# Crash Avoidance in the Age of Connected Vehicles

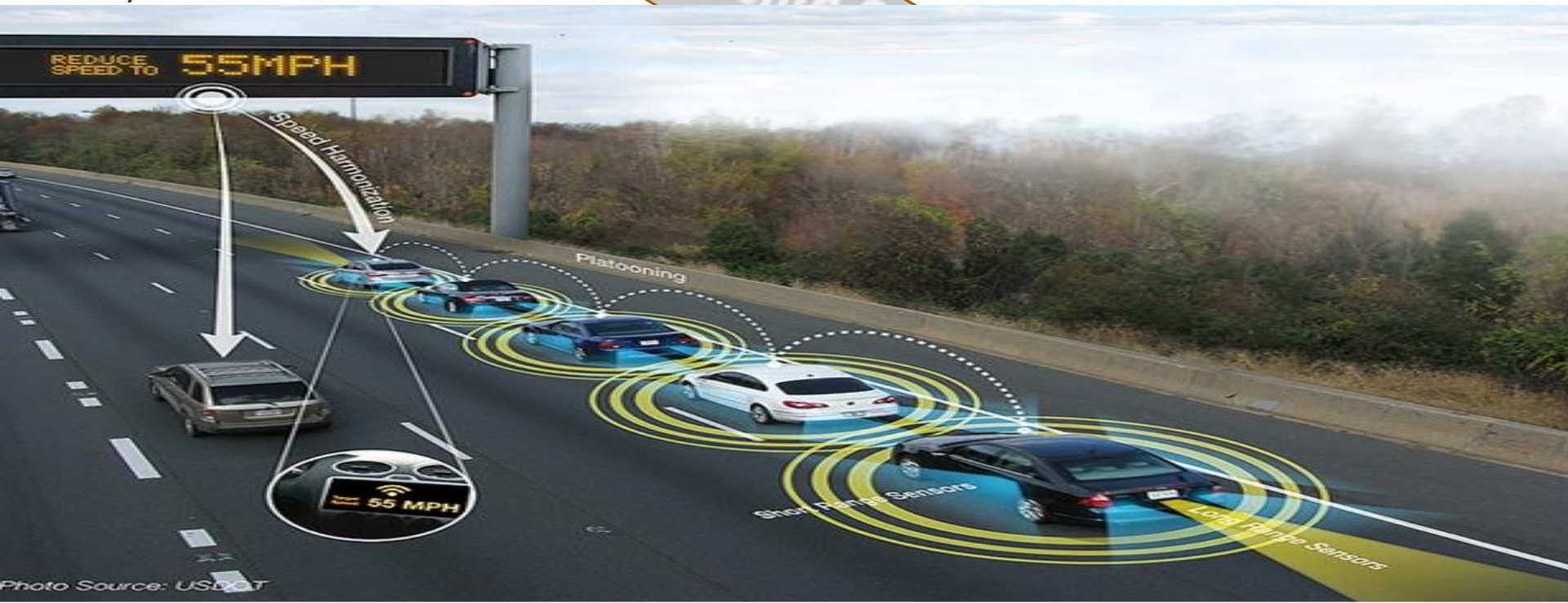
SYED AMAAR AHMAD, PHD

# Intelligent Transportation Systems

- Automotive industry moves towards vehicular communications 2002
- Vehicle-to-vehicle, vehicle-to-infrastructure, vehicle-to-pedestrian environments
- GPS can now provide accurate lane-level positioning in open sky conditions
- Dedicated Short Range Communications (DSRC) transmits and receives this positioning information
- Connected vehicles technology is distinct from autonomous vehicles ('self-driving' cars) but may be merged with it eventually

# Emerging Sensors

- Increasingly vehicles equipped with radars, lidars and cameras; each sensor has line-of-sight limitations
- DSRC is simply a modified form of WiFi that allows vehicles to communicate with each other up to 300m despite obstructions
- System can track and detect threats to warn drivers if crash is imminent



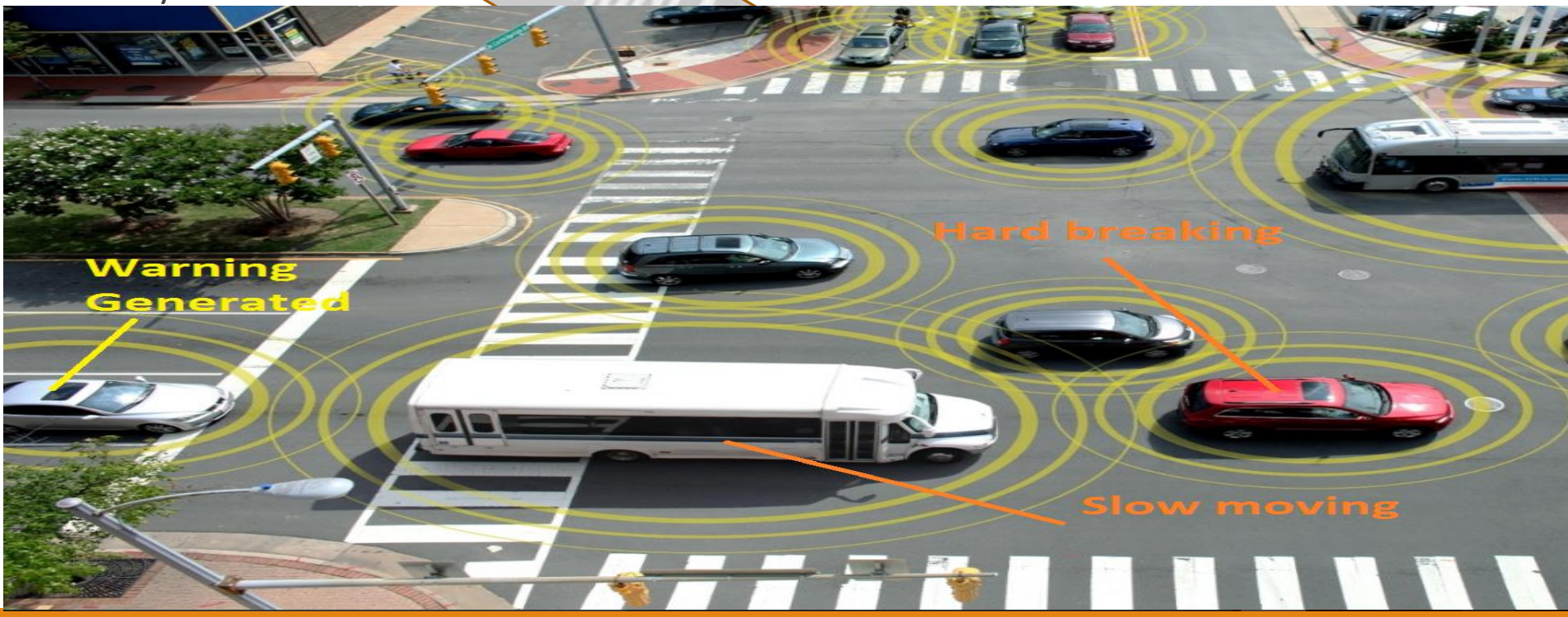
# How does Crash Avoidance work?



- DSRC operates at about 5.9 GHz wireless band without authentication or typical access as in the traditional household 2.4 GHz Wi-Fi
- Each vehicle with DSRC radios broadcasts messages 10 times a second; receives messages from other vehicles
- Each message (called a Basic Safety Message or BSM) contains GPS position, heading, speed and other critical information
- Real-time tracking of neighboring cars to determine possible collision path
- Algorithms determine the appropriate time to give audio or vibration warning to drivers

# Forward Warnings

- A vehicle assesses threat based on relative speeds and distances of in-lane cars
- Unlike radar or camera, collision warnings can also be given for hard-breaking vehicles not directly visible



# Intersection Warnings

- Threat assessed for cars moving from left or right at an intersection
- Obstructions like trees or buildings may not negatively affect warning from non-line of sight vehicles

# Blindside Warnings

- Threat assessed while moving into a new lane for the blind spots
- Low-cost radars and side-cameras may not provide warning for fast-moving incoming cars in side lanes

# Challenges

- GPS equipment needs to provide highly accurate degree of positioning; tunnels and high-rise buildings can compromise lane-level position accuracy
- As hundreds of vehicles in a vicinity broadcast messages, too much interference can reduce communication range and system effectiveness (scalability issue)
- Malicious users (hackers) may jam DSRC wireless channel and spoof vehicle positions to create false warnings or false negatives



# Summary



- Push towards DSRC from major car manufacturers, US DOT and NHTSA
- Testing and evaluation phase; initial deployment likely to begin by 2017
- DSRC may be absorbed into autonomous cars; multiple sensors to detect and avoid crashes
- Smart cities with road-side equipment to provide real-time GPS corrections, dynamic traffic light information and proximity warning to pedestrians
- New applications such as platooning, high speed curve warning etc.