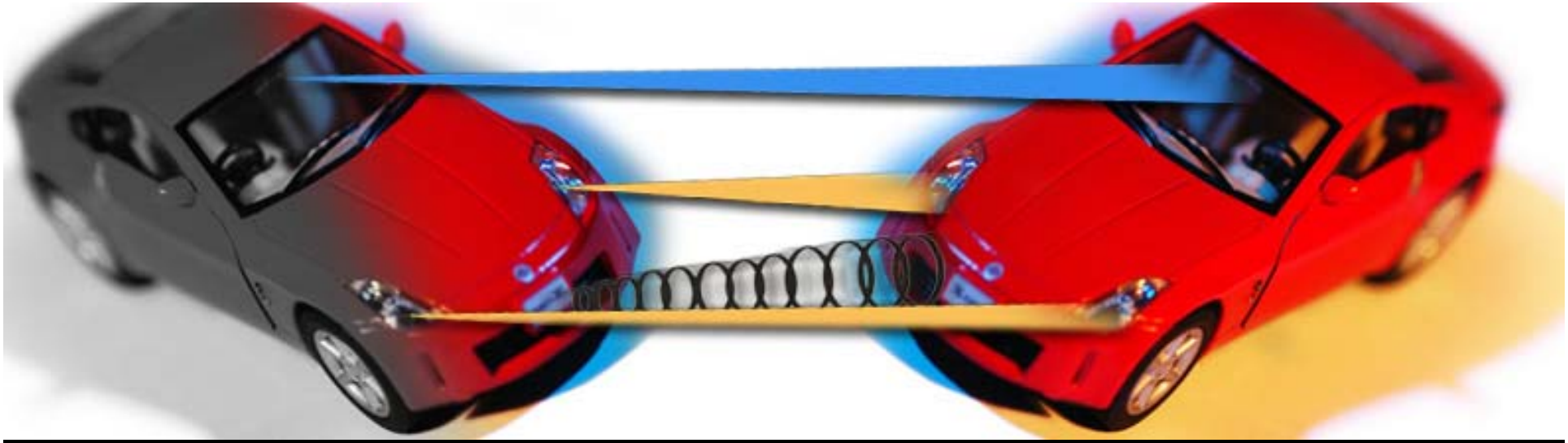
FISITA 2006 World Automotive Congress
Technical Session

The Safety Promise of Vehicle-to-Vehicle Wireless Communications:
Research in the United States



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Crashes of all Severities

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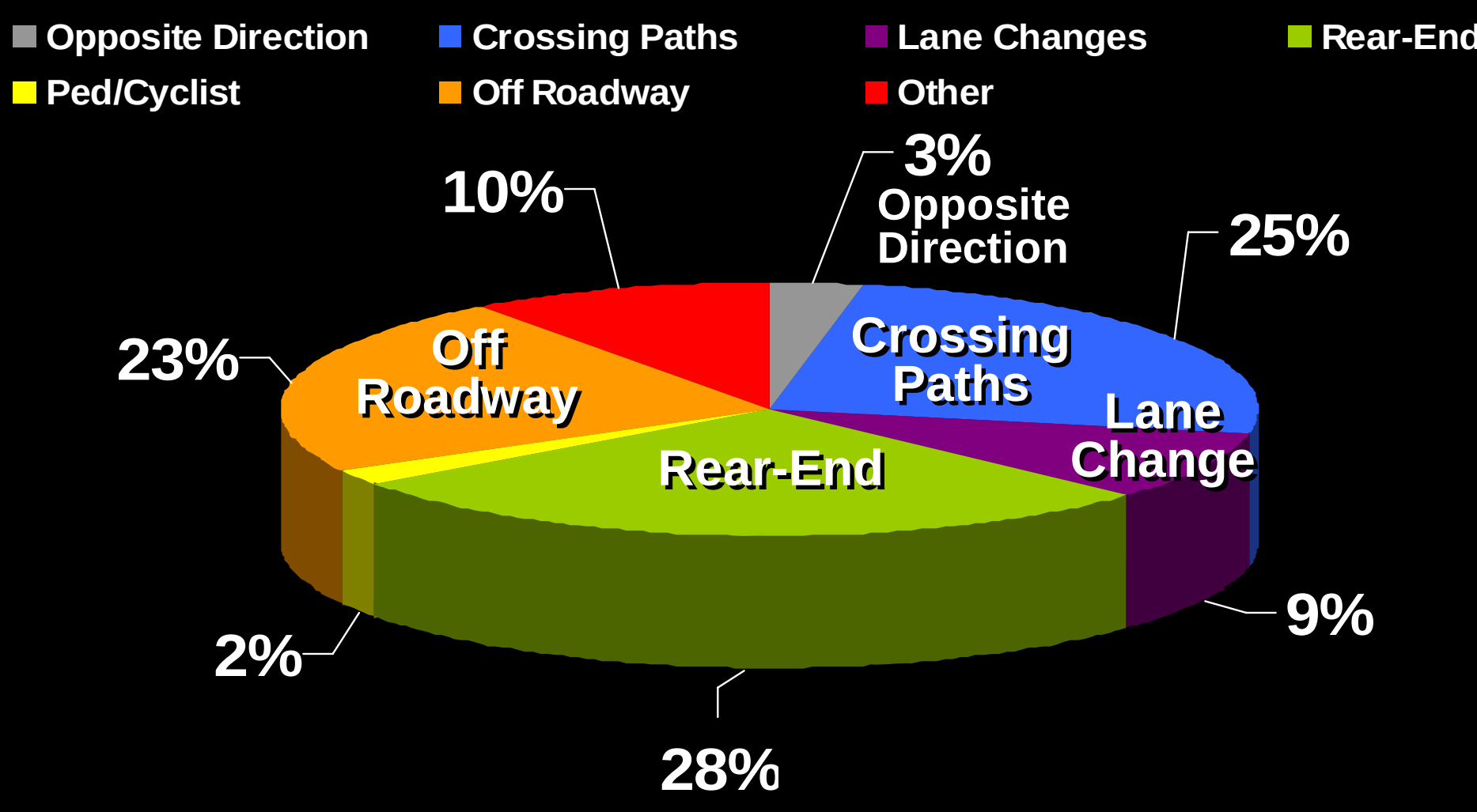

Crash Causal Factors

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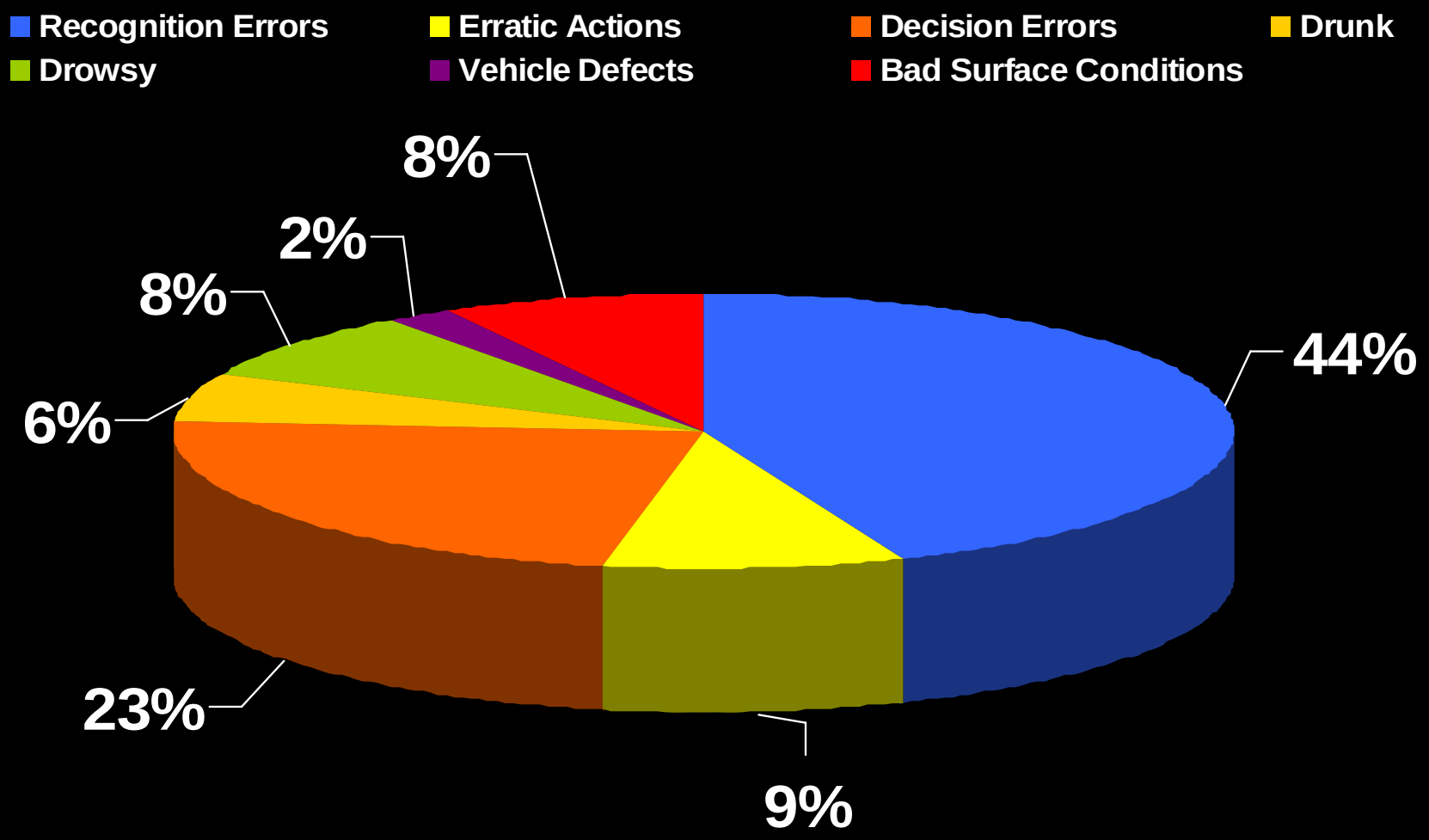

Vehicle-to-Vehicle Communication

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Potential Safety Benefits

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- Enhance and Complement active safety, vehicle based radar/vision sensor technologies.
- Develop new active safety applications using vehicle-to-vehicle communications.
- Enhance occupant protection systems.

Potential Safety Benefits (Continued)

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- More precise and reliable information.
- Improved threat assessment warning algorithms.
- Information delivered earlier and just in time.
- Works more effectively in adverse weather conditions
- Works around obstacles and large vehicles that could block radar/vision sensors.

Intervention in Crash Prevention and Severity and Injury Mitigation

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Prevention | **Severity Reduction** | **Injury Mitigation** | **Medical Attention**

Warn → **Intervene** → **Protect** → **Notify**

0

200 m.sec.

- Pre-activated Restraints
- Pedestrian Protection
- Adaptive Structures
- Adaptive Restraints

- Enhanced Crash Notification
- Tailored Medical Attention

Developed by: Joseph N. Kanianthra

Some Examples of Potential Vehicle-to-Vehicle Safety Applications

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- Cooperative Forward Collision Warning
- Pre-Crash Sensing and Collision Mitigation
- Emergency Electronic Brake Lights
- Lane Change Warning
- Stopped Vehicle Ahead Warning

Cooperative Forward Collision Warning

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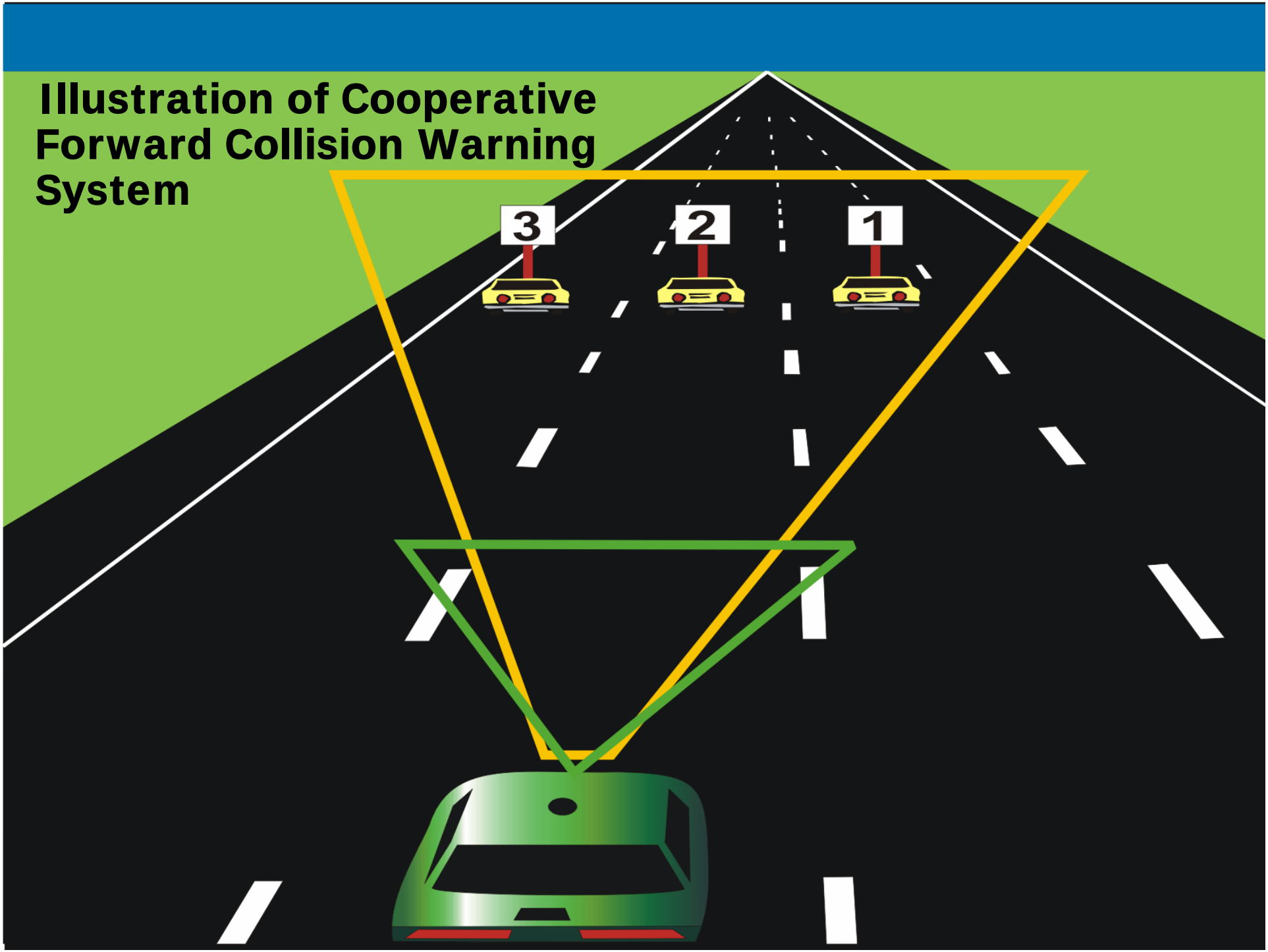
- Enhanced autonomous forward collision warning systems.
- Cooperative forward collision systems.
- Avoid missed detections, determine in/out of path lead vehicles, determine forward road geometry, and lead vehicle user intent.

Illustration of Cooperative Forward Collision Warning System



Pre-Crash Sensing and Collision Mitigation

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- Information on an impending collision to augment occupant protection system.
- Information on potential crash types, impact speed, impact time, and striking vehicle size and mass.
- Enhance air bag deployment, safety belt pre-tensioning, compatibility countermeasures, and emergency brake assist.

Emergency Electronic Brake Lights

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- Early notification of lead vehicle emergency braking.
- Enhanced visibility of brake lights and presenting information earlier.
- Enhanced visibility of brake lights blocked by large lead vehicles.
- Provide additional information on acceleration/deceleration.
- Provide additional driver warning.

Illustration of Emergency Electronic Brakes

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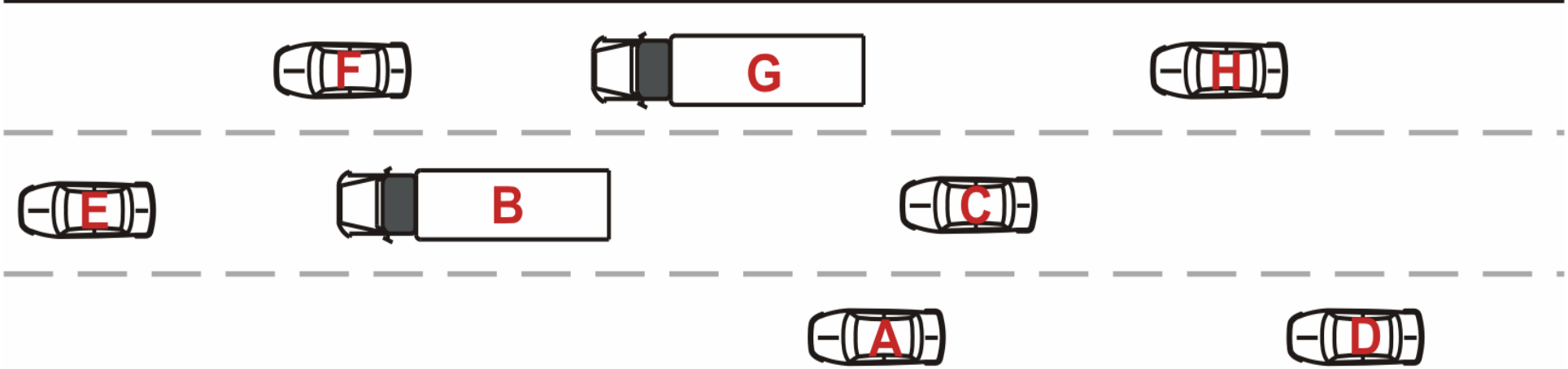

Hardware / Software Sub-Systems

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- DSRC: Veh-to-Veh Communications
- GPS: Vehicle Positioning
- Map database
- Vehicle Bus: Vehicle speed, acceleration,
- Threat Assessment Algorithm/Processor
- Driver Vehicle Interface/Driver Warning
- Complementary radar or camera sensors

Current Research Tasks

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- Identify the shortcomings of vehicle based sensor systems.
- Identify communication-enabled safety applications to complement other advanced technologies and autonomous applications.
- Develop analytical procedures, experimental tests, and on-road trials for effectiveness evaluation.

Current Research Tasks (Continued)

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- Develop prototype vehicles and associated equipment for selected applications.
- Perform tests to evaluate performance of systems and subsystems.
- Estimate safety benefits.

Deployment Challenges

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- **Security: Assure messages are from trusted sources.**
  - Identify compromised sources and false data.
- **Anonymity/Privacy: Assure anonymity of source.**
- **Safety priority messaging**
  - Priority to safety communication.
- **Interoperability and Standards**
- **Non-equipped vehicles - Transition provisions during build-up to 100 percent of the fleet.**

Deployment Challenges
(Continued)

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- Platooning, Chain events, Multiple events.
- Timing issues: Appropriate/Low latency. In-time warnings.
- Cost of communications and on-board hardware vs. benefits of applications (safety and non-safety).
- Driver/Vehicle Interface: More complex.
- Human factors research essential.

Conclusions

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- **Potential to Provide Major Safety Benefits**
- **Thorough Evolutionary Research Necessary**
- **Many Deployment Challenges Remain**
  - Fleet-wide availability
  - Reliability
  - Privacy Issues
  - Human Factors Issues
  - Complexity of Algorithms
- **Challenges are Solvable**