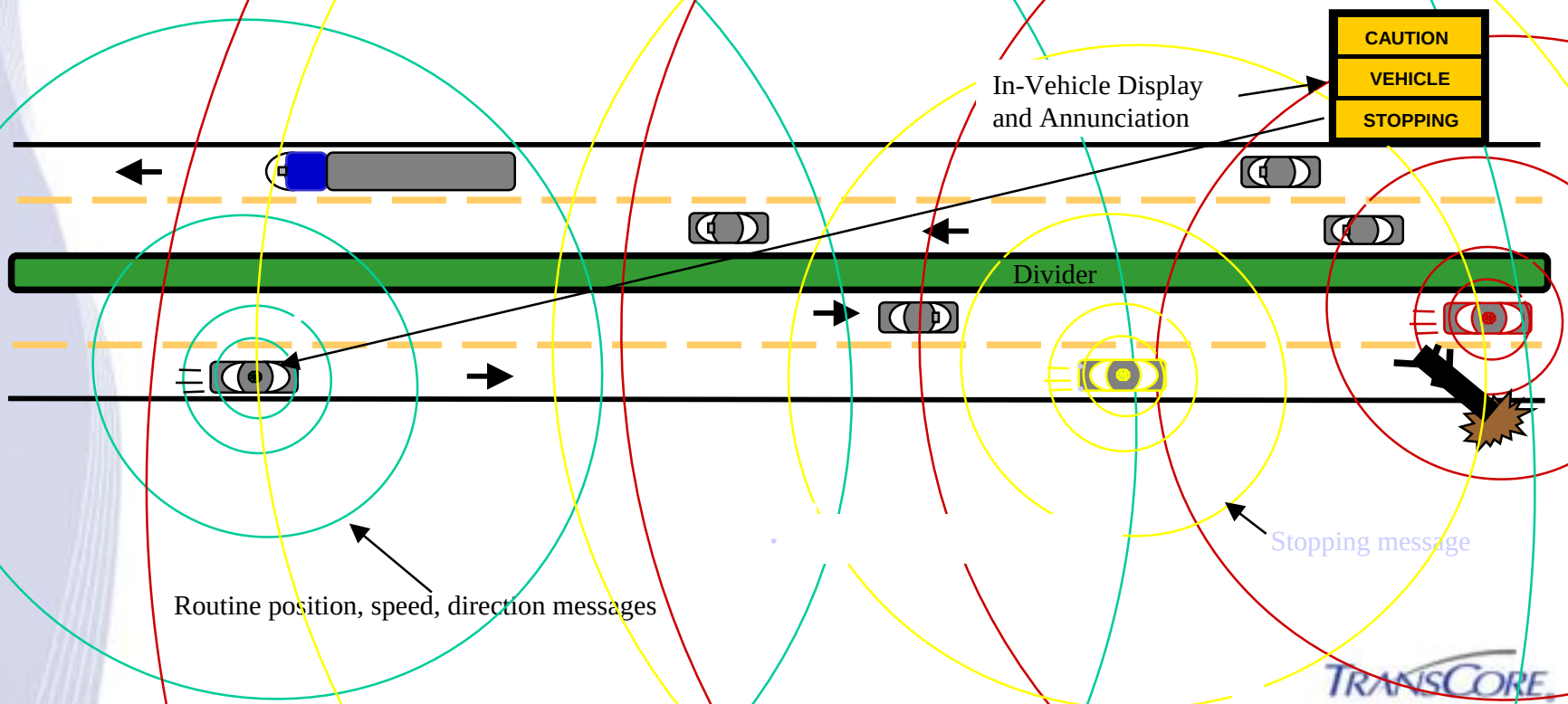
VEHICLE TO VEHICLE COLLISION AVOIDANCE - STOPPING VEH. WARNING



Cooperative Crash Avoidance (3)

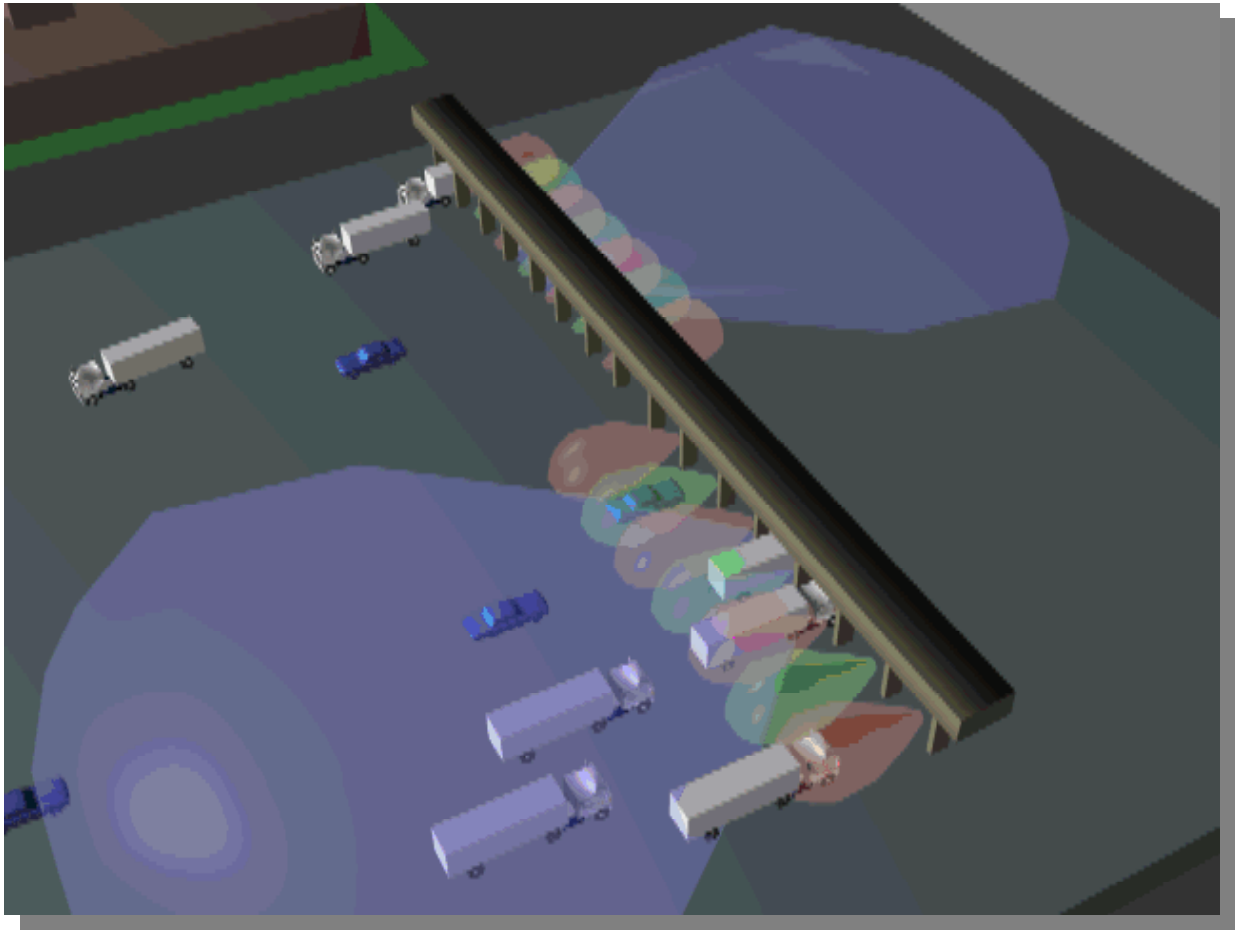
- If collision becomes unavoidable, vehicles trade lots of information in the final milliseconds to better protect occupants
  - Info: weight, vehicle characteristics & capabilities

- Vehicles now know all about the crash BEFORE IT HAPPENS
  - What's going to hit me?
  - Where will it hit me?
  - How much energy will be in the collision?
  - Do our bumpers line up?

Cooperative Crash Avoidance (4)

- Knowing this information, numerous protective measures can be considered
  - ‘Last-moment’ steering or braking operations
  - Pre-tensioning seatbelts
  - Re-positioning bumpers to better line up and/or absorb more energy
  - Deploying airbags in a customized way to best protect in THIS PARTICULAR CRASH
  - Etc.

Toll Collection – Plaza Zones



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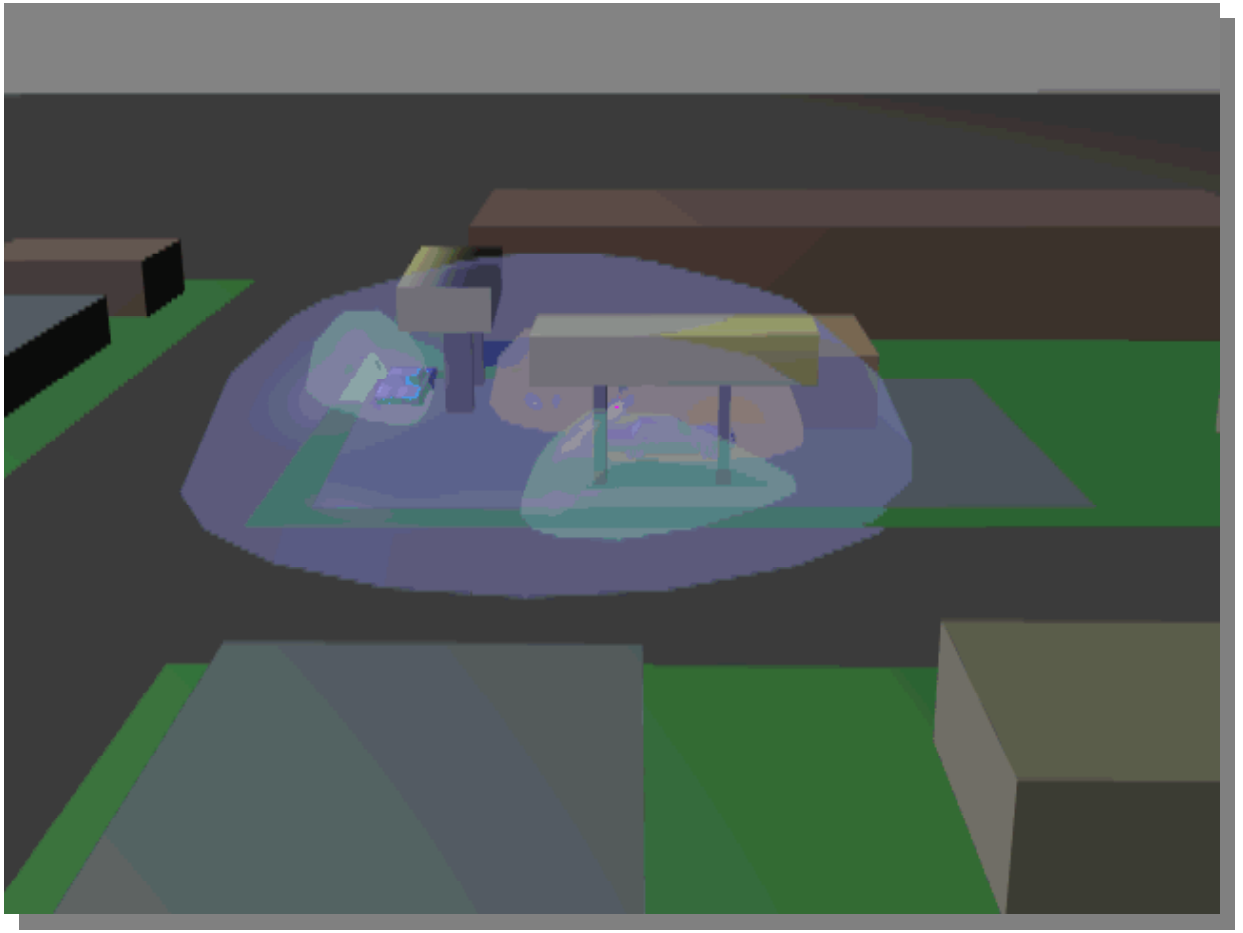
Gas Station – Zones Within Zones



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Summary

- 5.9 GHz DSRC developments are accelerating
- Both safety initiatives and business opportunities are providing incentive
- Money is starting to flow into development
- Automakers are supporting the program
- Many new applications will be enabled
- 2004 will be a pivotal year in these developments

- For more information:

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