Autonomous Vehicle Data Sharing Link (AVDSL)

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Abstract

Today's autonomous vehicles face critical challenges in situational awareness and decision-making due to limited sensor ranges.

The Autonomous Vehicle Data Sharing Link (AVDSL) addresses these issues by connecting vehicles, pedestrians, cyclists, and infrastructure, creating a secure and structured platform for data exchange.

This revolutionary system, powered by Vehicle-to-Everything (V2X) communication, enhances road safety, reduces traffic congestion, improves emergency response, and optimizes various aspects of transportation.

The flowchart outlines the seamless process of data sharing, while potential cybersecurity concerns highlight the need for robust protective measures.

By integrating cutting-edge hardware components and sophisticated software systems, AVDSL lays the foundation for a connected and intelligent transportation ecosystem, heralding a new era in mobility.

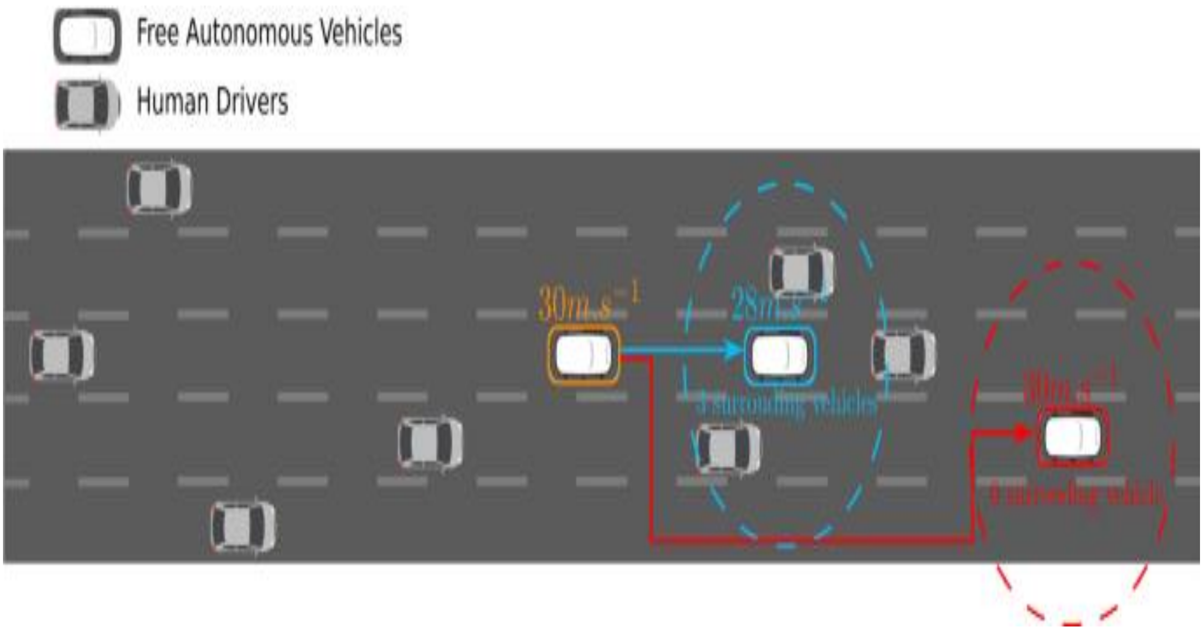


FIGURE 1

TODAY'S AUTONOMUS VEHICLE

Autonomous vehicles operate by utilizing a variety of sensors, such as radar for object detection, cameras for visual perception, and GPS for tracking the car's location.

These sensors act as the eyes and ears of the vehicle, enabling it to sense and detect objects in its surroundings. The collected data informs decisions on the vehicle's direction and speed, allowing for autonomous navigation.

Problem:

The primary challenge with these vehicles lies in their reluctance to share data, resulting in limited access to information collected by other cars.

Solution:

Connecting the data from one car to another would provide additional advantages and optimize resource utilization. This serves as a potential solution.

PROBLEMS

The problem that today's Autonomous vehicles faces comes from the way they detect and respond to situations.

Autonomous vehicles uses radar, LIDAR and cameras. All these detection methods have one common cons which is their detection range which is only about 200m. this reduces the situational awareness of the AI and hinder is making quick
and right decisions. The following points are:

1. Poor situational awareness
2. Limited visibility
3. Inefficient
4. Delayed emergency response
5. Low signal optimization
6. Lost of potential for AI

DESCRIPTION

The AVDSL (Autonomous Vehicle Data Sharing Link) allows other Vehicles, pedestrians, Cyclists, emergency vehicles, public transport and government infrastructures like traffic light to provide a secure and structured transfer of important data.

This warns the Autonomous system ahead of time thus improving response.

1. Enhanced Road Safety:

   Problem: Traditional vehicles lack real-time awareness of their surroundings, leading to accidents and collisions.

   Solution: V2X enables vehicles to communicate with each other, sharing information about their speed, position, and status. This helps in predicting and preventing accidents by providing advanced warning to drivers.

2. Reduced Traffic Congestion:

   Problem: Inefficient traffic flow and congestion lead to delays and increased travel times.

   Solution: V2X technology allows vehicles to share information about traffic conditions, helping to optimize traffic flow and reduce congestion. It enables dynamic route planning for drivers based on real-time data.

3. Improved Emergency Response:

   Problem: Emergency services often face challenges in reaching accident scenes quickly and efficiently.

Solution: V2X facilitates communication between vehicles and emergency services, allowing for faster response times and improved coordination during accidents or emergencies.

4. Pedestrian and Cyclist Safety:

   Problem: Pedestrians and cyclists may not always be visible to drivers, leading to accidents.

   Solution: V2X extends communication to pedestrians and cyclists, allowing vehicles to detect their presence and warn drivers. This enhances safety for vulnerable road users.

5. Mitigation of Blind Spot Risks:

   Problem: Drivers may not always be aware of vehicles in their blind spots, leading to potential collisions.

   Solution: V2X enables vehicles to exchange information about their positions, helping drivers be aware of vehicles in their blind spots and reducing the risk of accidents.

6. Efficient Parking Management:

   Problem: Finding parking spaces in urban areas can be time-consuming and frustrating.

   Solution: V2X facilitates the sharing of information about available parking spaces, helping drivers locate parking efficiently and reducing traffic congestion.

7. Environmental Impact Reduction:

   Problem: Inefficient traffic flow contributes to increased fuel consumption and emissions.

   Solution: V2X can optimize traffic patterns, reducing stop-and-go traffic and improving overall fuel efficiency, thus lowering the environmental impact.

8. Software Updates:

   Problem: Risk of cyber attacks, which could halt the entire network and affect cars.

   Solution: Over-the-air software updates allow for remote installation of new features, bug fixes, and improvements without requiring physical access to the vehicle

Steps:

i. Start: Initiate data sharing.
ii. Data Collection: Vehicles gather location,speed, and status.
iii. Wireless Transmission: Transmit data to external networks.
iv. Data Processing: Analyze and process data on the network.
v. Traffic Management: Utilize processed data for real-time traffic updates.
vi. Feedback to Vehicles: Send traffic updates back to vehicles.
vii. Remote Diagnostics: Transmit vehicle health data to service centers.
viii. End: Conclude the flowchart, completing the data sharing process.

FLOWCHART

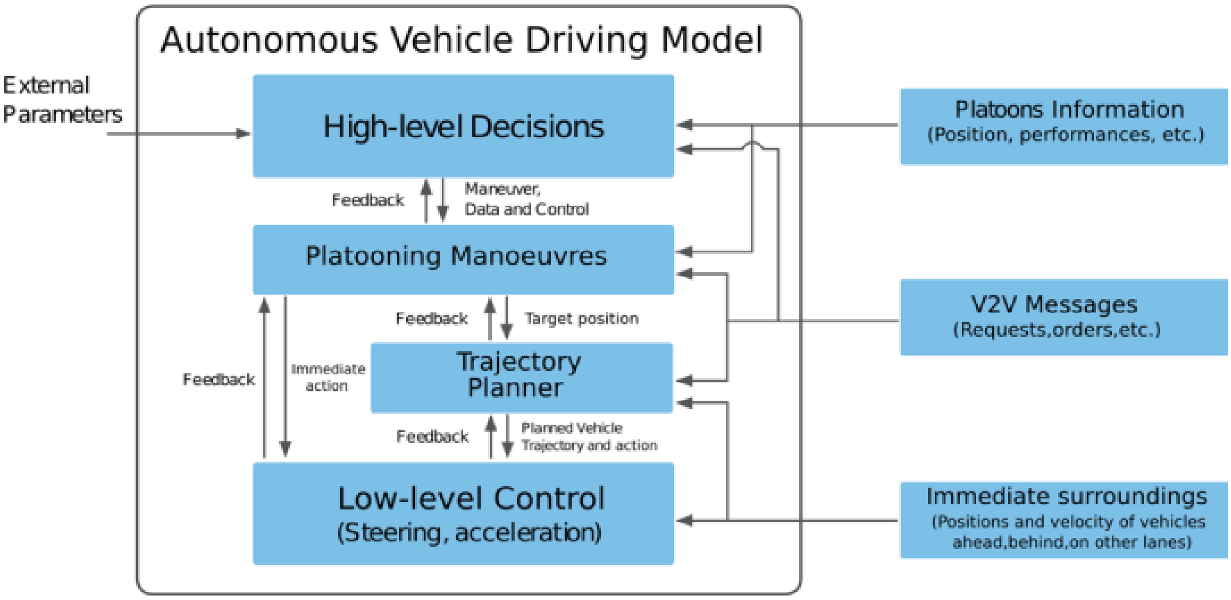


FIGURE 2

POTENTIAL PROBLEM

The primary potential issue in this technology is the risk of cyber attacks, which could halt the entire network and affect cars. Imagine a day without your mobile phone or internet connection – it's a real concern.

Consider the consequences if a network attack occurs, leading to the collapse of the entire transport industry. There is a risk of someone gaining control of your vehicle.

WORKING

Definition:

The working of V2X (Vehicle-to-Everything) communication involves vehicles exchanging information with each other and with various elements in their environment.

- **Communication Protocols:**

V2X communication relies on standardized protocols to ensure interoperability between different vehicles and infrastructure. Dedicated short-range communication (DSRC) and cellular communication (C-V2X) are common protocols used in V2X systems.

- **V2V Communication (Vehicle-to-Vehicle):**

Vehicles equipped with V2X technology can communicate directly with nearby vehicles. They exchange information such as speed, position, acceleration, and status. This real-time data sharing enables enhanced situational awareness.

- **V2I Communication (Vehicle-to-Infrastructure):**

V2I communication involves interactions between vehicles and roadside infrastructure such as traffic lights, road signs, and smart intersections. Vehicles receive information about traffic conditions, signal timings, and potential hazards, optimizing their route planning.

- **V2P Communication (Vehicle-to-Pedestrian):**

V2P communication extends the communication network to include pedestrians.A vehicle equipped with V2X technology can detect pedestrians carrying connected devices or using dedicated infrastructure, provides warning to drivers.

- **V2C Communication (Vehicle-to-Cyclist):**

Similar to V2P, V2C communication involves interactions between vehicles and cyclists. V2X-equipped vehicles can detect the presence of cyclists and vice versa, enhancing safety on the road.

- **V2N Communication (Vehicle-to-Network):**

Vehicle-to-network (V2N) communication involves the exchange of real-time data between vehicles and external networks. This enables improved traffic management, remote diagnostics, over-the-air software updates, connected services, and enhances safety applications. V2N facilitates information sharing for optimized routes, traffic flow, and seamless integration of digital services, contributing to the evolution of intelligent transportation systems.

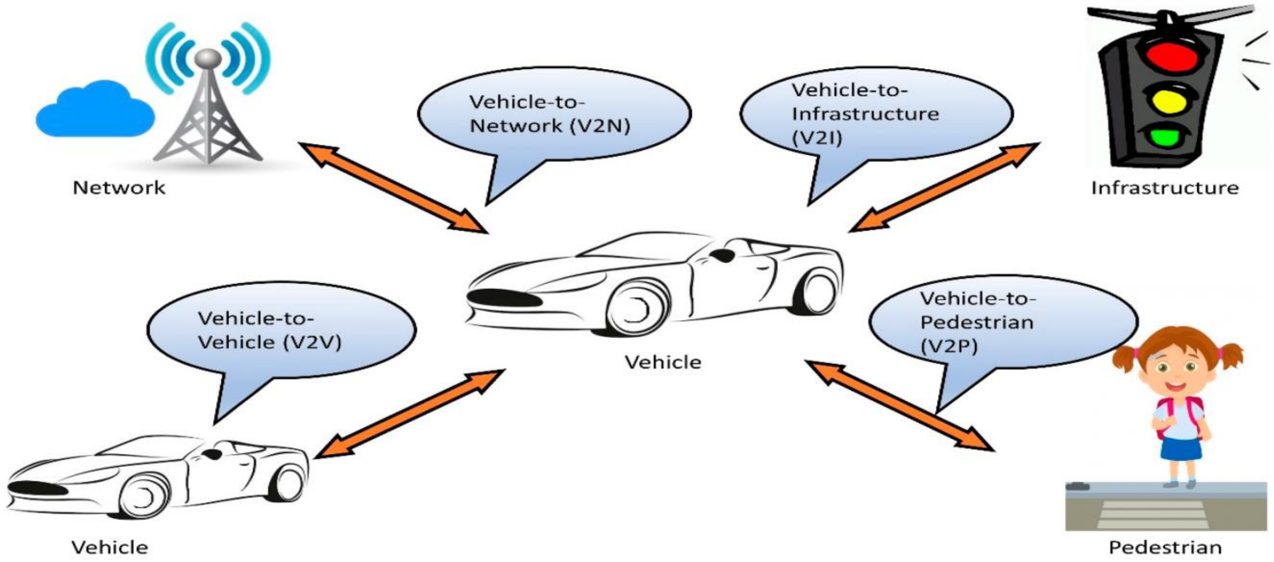


FIGURE 3

- **Data Fusion and Processing:**

Vehicles equipped with V2X technology utilize onboard sensors (such as cameras, radar, and LIDAR) to collect data about the surrounding environment. This data is fused with information received through V2X communication to create a comprehensive understanding of the road conditions.

- **Security and Privacy Measures:**

V2X systems incorporate security measures to protect the exchanged data from unauthorized access or manipulation. Encryption and authentication protocols are implemented to ensure the integrity and privacy of the communication.

- **Safety Applications:**

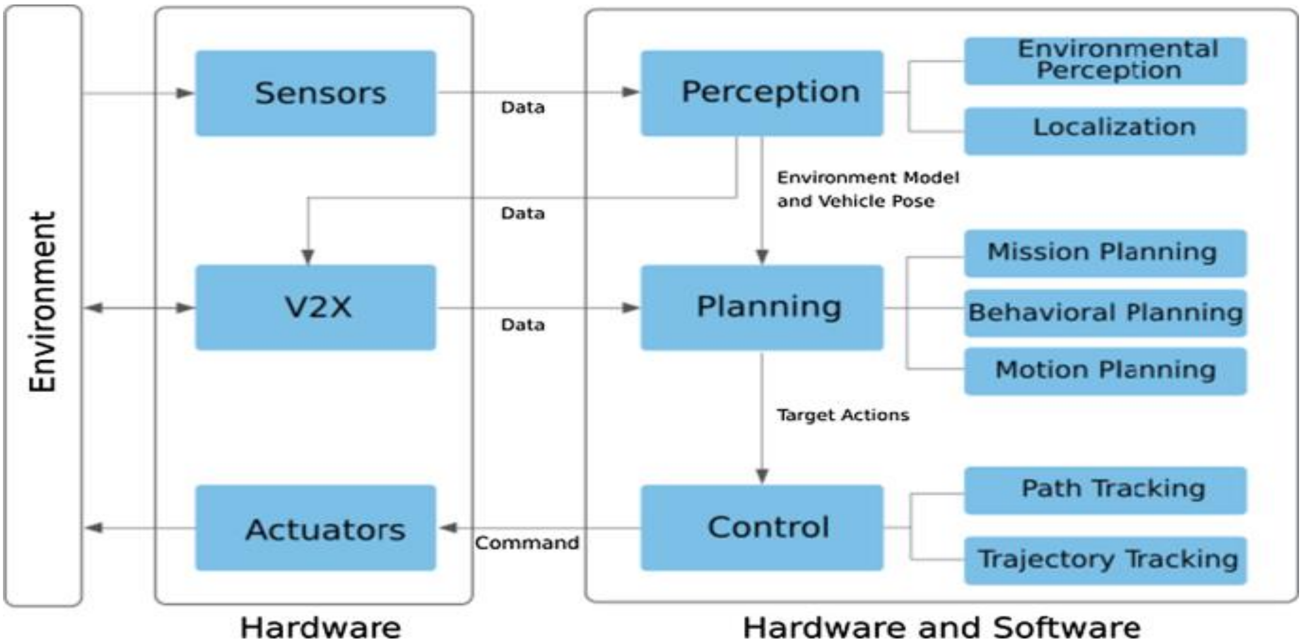
V2X enables the implementation of various safety applications, such as collision avoidance, intersection assistance, and emergency vehicle warnings. These applications use the shared information to enhance overall road safety.

- **Scalability and Future Applications:**

V2X systems are designed to be scalable, allowing for integration with emerging technologies. As the transportation ecosystem evolves, V2X communication lays the groundwork for the deployment of connected and autonomous vehicles.

- **Regulatory Standards:**

V2X technology adheres to regulatory standards set by transportation authorities to ensure consistency and compatibility across different vehicles and infrastructure components. In summary, V2X communication creates a dynamic and connected transportation environment by facilitating the exchange of real-time information among vehicles, infrastructure etc.,



HARDWARE COMPONENTS

1. SENSORS

LiDAR (Light Detection and Ranging): LiDAR sensors use laser light to measure distances and create detailed, high-resolution maps of the environment. This technology is crucial for autonomous vehicles as it provides a 3D representation of the surroundings, helping the vehicle understand the terrain and obstacles.

Radar (Radio Detection and Ranging): Radar sensors use radio waves to detect objects and determine their distance, speed, and direction. In autonomous vehicles, radar sensors contribute to the perception system, helping the vehicle sense and react to the movement of other objects on the road.

Cameras: Cameras are essential for capturing visual data. They play a vital role in image recognition and analysis, allowing the vehicle to identify and understand objects, traffic signs, pedestrians, and other critical elements in its environment.

Ultrasonic Sensors: These sensors use sound waves with frequencies higher than the human audible range to detect objects in close proximity. Ultrasonic sensors are often used for short-range object detection, especially during low-speed maneuvers like parking.

2. GPS (Global Positioning System):

GPS is a satellite-based navigation system that provides accurate positioning information, allowing the vehicle to determine its location, speed, and direction. GPS is crucial for navigation and can be integrated with other sensor data for more precise localization.

3. CONNECTIVITY HARDWARE

Communication Modules: These modules facilitate communication between vehicles (V2V) and between vehicles and infrastructure (V2I). V2V communication allows vehicles to share information such as speed, position, and status, enhancing overall road safety. V2I communication enables interaction between vehicles and the surrounding infrastructure, such as traffic lights and road signs, contributing to more efficient and coordinated traffic flow.

4. IMU (Inertial Measurement Unit):

An IMU is a sensor package that typically includes accelerometers, gyroscopes, and sometimes magnetometers. It measures and reports specific force (acceleration), angular rate (rotation), and, in some cases, the magnetic field. The data from the IMU contributes to the vehicle's understanding of its own motion and orientation, aiding in navigation and control systems.

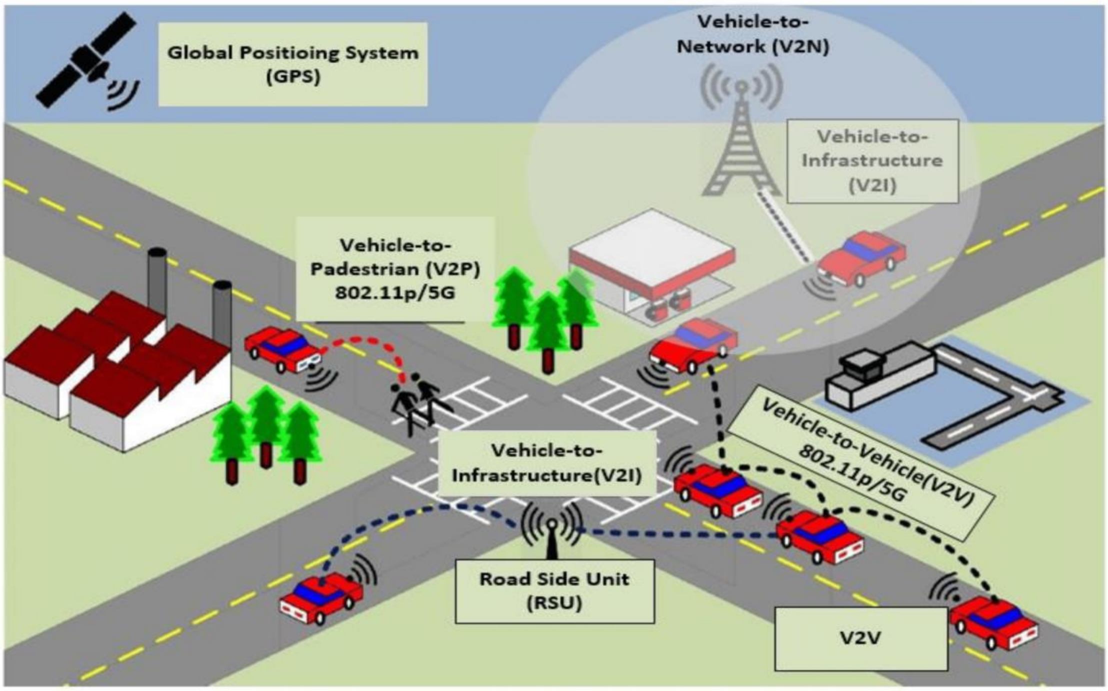


FIGURE 4

SOFTWARE COMPONENTS

1. Object Detection and Recognition:

Object Identification: Utilizes computer vision algorithms to identify and classify objects in the vehicle's surroundings. This involves recognizing and categorizing pedestrians, vehicles, road signs, and other relevant elements for safe navigation.

2. Localization:

SLAM (Simultaneous Localization and Mapping): SLAM algorithms enable the vehicle to create a real-time map of its environment while simultaneously determining its own position within that map. This is crucial for accurate navigation, especially in dynamic and unfamiliar surroundings.

3. Path Planning:

Algorithms: Path planning algorithms evaluate the information from sensors, localization, and maps to determine the optimal path for the vehicle to reach its destination. They consider factors such as traffic conditions, obstacles, and safety constraints to plan a trajectory that ensures efficient and safe navigation.

4. Control System:

PID Controllers (Proportional-Integral-Derivative): PID controllers are used to regulate and fine-tune the vehicle's movements. They ensure precise control over parameters such as steering, acceleration, and braking, helping the vehicle follow the planned path while adapting to dynamic environmental conditions.

5. Communication Protocols:

V2V and V2I Protocols: Standardized communication protocols facilitate seamless interaction between vehicles (V2V) and between vehicles and infrastructure (V2I). Common protocols ensure interoperability and enable the exchange of critical information such as traffic updates, road conditions, and potential hazards.

6. Cybersecurity Measures:

Security Software: Cybersecurity measures protect the vehicle's systems from potential cyber threats, unauthorized access, and data manipulation. This includes encryption, firewalls, intrusion detection systems, and regular software updates to patch vulnerabilities and ensure the overall safety and integrity of the vehicle's software.

7. Human-Machine Interface (HMI):

User Interfaces: HMI components provide a means for user interaction and feedback. This is especially important during testing and emergencies, allowing human operators to monitor the vehicle's status, intervene when necessary, and receive alerts or warnings. Clear and intuitive interfaces enhance the overall user experience and contribute to the safe deployment of autonomous vehicles.

Building autonomous vehicles requires a seamless integration of these hardware and software components, along with rigorous testing and validation to ensure safety and reliability in various driving conditions.

AI DRIVERS IN CURRENT WORLD

AI in cars helps to gain advantages such as enhanced safety features, autonomous driving capabilities, and continuous software updates.

Tesla:

Tesla excels with its Autopilot system and over-the-air updates.

Baidu:

Baidu focuses on the Apollo platform for autonomous driving,

Waymo:

Waymo pioneers in self-driving technology

Aurora:

Aurora specializes in autonomous cars.

Nauto:

Nauto prioritizes AI for driver monitoring and fleet safety.

CONCLUSION:

Thus, the integration of AI enhances these electric vehicles' performance, efficiency, and overall user experience, contributing to the evolution of smart and sustainable transportation.

REFERENCE:

[1] Jafarnejad, S., Codeca, L., Bronzi, W., Frank, R. and Engel, T., “A Car Hacking Experiment: When Connectivity meets Vulnerability,” 2015 IEEE Globecom Workshops (GC Wkshps), San Diego, CA, USA, 2015, pp. 1-6.

[2] Coppola, R. and Morisio, M., “Connected Car: technologies, issues, future trends,” ACM Computing Surveys (CSUR), vol. 49, no. 3, 2016, Art. no. 46.

[3] “Driverless Cars- Robots Are Taking the Wheel,” 2018. [Online]. Available: https://www.bloomberg.com/quicktake/driverless-cars.

[4] Driggs-Campbell, K. R., Shia, V. and Bajcsy, R., “Decisions for autonomous vehicles: integrating sensors, communication, and control,” Proceedings of the 3rd international conference on High confidence networked systems, 2014, pp. 59-60.

[5] “Google's Self-Driving Car Project Is Losing Out to Rivals,” 2016. [Online]. Available: https://www.bloomberg.com/news/articles/2016-09-12/google-car-project-loses-leaders-and-advantage-as-rivals-gain.

[6] “The Benefits and Challenges of Autonomous Vehicles,” 2017. [Online]. Available: http://www.engineering.com/DesignerEdge/DesignerEdgeArticles/ArticleID/12838/The-Benefits-and-Challenges-of-Autonomous-Vehicles.aspx.